



THE JOURNAL OF INTERDISCIPLINARY NETWORKS

**Special Issue on Interdisciplinary Research
and Development in ASEAN Universities**

Volume 2 (Special Issue), Number 2, July-December 2013

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Editor's Note

The Journal of Interdisciplinary Networks (JIN) special issue#1 is a collection of papers from the International Conference on Interdisciplinary Research and Development in ASEAN Universities on August 8-10, 2013 hosted by Maejo University and several academic institutions. The conference aims to present latest research outcomes from global researchers to share with those from ASEAN Universities under the theme ***Global Education: Building Bridges across ASEAN***. The content includes inter-disciplines among applied agriculture, organic and green, plant and animal applications, apiculture and apitherapy, health and wellness, functional foods and nutraceutical, natural science, global and environmental sciences, climate changes engineering and technology, applied education, socioeconomics, business and management, and information science and technology.

We hope that this special issue will draw attention of all peers. Our sincere appreciation is extended to all the authors and reviewers who provide great efforts to our special collection of JIN.

Siriwat Wongsiri
Guest Editor
Niwooti Whangchai and Somkiat Jaturonglumlert
Associate Editors

KEYNOTE LECTURES

Inter- Disciplinary Subjects and Common Liberal Arts Studies

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Abstract

Major social problems at national, regional and international levels in general become complex and interrelated, for examples fossil fuel utilizations, global warming, water management. To solve such problems, inter-disciplinary knowledge is required. During the last three decades, leading universities in developed regions such as Australia, EU and USA have continuously developed new inter-disciplinary groups for research and teaching.

A multi-disciplinary subject is in general a combination of two main academic disciplines in the same group of disciplines such as bio-chemistry, geo-physics in natural science; mechatronics, naval architecture in engineering. An inter-disciplinary subject is a combination of two or more main academic disciplines across two or more groups of academic disciplines, such as bio-engineering, built environment, digital humanities, human biological science.

About 25 years ago, ASEAN identified five inter-disciplinary technologies for research cooperation including bio-technology, energy technology, environmental technology, information technology and materials technology. Energy technology is a good example of an inter-disciplinary subject. To utilize bio-energy resources, impacts on economics, environment, food and water have to be studied.

Teaching and research in inter-disciplinary subjects require common basic knowledge in arts and science. Liberal arts colleges, colleges of arts/letters and science normally require common arts and science studies in the first two years of bachelor degree programs. With broad basic knowledge in arts and science, students will make better decisions for selection of suitable major disciplines in the last two years of their studies.

Cross-Disciplines for Agricultural Development in SEARCA

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and Henry M. Custodio

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Abstract

A convergence of interrelated economic, environmental and social drivers is shifting the landscape within which university-based (and other institutions') knowledge generation takes place. The shifting landscape calls for the development and broader application of research practices that are characterized as problem-focused, contextualized, participatory/consultative and which take deliberate directions. These are the features of cross-disciplinary research. Interdisciplinary, concerns the transfer of methods from one discipline to another, allowing research to spill over disciplinary boundaries, but staying within the framework of disciplinary research. Transdisciplinary, concerns that which is at once between the disciplines, across the different disciplines, and beyond each individual discipline; goal is the understanding of the present world, of which one of the imperatives is the overarching unity of knowledge. There is high involvement of non-academic (e.g. target beneficiaries, LGUs, and the private sector) in transdisciplinary research. Beneficiaries and stakeholders are empowered to take part in the design and implementation of the project interventions.

Creating and fostering of research through the International Research Network Scheme of the Royal Golden Jubilee Ph.D. program

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TRF Senior Research Scholar (Biotechnology) Year 1997

Abstract

It has been well documented that successful research programs usually have to be multidisciplinary in nature and require extensive collaboration among researchers. The multidisciplinary and collaborative research programs can be achieved through effective operation of research networks. The Royal Golden Jubilee Ph.D. program (RGJ-Ph.D.) has been initiated since 1996 and at present, graduated over 2,000 Ph.D. with over 1,600 doctoral degree students in various stages of completion. The program has involved more than 1,400 Thai advisors and more than 2,500 international co-advisors in 40 different countries. RGJ program is known for her high standard achievements due mainly through the selections of high quality students and supervisors. The out-puts of RGJ program through research publications have been very outstanding with each graduate has been able to publish approximately 2 publications in peer-review scientific journals. One of the most striking achievements through this program has been success in continuing research collaborations and formation of research networks among Thai and oversea scientists. Recently, a new program named International Research Network (IRN) has been initiated based on the successful achievements of RGJ-Ph.D. program. Each IRN is composed of a group of Thai researchers working in collaboration with a group of oversea researchers on a very focused research topic. Once an IRN is established, the RGJ-Ph.D. program awards five Ph.D. fellowships per year for a period of five years to the network. Additional research supports such as research grants, post doctoral fellowships, and others for the IRN can be seeked from other research funding sources. Such long lasting collaboration through the IRN's will ensure the sustainability of the research programs and research achievements.

Renal injury and animal toxins

Visith Sitprija

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Abstract

Animal toxins are complex substances composing of enzymes, peptides, proteins and chemicals causing diverse clinical effects. As a highly vascularized organ consisting of vascular endothelium, vascular smooth muscle and epithelial cells, the kidney is most vulnerable to injury by toxins. Hemodynamic changes especially decreased renal blood flow and glomerular filtration rate are integral in renal injury. In this respect acute renal failure is common in toxin injury. Beside proinflammatory cytokines and vasoactive mediators in the inflammatory process which are well known causes of hemodynamic changes, toxins either enzymes or peptides can directly cause hemodynamic alteration through their effects on ion channels of the vascular endothelium, vascular smooth muscle and autonomic neurons. Coagulopathy, hemorrhage, hemolysis and rhabdomyolysis further compromise renal blood flow. Direct toxin injurious effects to renal tubular epithelium and vascular endothelium are also important insults. Immunologic mechanism plays a minor role in renal injury. Clinically, acute renal failure is often observed, especially in snake bites and insect stings. Pathologically, tubular necrosis is common in toxin injury. Other renal pathological changes include cortical necrosis, glomerulonephritis, vasculitis and interstitial nephritis. Effects of animal toxins on the renal epithelial ion channels are of physiological interest. Data from animal experiments include natriuresis, kaliuresis, hyponatriuria, hypokaliuria, glycosuria and hyperphosphaturia. Except hyperkalemia which is commonly observed, human clinical data on fluid and electrolyte changes are scanty and deserve more attention.

Taking research on transmission of vector-borne parasites from the lab to the field

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Abstract

Investigating the transmission mechanisms of human parasites is an important area of interdisciplinary research as detailed understanding can help in both the design and testing of new ways to prevent disease occurring. Progress in defining the transmission mechanism of malaria and leishmaniasis has not only helped to reveal interesting biology but has also informed the process of vector incrimination in the field. This has practical implications in understanding new outbreaks and foci of disease as well as the spread of disease in established areas. I will discuss various specific examples to show how both basic laboratory-based research on transmission mechanisms as well as field-based investigations on vectors and reservoir hosts are both necessary and mutually interdependent means of improving disease control in malaria and leishmaniasis, and by implication other vector-borne diseases. Effective control of these diseases will be dependent on effective cooperation between ASEAN universities and health ministries across national boundaries.

The History of Interdisciplinary Pharmacy Education in Thailand

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Abstract

The upcoming centennial anniversary of Thai pharmacy, December 8th, 2013 is regarded as one of the most important events in the Thai pharmacy history. This long remarkable history has led to the interesting development of pharmacy in Thailand.

Pharmacy education in Thailand was established on December 8th, 1913. At the beginning, the study duration based on the pharmacy curriculum used to be only a three-year study. It was later changed to four, five, and six year study in 1939, 1957 and 2008 respectively. Moreover, the pharmacy curriculum was transformed from pharmaceutical science to patient-oriented. The current curriculum also requires much greater professional practice than in the past. This also included knowledge and insights from many other areas apart from Pharmacy and therefore has become Pharmacy Interdisciplinary Study.

With concern to the real practice, the faculty of pharmacy is currently supported by both government and private sectors. It emphasizes patient oriented practice in various settings such as drug stores, hospitals (primary, secondary and tertiary), and so on. The pharmaceutical care approach has been significantly improved and smoothly synchronized with Thai culture both in terms of institution and home perspectives.

The latest Thai pharmacy's development is family practice pharmacy. All pharmacists must not only take good care of patients, but show great concern to the whole members of the family. Although pharmaceutical technology has remained as the most important area in the pharmacy industry, the significance of real practice pharmacy has greatly increased which would be more applicable and suitable for each different culture.

In order to honor and respect the prestige and long history of Thai pharmacy, there will be several grand centennial celebrations at the end of the year on December 8th, 2013.

Research Activities on Solar Thermal Applications in Thailand

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Abstract

In this paper, a review of activities on solar thermal applications and their implementations in Thailand was presented. Low and medium temperature heat from flat plate, evacuated tube solar collector and greenhouse as a source for thermal applications were considered.

The applications covered various techniques those generated heat for low and medium temperature hot water heatings for domestic use, hotel or hospital or other industrial heating processes; drying, distillation, cooling and other thermal applications. Recently, a concept of solar organic Rankine cycle for power generation was also introduced. Integration of various bodies of knowledge is necessary to generate new rooms of technologies and innovations those can solve the problems correctly. Moreover, solar energy technology is a negative carbon concept.

Keywords: Solar energy, Thermal energy, Heating and Cooling, Power generation

Frontier Concept for Unlimited Researches Using PANDA Ring Circuits

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Abstract

We propose the use of a small scale nonlinear optical device known as a PANDA ring to form the multi-disciplinary researches by light. The key concepts of this proposal are based on the following details: (i) device can constructed (fabricated) by nonlinear semiconducting material, (ii) device structure is a ring resonator with two side rings (a PANDA ring), and (iii) a commercial laser pointer is the input light source. To guarantee that this work can be the realistic ones, therefore, the device (PANDA ring circuit) structure is designed base on the practical device parameters, which can be fabricated and tested. After the design, the simulation results can be obtained by using the analytical solution or scientific programs for easy interpretations. By using the two well established programs (MATLAB and Opti-wave), we found that there are many interesting results that can be useful for multi-disciplinary studied and investigated. The proposed device structure dimension is within the micro-scale, which is useful in many applications. In this presentation, we will focus on few interesting works as following details: dark matter generation and detection, color soliton, 3D pixel for new display device, micro LINAC, optical capsule and drug delivery, atomic antenna, etc. In addition, the use of each small device to form the system can also be performed and discussed, for instance, for nanoscale communication, medical therapeutic applications, communication security, computer communication, atomic cellular automata, etc. This concept can also be available for large systems ranging from millimeter scale to universal scale, which can bring the long lasting researches and investigations, which will also be discussed in details.

Functional Food Trends in Rice Seedling Products

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Abstract

Functional food trends have been reported on health and wellness in recent years. Natural based extracts or products combination with particular ingredients are developed for their highest functions as well as most consumers gratified. Rice seedling, or young rice grass, is abundant and grow-able in most area in Thailand. An idea on rice seedling utilization for human consumption was initially created in 2009 and preliminary studies were conducted since then. With gratefully supportive grants from National Research Council of Thailand (NRCT) in 2011, the rice seedling was intensely studied. With a certain growing period and management, comparable essential amino acids to wheat grasses' are reported with antioxidant properties and polyphenols. In addition, *in vitro* studies on ion chelation showed stronger positive results to iron ions (Fe^{2+} , Fe^{3+}) than Cu^{2+} and Zn^{2+} , respectively. It potentially therefore could chelate excess iron ions in Thalassemia patients, forming complex substances, and removed them out from the bodies. Chances of liver disorder in the particular patients could be reduced as a consequence. More studies both in rat and human systems are needed to confirm the evidence especially doses of the plant extract. The rice seedling is now commercially processed to product varieties, i.e. dried rice seedling, rice seedling beverage, and rice seedling extracts. Under certain processes, the rice seedling extract is rich in antioxidants with free amino acids available. The products are one of the functional food trends from Thai plant in this year.

Keywords: Rice seedling, Rice grass, Beverage, Ion chelation, Monocotyledon

A Strategic Model of Fostering Interdisciplinary and Transdisciplinary Research

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Abstract

Since every researcher belongs to a distinct research discipline and explores specified problems within their domain, it is possible that a scholar from one discipline may have difficulty in understanding research articles from other disciplines. In addition, discipline oriented research is also considered remote from societal needs, because researchers in a discipline split whole problems into disciplinary chunks and produce fragmented solutions to the society. Interdisciplinary and transdisciplinary research can be one of the ways to overcome the compartmentalization of scientific research and development as well as the narrowness of disciplines; and to address a problem in its real form without disciplinary restrictions. Most problems of the real world can be addressed effectively by not only interdisciplinary research in which scholars from more than one discipline participate but also transdisciplinary studies in which researchers from different disciplines collaborate with those outside of science. This article investigates (a) what kinds of benefits scientific communities and the society can have from interdisciplinary and transdisciplinary research, (b) what factors have influence on effective interdisciplinary and transdisciplinary research, and (c) what the strategic model to foster interdisciplinary and transdisciplinary research is.

Closing knowledge-action gaps in adaptation to climate change: a critical review of initiatives in the Asia-Pacific

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Abstract

Major knowledge-action gaps remain with respect to adaptation, despite a rapidly growing body of research on potential impacts and vulnerabilities to climate change and increasing policy attention to mainstreaming adaptation. Knowledge-action gaps can arise because knowledge is missing, inaccessible or unused and therefore action is not taken or actions taken are uninformed. Past efforts at closing knowledge-action gaps in the Asia-Pacific include convening dialogues, conducting assessments, funding research programs, running training courses, launching information campaigns, creating information systems, establishing coordination offices and launching pilot actions. This study critically reviews a representative set of such initiatives and finds the results have been mixed. Recurrent challenges relate to the specific characteristics of climate change that make communication and identifying incentives difficult and an over-simplified view of the relationships between science and policy. Promising strategies are identified to help narrow knowledge-action gaps.

Keywords: Adaptation, Climate change, Knowledge management, Science-policy, Asia-Pacific

Interdisciplinary Degree Programs in ASEANPlus Six

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Abstract

Most problems in national developments nowadays have to be solved by using interdisciplinary approach or using two or more fields of specialization. Therefore, many educational institutions all over the world including ASEAN have established or are in the process of establishing interdisciplinary degree programs. This paper presents a survey of interdisciplinary degree programs in the ten ASEAN countries, namely, Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam. Since six other countries have also been joining ASEAN activities, interdisciplinary degree programs in Australia, China, India, Japan, New Zealand, and South Korea are presented in this paper as well.

SCIENCE AND TECHNOLOGY

Preliminary Study of “Tikod Amo” (*Spondylus sp.*) on its Potential as an Oyster Culture Species

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Abstract: “Tikod Amo” (TA) is oyster is the Genus *Spondylus* known locally in Lianga Bay in Surigao del Sur. Its high demand in the market resulted in rampant collection that decreased its population in Barobo Coastal Waters. To mitigate the impact of the activity, the potential of “Tikod Amo” as an oyster culture species was studied to generate its culture technology. The biology of the oyster; the physico-chemical parameters of its habitat; the plankton communities; the spatfall (spawning season) the effective substrate materials for the TA spats collection; the survival rate, growth and yield of transplanted TA spats; the most effective culture system and method including the socio-economic profile of TA gatherers; market landing and demand of “Tikod Amo” were determined. High diversity of planktons which was positively correlated to the growth and yield of “Tikod Amo” was observed. The physico-chemical parameters favorable for shellfish culture such as temperature (27.7°C), DO (9.0 mg/L), TSS (26.0 mg/L), water transparency (5.7 m), pH (8.2), water movement (4 cm/s), bottom depth (6.6 m), salinity (31.9 ppt), ammonia nitrogen (0.46 mg/L), nitrate (0.22 mg/L) and phosphorous (0.39 mg/L) were noted. Spatfall or spawning period was observed from September to October. The most effective collector was the tubular net that collected the highest density of TA spats (142 spats/m²). The monthly growth increment of transplanted TA spats was 0.8 cm after nine months from transplanting with an average survival rate of 79% and average yield of 6.3 grams per shell meat. “Tikod Amo” oyster species can be cultured however, though there is no significant difference on the growth and yield of TA between different culture systems and methods used in the study, the bottom culture method is recommended since it is the most economical.

Keywords: Tikod Amo, *Spondylus*, Barobo, Spats

INRODUCTION

Oyster culture in the Philippines is widely practiced by small producers. CARAGA region has sites and species of oyster potential for culture, however, no attempts were made to develop oyster culture in the region. “Tikod Amo” (TA) is an oyster under the genus *Spondylus* known locally in Barobo Coastal waters in Lianga Bay in the province of Surigao del Sur. Due to its palatable taste, the demand remarkably increased irrespective of its high price in the market, which resulted to rampant collection that consequently decreased the population of TA species in Barobo Coastal Waters. In order mitigate the possible direct impact of the activity to the economics and environmental well being of the coastal area of Barobo and Lianga Bay, the potential of “Tikod Amo” as an oyster culture species was studied to generate its culture technology.

This study attempts to generate culture technology of *Spondylus* sp. Aquaculture of TA offers a great opportunity for learning about its biology and may produce the key to restoring depleted areas. The result of the study will develop not only the taxonomy of the oyster but establish the proof that TA species can be cultured using specific methods and systems that could be used as a source of revenue for the shellfish gleaners not only in the municipality of Barobo but in the whole country as well. Consequently, it will rehabilitate the environmental capability of the marine waters that will impact the whole marine ecosystem.

In addition this study supports the national and international objectives of addressing poverty by providing communities with sustainable livelihood that will help them support their families' basic needs. It will also strengthen the wise utilization of coastal and marine resources for sustainable area development and complement the existing Coastal Resource Management Plan of the municipality and of the entire country in general.

MATERIALS AND METHODS

Determination of Biological Components

Biological components of the study included the identification of the anatomy of TA oyster and the spatial and temporal distribution of plankton communities in Lianga bay.

Collection of "Tikod Amo" Samples for Species Identification

Samples of TA were purposively collected from sampling stations inside the Coastal-Based Resource Management Project (CBRMP) Fish Sanctuary and. Collection of oyster samples was conducted at the first month of the project's implementation. Samples were identified through the physical characteristics of its shell and meat.

Plankton Samples Collection and Analysis

Phytoplankton and zooplankton samples were collected using plankton net in four (4) sampling stations in Barobo Coastal Waters once a month for one (1) year period to cover the dry and wet seasons from the month of February 2009 to January 2010. Samples collected were identified up to species level using the guide illustrations of Yamaji (1982), Todd and Laverack (1991) and Boltovsky (1999).

Determination of Physicochemical Parameters

Sampling period of the physico-chemical parameters collection was done once a month for one (1) year period to cover the dry and wet seasons. Collection of samples was daytime (7 am to 5pm) in four (4) identified sampling stations. The following physico-chemical characteristics were determined:

Water temperature was determined in situ using a field thermometer. The thermometer was dipped for 15 seconds into the water sample that was collected from a depth of five (5) meters using the water sampler. Water transparency was determined using a Secchi disc painted alternately with black and white. Salinity was estimated *in situ* using a refractometer (ATAGO). Total suspended solids were measured using the gravitational filtration set-up while Winkler's titration method was used in the estimation of dissolved oxygen as outlined by Grasshoff et al. (1993). pH was measured using a portable pH meter (Multiline F/SET-3). For dissolved reactive phosphate and nitrate and ammonia nitrogen in water were estimated adopting the methods given by Menzel and Corwin (1965), Christopher *et al.* (1977) and Strickland and Parsons (1972). Surface water movement (based on current

speed and direction) was measured using an improvised weighted current drogue. Bottom type of the sampling sites was determined through direct observation by diving into the bottom during high and low tides. The depth was measured using a rope that was towed into the bottom. The monthly amount of rainfall and the number of rainy days in a month was obtained from the data of PAG-ASA in Hinatuan, Surigao del Sur.

Cultch and Culture Materials

Oyster shells, bamboo poles and tabular nets were used as cultch materials for spat collection that were randomly distributed in longline and raft. The prepared systems were suspended in the water at the time when spatfall was positive. The rafts and longlines were prepared as culture methods that served as holders of the cultch materials during the spat collection and growing of oyster.

Determination of Spatfall

The methods for predicting spatfall were tested on the field with spat collection trials in order to know the right time to suspend the cultch materials.

The following methods of predicting spatfall were tested in monthly basis namely: the gonad maturity surveys; eyed larvae counts; and observations of spatfall on locally occurring substrate.

Collection of Spats

Cultch materials prepared were randomly suspended in water to two (2) different depths such two meters (2); and five (5) meters during high tide to capture the vertical distribution of the spats. The suspension of the cultch materials was done when two out of three field tested methods were positive as indicator of spatfall.

Nursing of Spats

Spats collected from tabular net cultch materials were removed and were allowed to grow in trays lined with plastic mesh up to 3.0 cm size before transferring to grow-out trays.

Grow-out Culture

The rafts and longlines used in the collection of spats were utilized for the grow-out culture. The spat removed from netlon cultch materials that were grown up to 3cm size in plastic trays during the nursing period were transferred to plastic mesh bags with a density of 50 oysters per bag for the experimental treatments (Off-bottom culture) and control treatment (Bottom culture). The control treatment was instituted following the practice of growing TA oyster done by some gleaners directly on the bottom following the same container and density of TA oysters as in experimental treatments. The survival rate of the transplanted oyster was determined from transplanting to harvesting. The oysters grown in plastic mesh bags were measured monthly in terms of length until harvest. Then the meat was extracted and weighed in grams.

RESULTS AND DISCUSSION

Anatomical and other Biological Features of “Tikod Amo”

Tikod Amo is a bivalve oyster under the family of Spondylidae, and included within the superfamily Pectinacea of the order Pterioida in accordance with the most recent classification of the Bivalvia (Newell & Newell 1963). The local name was adopted due to

the shape of the adductor muscle that resembles a heel of a monkey. Observation further showed that there are five different colors of TA gonads that will be confirmed through further observation on the maturity of its reproductive organs (Figure 2a - Figure 2e).



Figure 2 a-e Five different colors of the internal parts of Tikod Amo (Figure 2a, white; Figure 2b, pink; Figure 2c, red; Figure 2d, yellow; and Figure 2e, orange).

On the other hand, based on the related study of the molecular biology of TA done in UPLB by Baay, M.O (2009), it was found out that there were five percent difference of the DNA of TA from the DNA of *Spondylus squamosos*. This difference will be further verified so that TA could be considered as new species of *Spondylus*.

Physicochemical Parameters

The annual means of physicochemical parameters of the seawater in the area are favorable for shellfish culture such as temperature (27.7⁰C), DO (9.0mg/L), TSS (26.0 mg/L), water transparency (5.7 m), pH (8.2), water movement (4cm/s), bottom depth (6.6 m), salinity (31.9 ppt), ammonia nitrogen (0.46 mg/L), nitrate (0.22 mg/L) and phosphorous (0.39 mg/L)(Figure 4). The physicochemical parameters determined were considered as basis for the culture of *Spondylus sp.* in other coastal waters.

Plankton Species Diversity

A total of two-hundred-forty-five (245) phytoplankton taxa belonging to sixty-one (61) genera, twenty-five (25) families and five (5) phyla of five (5) major groups. While there were one hundred-twenty-eight (128) zooplankton taxa belonging to ninety-one (91) genera and four orders were observed in four (4) sampling stations from the month of February 2009 to January 2010 (Table 1). Phytoplankton and zooplankton diversities were high in Barobo Coastal waters that maybe attributed by the favorable physicochemical parameters. The high abundance of plankton species could be one of the good food sources for filter feeders like *Spondylus sp.*

Table 1 Annual physicochemical parameters of Barobo Coastal Water.

Physicochemical Parameters	Annual Mean Values
Temperature	27.65 ⁰ C
Dissolved Oxygen (DO)	9.03 mg/L
Total Suspended Solids (TSS)	25.96 mg/L
Water Transparency	5.74 m
pH	8.19
Water Movement	4.04 cm/s
Depth	6.55 m
Salinity	31.88 ppt
Ammonia Nitrogen	0.46 mg/L
Nitrate	0.22 mg/L
Phosphorous	0.39 mg/L

Table 2 Diversity index of planktons in Barobo Coastal Waters.

	Zooplankton	Phytoplankton
Taxa_S	128	245
Individuals	24271	58597
Dominance_D	0.008046	0.006256
Shannon_H	4.84	5.239
Evenness_e^H/S	0.9876	0.7692

Spatfall (Spawning Season) of “Tikod Amo” Oyster

The highest percentage (85-90%) of matured gonads of TA oysters was noted in the month of September in all sampling stations (Figure 5a). This means that the gonad of TA oyster mostly matured in the month of September that indicates spatfall or spawning period. Eyed larvae of TA oysters were highest in the month October (132 individuals) (Figure 5b). While spatfall based on the size of the spats, was observed in the months of May, last week of October and first week of November (Figure 5c). Though spats on natural substrate with size less than 2 mm were observed in the month of May, the other indicators revealed that spatfall is more convincing in the month of September.

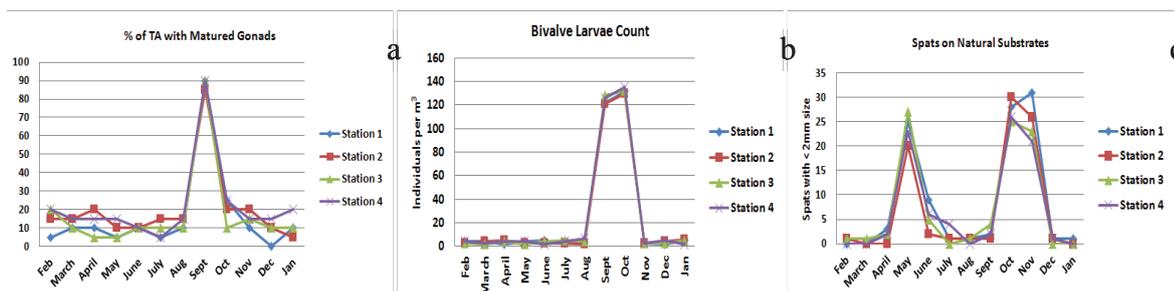


Figure 5a-c % TA with matured Gonads (a); Bivalve Larvae count (b); Spats on Substrate Natural (c)

However as noted, spats of “Tikod Amo” only attached on silted and fouled natural substrates (fish pens, empty shells and submerged rocks) thus cultch materials were submerged to water earlier than spatfall period to allow siltation and befouling on the collectors for favorable spats attachment. Accordingly, spatfall determination is no longer needed for the timing of the collection of TA spats.

Density of Spats Collected in Different Substrate Materials

Spat collection offers the advantages of being a relatively inexpensive and simple way to obtain spat in the wild. Spat collection occurs when any material designed to attract spat settlement is placed in the water and tended. Properly designed spat collectors also protect the small spat while they grow. They are harvested when they reach the desired size (Haws, 1999). In this study, netlon, bamboo poles and empty shells were used as TA spat collectors suspended in water in 5 meters and 2 meters depths in rafts and longlines instituted in four sampling stations. Results revealed that netlon had the highest mean density of spats collected (113 spats/m²) while bamboo poles showed the lowest spat density of only 0.16 spat/m² (Figure 6).

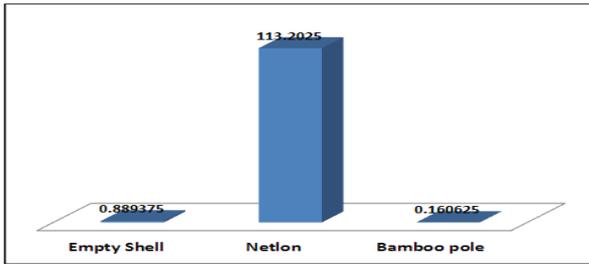


Figure 6 Mean Density of TA spats (spats/m²) collected using different substrate materials.

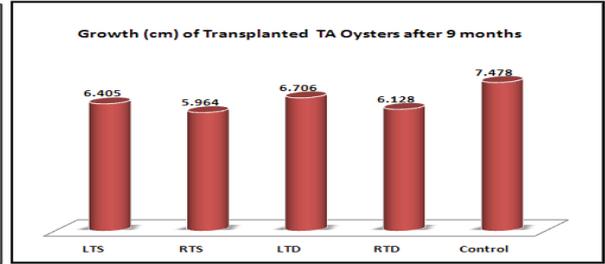


Figure 7 Growth gained of the transplanted TA oysters after 9 months grow-out period in different treatments

Monthly Growth Increment of Transplanted “Tikod Amo” Oyster

The transplanted TA oyster samples ranged in length from 9.8 cm to 10.7 cm with an average of 10.5 cm after 9 months grow-out period with a monthly growth ranging 0.18 cm.- 1.55 cm. The length gained of transplanted TA oyster after 9 months grow-out period ranged from 5.9 cm to 7.9 cm. (Figure 7). Results also revealed that the highest mean of growth increment was noted in control treatment (bottom culture). The high growth increment of the oysters is probably because the bottom culture has lesser disturbance from wave movements than hanging type.

Survival Rate of Grown “Tikod Amo”

The cumulative survival rates of the transplanted TA deployed using different treatments were determined after nine months of grow-out in the field. Results in Figure 8 show that the highest mean of survival rate (92.7%) in the last month of grow-out culture is seen in the control treatment with a range of 90.8 % to 96.8% while the lowest mean of the rate of survival (68.9%) is in the LTS treatment ranging 58.4 % to 82.4 %. The high survival rate in control treatment was due to the less disturbed condition of the transplanted TA oyster in the bottom. Apparently, densities of TA in nine months grow-out period did not reach a stress level thus thinning were not applied.

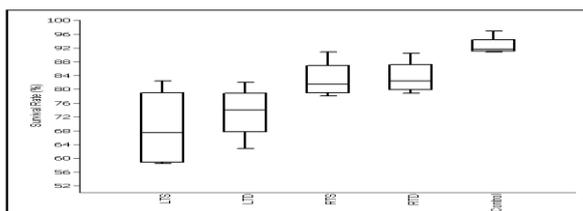


Figure 8 Means of the Survival Rates of transplanted TA oysters after 9 months grow-out period in different treatments.



Figure 9 Yield of transplanted TA after nine months grow-out period in different treatments.

Yield of “Tikod Amo”

Yield of transplanted TA oysters in this study was determined based on the weight of the meat. Changes in the meat content of an oyster are important to the grower for it greatly affects the meat yield and therefore the financial return. However, the productivity of TA was authenticated through the oyster shell and meat production or in other words its growth and yield.

The weight of the meat of transplanted TA oyster ranged 5.5 grams to 8.06 averaging 7.06 grams. Results in Figure 9 show that the highest mean yield (7.06 grams) obtained by

the transplanted TA was noted in Control treatment (Bottom culture). This is also the most economical method with an ROI 75.3%.

CONCLUSION

The diversity of plankton in the area is high, however there were toxic species noted; the physico-chemical parameters of the area is favorable for shellfish culture; spatfall was observed from September to October however, timing of spat collection is considered not applicable for TA because spats will not attach to clean collector/substrate; tubular net collected the highest density of TA spats while bamboo and empty shells collected very less spat density; the mean of the monthly growth increment of transplanted TA spats is 0.8 cm.; TA can be harvested after nine months from transplanting with an average survival of 79% and average yield of 6.3 grams per shell meat. Then, “Tikod Amo” oyster species can be cultured and its culture technology has been generated in this study.

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Polylactic Acid Synthesis with Lipase-catalysed Polymerization and Its Degradation Behavior in Soil

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Abstract: The biodegradable polylactic acid (PLA) polymer can be synthesized from lactic acid (LA) with lipase-catalyzed polymerization. This work focused on optimizing PLA production by Taguchi method, as well as characterization of PLA, to develop an environmental friendly material. Lipase-catalyzed polymerization was used for synthesizing PLA from LA monomer. The influences of several factors, i.e. various commercial lipases, enzyme concentration, monomer concentration, temperature and reaction time were studied. The PLA products were characterized by end group/HPLC analyses for Mn/Mw determination. The results indicated that low molecular weight PLA could be successfully produced from LA by lipase-catalyzed polymerization. Using lipozyme TL IM as biocatalyst, those obtainable Mn and Mw of PLA were 7,933 Da and 194 Da, respectively. For Lecitase Ultra, Mn and Mw of PLA were 8,330 Da and 216 Da, respectively. Moreover, the PLA products were isolated and mixed 50:50 with the commercial PLA beads. Thus, the obtainable solutions were casted onto the glass plates for making PLA blend films. Subsequently, their degradable behaviors were studied under controlled soil burial laboratory conditions. The PLA blend films were characterized using visual observations, measuring weight loss, DSC and FTIR analysis. It was indicated that PLA blend films were more flexible than the pure commercial PLA film. Besides, the blends of PLA films were capable to disintegrate in soil within a short burial time. Indeed, this study revealed that PLA polymers could be synthesized by lipase-catalyzed polymerization from LA, which performs beneficially under mild conditions. Nevertheless, the present PLA products need further process optimization to finalize its potential without the commercial PLA blending. This possibility is quite promising commercially for preparing new green biomaterial in Thailand in the near future.

Keywords: PLA, Lipase-catalyzed polymerization, Taguchi method, Blend film, Soil burial

INTRODUCTION

Polylactic acid (PLA) is a biodegradable material, it can be degraded by simple hydrolysis of microorganisms under the appropriate conditions. Moreover, PLA has been attractive to apply for packaging and composite materials of clothing. Besides, biocompatible and bioabsorbable properties of PLA can be used for wide range applications in biomedical and pharmaceutical technology such as surgical sutures, tissue engineering scaffolds, absorbable bone plates, artificial skin, and controlled drug-release systems[1, 2]. PLA was derived from polymerization process of lactic acid by using a catalyst. The original synthesis used with chemical catalyzed polymerization to produce PLA but they made the residue toxic

catalyst such as oxides of zinc (Zn) and stannum or tin (Sn), including the chemical process needs high purity monomers, high temperature and high vacuum for serving reactions. On the other hand, the bioprocess use an enzyme based catalysts such as lipases instead of using a chemical process which is non-toxic. Besides, polymerization reaction can be run under mild and environmentally friendly conditions which will be the real green material [3, 4]. The study dealing with enzymatic polymerization and development of biomaterial applications such as PLA film forming are still limited. In this research, the objectives were to study PLA synthesis from commercial lactic acid by microbial lipase catalyzed polymerization to enhance the probability of enzymatic catalysis and the performance of production process. As well as, to characterize PLA produced from commercial lactic acid and to produce PLA blend films (50:50 ratio of commercial PLA beads and synthesized PLA products). The degradable behavior of PLA blend films were studied under controlled soil burial laboratory conditions. These are the alternative route for improvement potentially of the environmental friendly biomaterials in the near future.

MATERIALS AND METHODS

Materials

Commercially lactic acid (liquid, 85%) was obtained from Ajax Finechem, Australia. The commercial lipases, immobilized lipase (Lipozyme TL IM) and free lipase (Lecitase Ultra) were procured from Novo Nordisk A/S, Denmark.

Methods

Polymerization Reactions of PLA Synthesis

Polymerization experiments were investigated according to the methodology described earlier [5]. The mixtures of commercial lactic acid (LA) and toluene were heated to give a homogeneous solution. Then, the enzyme (immobilized lipase or free lipase) was added to the mixtures. All reaction mixtures were stirred under nitrogen atmosphere. After the reaction, PLA products were isolated by precipitation method and to characterize the conversion of LA and the number average molecular weight or M_n by end-group analysis [4], the weight average molecular weight or M_w by HPLC analysis.

Preparation of PLA Blend Films

The PLA products from the polymerization experiments and commercial PLA beads were prepared with the ratio as 50:50 and then dissolved the mixture in chloroform while mixing vigorously at room temperature. The dissolved solution was casted onto the glass plate and then allowed to dry for about 24 h at room temperature. The specimen of film was peeled from the casting surface and to characterize the properties of blend film, such as ATR-FTIR spectra analysis and the thermal property by DSC method [6].

Soil Burial Biodegradation Test

PLA blend films were evaluated by soil burial test under laboratory conditions. The experiments were carried out in the bioreactors containing soil. Samples were cut and placed into an envelope of plastic nets and buried at 8 cm depth from the soil surface. The relative humidity was kept approximately 40%. The experiments were performed at room temperature. Weight loss of PLA blend films were determined during the experiment for 14 days [7].

RESULTS AND DISCUSSION

Polymerization Reactions of PLA Synthesis

In order to determine the polymerization reaction of polylactic acid from commercial lactic acid by lipase catalyst. The reaction mixtures containing LA, toluene and lipase were controlled under varying conditions to form PLA polymer. Studies have shown that after the reaction, the PLA polymer separated from the solvent and falling in the bottom phase. The increased viscosity of the reaction mixtures indicated a linkage of LA molecule to form a structure of higher molecular PLA polymer which affected on the insoluble property [8]. Table 1 showed the highest molecular weight, M_n , M_w and the conversion of PLA products from the experiments. The highest M_n was 7,933 Da, M_w was 194 Da and the conversion in percentage was 77.5 % obtained by used immobilized lipase as a catalyst at the reaction temperature 70°C for 6 hours. While the highest M_n was 8,330 Da, M_w was 216 Da and the conversion in percentage was 78.5 % obtained by used free lipase as a catalyst at the reaction temperature 60 °C for 4 hours.

Table 1 Lipase catalyzed polymerization of lactic acid: enzyme type, M_n , M_w and conversion of PLA polymer products.

Enzyme type	Time (h)	Temperature (°C)	M_n (Da)	M_w (Da)	conversion (%)	M_n from previous research reference (Da)
Immobilized lipase	6	70	7,933	194	77.5	3,300 ^a
Free lipase	4	60	8,330	216	78.5	1,423 ^b

^aHans *et al.* (2009) and ^bKiran *et al.*, (2003)

From the results, the difference type of enzyme, free lipase and immobilized lipase have shown the ability of being a catalyst at the difference condition. Similarly, Lassalle and Ferreira (2008) reported that the free enzyme could increase the conversion of polymer better than the immobilized enzyme due to the function of water in the enzyme solution would activate an active site of enzyme. However, the immobilized enzyme can be recovered from the first reaction and reused in the later reaction. Moreover, using the specific optimal temperature and the reaction time with the enzyme type could derive the high conversion and high molecular weight of PLA. As well as, Hans *et al.* [3] reported that the high temperature and the long time of the reaction would inactivate the ability of enzyme for being a catalyst. These effected to decrease the conversion value and the molecular weight of PLA. Although, the low molecular weight of PLA products by lipase catalyst have not been a good properties for packaging development when were compared with the chemical catalyst (i.e., $M_n = 40,000$ – $100,000$ Da) [9]. The low molecular weight of PLA could be applied for the biomedical and pharmaceutical products, such as drug delivery system [10].

Properties of PLA Blend Films

Due to the low molecular weight of PLA derived from lipase catalyzed polymerization could not cast for film forming. Blending synthesized PLA with the commercial PLA beads is an alternative method for improvement the new material. After blending with the ratio as 50:50 and casted on the glass plate, PLA blend film products were characterized the chemical structures of polymer by ATR-FTIR analysis. The results were shown in Figure 1, the typical transmission spectra of PLA appeared in three main regions as follows: the C-H stretching, between 2,800 and 3,000 cm^{-1} ; the C=O stretching, between 1,600 and 1,800 cm^{-1} ; and the C-O stretching, between 1,000 and 1,200 cm^{-1} [11]. The peaks

PLA located at 2,996, 2,923, 1,748, 1,181, 1,129, 1,081 and 1,043 cm^{-1} for the commercial PLA film. For the PLA blend films produced from free lipase and immobilized lipase, gave similar peaks of PLA located likely the commercial PLA film. These showed significantly no change of the chemical structures by using lipase catalyst for PLA synthesis.

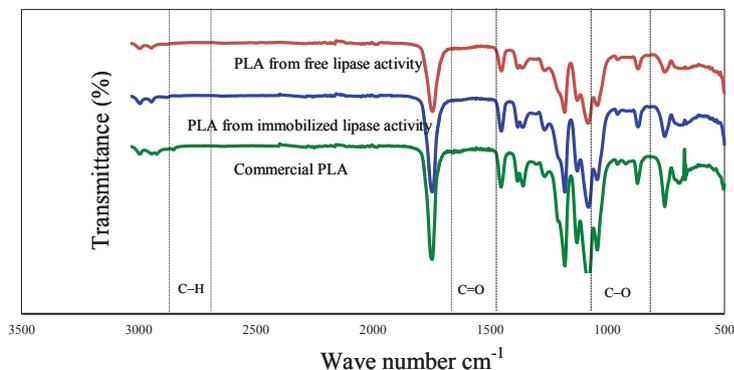


Figure 1 ATR-FTIR spectra of PLA blend films; The PLA products from the polymerization experiments using lipase catalyst and commercial PLA beads were blended with the 50:50 ratio.

Moreover, the morphological of PLA blend films were determined by DSC method. The results were shown in Figure 2, two values such as glass transition temperature (T_g) and melting temperature (T_m) were derived from the estimation [12]. These were found T_g at 36.65 °C for the PLA blend film using free lipase, and at 35.11 °C for the PLA blend film using immobilized lipase. For T_m were found at 133.62 °C for the PLA blend film using free lipase, and at 135.80 °C for the PLA blend film using immobilized lipase. Whereas, *the commercial PLA film showed T_g at 64.12 °C and T_m at 138.44 °C*, which higher than the PLA blend films using both free lipase and immobilized lipase, respectively. Thermal properties, T_g and T_m were the parameter to explain the morphological of film. The high temperature both T_g and T_m could explain that there was the arrangement of the internal molecular structure of film regularly. This effected to the high rigid and brittle properties of film. Therefore, these experiment results were indicated that the PLA blend film showed more flexible property than the commercial PLA film due to the lower T_g and T_m is finding introduced to develop a flexible products for the several application, such as soluble fibers, silk for making the filter and geopolymer products. These are the alternative materials for replacement or integration with using the commercial PLA from chemical processes further.

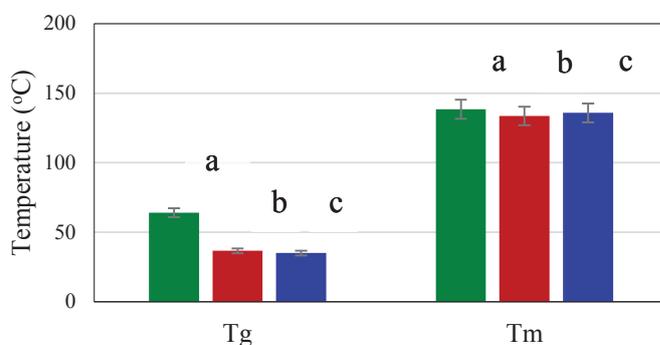


Figure 2 Glasstransition temperature (T_g) and melting temperature (T_m) of PLA blend films; (a) was a commercial PLA film, (b) was PLA blend film using free lipase as biocatalyst and (c) was PLA blend film using immobilized lipase as biocatalyst

Degradation Behavior of PLA Blend Film in Soil

Changes of PLA blend films samples were demonstrated during the biodegradation, shown in Figure 3. From the visual observations during 14 days of burial in soil, the specimens were disintegrated gradually upon the time. PLA blend films changed some of their characteristics such as brittle and turbidity after 7 days of soil burial. This is due to re-crystallization in the structure of PLA blend films under fluctuating temperature during biodegradation [12]. Besides, comparing with a commercial PLA film, and the PLA blend films presented more flexible property.

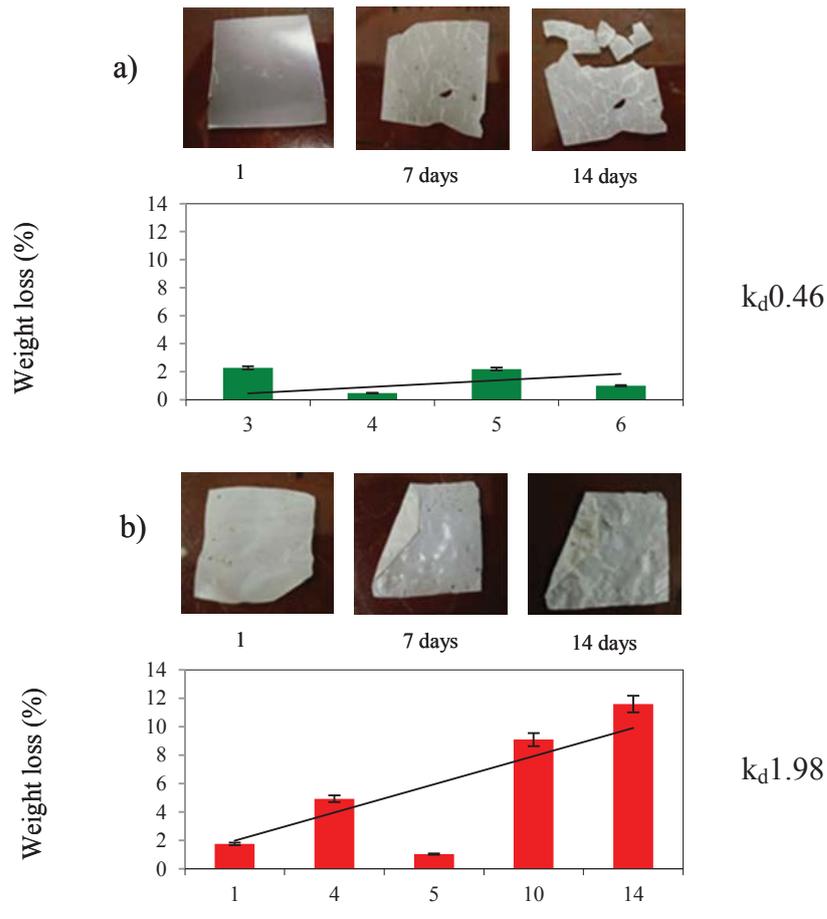


Figure 3 Biodegradable changes of PLA blend films in soil; visual observations, weight loss (%) and k_d is the biodegradation constant; (a) was a commercial PLA film, (b) was PLA blend film using free lipase as biocatalyst and (c) was PLA blend film using immobilized lipase as biocatalyst

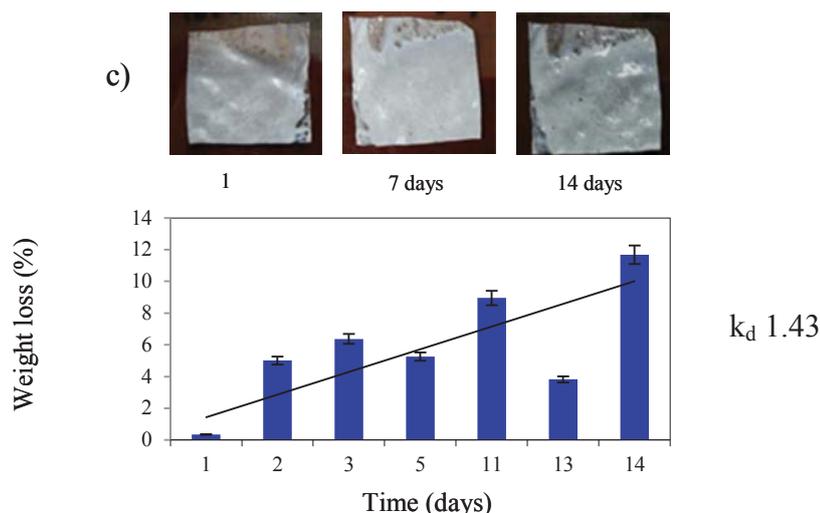


Figure 3 Biodegradable changes of PLA blend films in soil; visual observations, weight loss (%) and k_d is the biodegradation constant; (a) was a commercial PLA film, (b) was PLA blend film using free lipase as biocatalyst and (c) was PLA blend film using immobilized lipase as biocatalyst (continue)

Moreover, the weight loss of PLA blend films was determined and presented the ability of degradation with the biodegradation constant (k_d). The PLA blend films from free lipase and immobilized lipase as biocatalysts, deteriorated as a function of degradation time. The weight losses were increased during the biodegradation, especially greater than that obtainable from commercial PLA film. These results showed relatively with the biodegradation constant (k_d) were 1.98 and 1.43 from the degradation of PLA blend film using free lipase and immobilized lipase as biocatalysts, respectively (Figure 3). Whereas the k_d from the commercial PLA film was 0.46 less than those from the PLA blend films. These results was explained in the previous reports that a change of weight of films related to the water absorption of films since biodegradation which depends on transporting water from the surface to the structure of films. Besides, the water intake within PLA films enhanced microbial growth and initiated biodegradation [13]. Moreover, these degradation behavior was related with the properties of film, found that the flexible property of PLA blend film could disintegrate greater than the stronger commercial PLA.

CONCLUSION

PLA polymers could be attained by free lipase and immobilized lipase catalyzed polymerization of commercial lactic acid. Although, the molecular weight of PLA polymer obtaining from lipase catalyzed polymerization is lower than PLA products from chemical catalyzed polymerization, it can be used as the substrate for film forming and application to use in the medical and pharmaceutical industries with an improvement in the near future. Interestingly, blending films between the commercial PLA and PLA from using lipase catalyzed polymerization under mild condition and environmental friendly is promising an alternative route for creating a new material. Moreover, PLA blend films have shown clearly capability of the degradation behavior in soil. Therefore, this new discovery is potentially a valuable tool for the production of bioplastics and will harness an improvement of new green biomaterials.

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Inhibitory Effect of Fermented Glutinous Rice on Enteropathogenic Bacteria

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Abstract: This research aimed to study the diversity of microorganisms in Thai indigenous starters (Loog-Pang Kao-Mark) from provinces in the central part of Thailand; Ayutthaya, Angthong, Lopburi and Saraburi Provinces; and to determine the inhibitory effect of fermented glutinous rice (Kao-Mark) on enteropathogenic bacteria : *Salmonella typhi*, *Shigella boydii*, *Shigella flexneri*, *Shigella sonnei*, *Staphylococcus aureus* and *Escherichia coli*. Microbial screening was done on solid media. The isolates was identified by morphological analysis and rDNA sequencing method. Inhibitory effects were detected by paper disc diffusion method. It was found that microbial isolates were yeasts, molds and a lactic acid bacterium. Three yeast isolates were *Candida parapsilosis*, *Pichia kudriavzevii* (*Issatchenkia orientalis*) and *Candida quercitrusa*. Two mold isolates included *Rhizopus oryzae* and *Mucor indicus*. A bacterial isolate was *Pediococcus pentosaceus*. Restricted growth of the 6 enteropathogenic bacteria were found in extracted pulp of fermented glutinous rice made from Loog-Pang Kao-Mark at 4 provinces. Efficacy of fermented liquid of Kao-Mark produced from Loog-Pang Kao-Mark at Lopburi province showed highest inhibitory effect against 5 enteropathogenic bacteria. These isolates from Thai indigenous starters will be kept and used for further application.

Keywords: Thai indigenous starters, Fermented glutinous rice, Enteropathogenic bacteria

INTRODUCTION

Loog-Pang Kao-Mark, Thai fermented starter, is made from flour mixed with herbs. Major microorganisms in Loog-Pang are molds and yeasts. Lactic acid bacteria may be found in Loog-Pang from some areas of the local productions. The roles of these microbes and herbs are important in flavor and aroma of Loog-Pang and Kao-Mark which is specific characteristic of the making areas. Kao-Mark may be called sweet fermented dessert that is cooked from Loog-Pang and sticky rice. Texture of Kao-Mark is soft, juicy and pale white grain. Molds in Loog-Pang degrade starch of sticky rice into simple sugar for yeast nutritional utilization and sugar converting to ethanol. Herbs in Loog-Pang influence on microbial selection by inhibition capability. Pathogen or food spoilage microorganisms cannot grow because of inhibitory effect. Alcohol produced from yeast also affect on Kao-Mark taste and food preservation. Amyolytic molds such as *Rhizopus* and *Mucor* are found in Loog-Pang [1]. Many alcoholic yeasts such as *Endomycopsis*, *Hansenula* and *Saccharomyces* have been reported [2-3]. Presence of lactic acid bacteria in fermented starter was most likely as opportunistic contamination. In addition, some yeast strains and lactic acid bacteria found in fermented foods have been accepted as therapeutic agent for preventing diarrhea and other gastrointestinal disorder [4-5]. These microbes are called probiotics which

can be found in Kao-Mark. In general, fermentation of Kao-Mark allows these probiotics grow and enhance nutritive value. Thus, Kao-Mark should be accepted as one of wholesome foods.

Incidence of diarrhea infection is an important public health problem in the local community. Major enteropathogenic bacteria included *Sallmonella* spp., *Shigella* spp., *Escherichia coli* and *Staphylococcus aureus* were caused epidemic diarrhea in children and adults. Resistance strains of these pathogenic bacteria are occurring because of antibacterial agents or antibiotics for curing gastrointestinal infection. Therefore, it is necessary to discover new compounds with low side effect to treat enteric diseases. Currently, natural herbs and probiotics showed antibacterial activities and therapeutic properties in numerous studies [6]. Thai fermented foods such as Kao-Mark composed of useful microbes and herbs that maybe apply for treatment diarrhea and balance intestinal microbes. This research aimed to determine antibacterial effects of ethanolic pulp extract of Kao-Mark and fermented slurry on selected enteropathogenic bacteria. Isolation and identification of microbial species in Loog-Pang samples were also investigated.

MATERIALS AND METHODS

Loog-Pang Kao-Mark Samples

Loog-Pang samples were obtained from local communities at four provinces in the central part of Thailand included Ayutthaya, Angthong, Lopburi and Saraburi provinces. Four Loog-Pang balls from each area were collected in sterile plastic bag and kept in dry ambience condition.

Microbial Isolations

Yeasts and Molds were isolated from 0.1 g of Loog-Pang samples on PDA (potato dextrose agar) plates by dilution and spread plate techniques. Isolated colony was restreaked on PDA plate, and then incubated at room temperature. Pure yeast and mold isolates were maintained on PDA slants at 4 °C.

Lactic acid bacteria were isolated with aseptic technique from Loog-Pang samples (0.1 g) on MRS (deMan, Rogosa and Sharpe) agar plates. Ten-fold dilution and spread plate technique were conducted. Culture plates were incubated at 37 °C for 48 h. Isolated colonies with yellow zone around them were restreaked on MRS agar plates, and pure isolates were stored on NA slants in a refrigerator (4 °C).

Identification of Isolated Microorganisms

Yeast Identification

Yeast isolates were observed cell morphology under microscope (1,000 X) with methylene blue staining. They were identified to species by 26S rDNA sequencing technique as following. Isolation of DNA was carried out by cell lysis with boiling and buffering incubation according to modified methods of Manitis et al. [7]. The divergent D1/D2 region of 26S rDNA was amplified with the two primers; NL-1 (5'-GCA TAT CAA TAA GCG GAG GAA AAG-3') and NL-4 (5'-GGT CCG TGT TTC AAG ACG G-3') [8]. The amplified DNA of yeast isolate was purified with QIAquick PCR Purification Kit. Visualization of purified DNA was detected by electrophoresis and stained with ethidium bromide. It was observed under UV-illuminator. The nucleotide sequences of D1/D2 region of 26 rDNA were

directly monitored using PCR products according to Kurtzman and Robnett [8]. Cycle sequencing of the D1/D2 region was employed with forward primer (NL1) and reverse primer (NL4) by ABI Prism™ BigDye™ Terminator Cycle Sequence Ready Reaction Kit (Applied Biosystems, Stafford, USA). The sequences of D1/D2 region were compared by BLASTn Homology Search (<http://www.ncbi.nlm.nih.gov/blast>).

Mold Identification

Identification of mold isolates from Loog-Pang samples performed by morphological characters [9] included examination of sexual spore reproduction and conidiogenesis with slide culture and microscopic techniques. Colony descriptions were observed on PDA at room temperature. The morphology of hyphae, sporangia, spores and rhizoid were determined under microscope at 400X.

Bacterial Identification

Pure culture of lactic acid bacteria were identified by 16S rDNA sequencing technique. DNA samples for PCR amplification were prepared by using Genomic DNA mini kit (Geneaid Biotech Ltd., Taiwan). DNA coding for 16S rRNA regions was amplified by PCR technique [10]. The PCR product for sequencing 16S rDNA was prepared by using the following two primers; 20F (5'-GAG TTT CCT GGC TCA G-3') and 1500R (5'-GTT ACC TTG TTA CGA CTT -3') by the *E. coli* numbering system [11]. Direct sequencing of the single-banded and purified PCR products about 1500 bases, on 16S rDNA was carried out. The DNA sequencing was performed on an ABI Prism® 3730 XL DNA sequence (Applied Biosystems, Foster City, California, USA). The identification of phylogenetic neighbors was initially carried out by the BLAST [12] and megaBLAST [13] programs against the database of type strains with validly published prokaryotic names [14].

Preparation of Kao-Mark Extracts

Glutinous rice soaked with tap water for 3 h followed by steaming for 2 h. Cooked rice was cool down by air exposure on clean tray, and then washed with boiled water. Loog-Pang Kao-Mark samples were grinded and mixed the powder to cooked glutinous rice (2% w/w). Kao-Mark fermentation was in clean plastic box with a cover at room temperature (30 °C) for 3 days. Pulp and slurry of Kao-Mark were separated with filter paper (Whatman No. 40) and repeated filtration of the slurry with millipore filter (0.45 µm). The pulp was extracted with ethanol (50% w/v) for 24 h followed with alcoholic evaporation in oven at 50 °C for 2 h. Kao-Mark slurry was concentrated with rotary evaporator at 50 °C for 6 h. The non alcoholic pulp extracts and slurry were kept at 4 °C.

Tested Enteric Bacteria

Enteric bacteria cultures consisted of *Salmonella typhi*, *Shigella boydii*, *Shigella flexeri*, *Shigella sonnei*, *Staphylococcus aureus* and *Escherichia coli* were obtained from Department of Medical Science, Ministry of Public Health, Thailand. Bacterial stock cultures were cross-streaked on NA (nutrient agar) plates. Isolated colony of each culture was transferred to NB (nutrient broth) tube and incubated at 37 °C for 24 h. The bacterial cultures were used as tested microorganisms in antibacterial assay.

Antibacterial Activity Tests

Paper disc diffusion method was used to determine antibacterial activities of Kao-Mark pulp extracts (10 mg/disc) and slurry (10 µl). Inoculums of six tested enteric bacteria were prepared with 0.5 Mc Farland turbidity standard. Bacterial inoculums were spread on

NA plates using sterile cotton swabs. Antibacterial disc contained 10 µl of Kao-Mark extract (10 mg/disc) or slurry was placed on each bacterial lawn plates and pressed slightly with the control using sterile distilled water. All plates were incubated at 37 °C for 24 h. The diameter of inhibition zone on cultured plate was measured in centimeter (cm). The experiments were repeated three times and each treatment was conducted in triplicate.

Statistical analysis of clear zones was done with one-way ANOVA to determine the variances of the data in SPSS 14.0 for Windows (SPSS, Chicago, III., USA) software package. Mean significant differences were evaluated at $p < 0.05$ by using Duncan's new multiple's range test.

RESULTS AND DISCUSSION

Microbial Identification

Microbes were isolated from Loog-Pang samples produced in Angtong, Lopburi, Ayutthaya and Saraburi provinces. They were yeast mold and bacterial isolates which were the major fermentative microbes in Kao-Mark production. Different colonies of microbial cultures on agar plates were selected to check cell morphologies and staining properties. Yeast and bacterial isolates were identified to species by using rDNA sequencing technique with 98.51-100% of similarity among DNA fragments which was calculated by BLAST program (Table 1). Amylolytic molds, *Rhizopus oryzae* and *Mucor indicus*, were found in Loog-Pang samples from the four provinces. One species of lactic acid bacterium, *Pediococcus pentosaceus*, was found in all samples. Yeast species, i.e., *Pichia kudriavzevii* (*Issatchenkia orientalis*), *Candida parapsilosis* and *Candida quercitrusa* were isolated from Loog-Pang samples in the provinces of Thailand (Table 1)

Table 1 Identification of yeasts, molds and bacteria isolated from Loog-Pang Kao Mark produced in Angtong, Lopburi, Ayutthaya and Saraburi provinces

Province	Yeast strain (% similarity)	Mold strain	Bacterial strain (% similarity)
Angtong	<i>Candida parapsilosis</i> (98.07%)*	<i>Rhizopus oryzae</i> <i>Mucor indicus</i>	<i>Pediococcus pentosaceus</i> (99.11%)
Lopburi	<i>Pichia kudriavzevii</i> (100%)	<i>Rhizopus oryzae</i> <i>Mucor indicus</i>	<i>Pediococcus pentosaceus</i> (99.11%)
Ayutthaya	<i>Candida parapsilosis</i> (98.07%)*	<i>Rhizopus oryzae</i> <i>Mucor indicus</i>	<i>Pediococcus pentosaceus</i> (98.51%)
Saraburi	<i>Candida quercitrusa</i> (99.82%)	<i>Rhizopus oryzae</i> <i>Mucor indicus</i>	<i>Pediococcus pentosaceus</i> (99.11%)

*Nucleotide sequences at D/D2 region of 26S rDNA of the yeast isolates were different from *Candida parapsilosis* CBS 604^T (sequence accession no. U45754) for 11 pairwises.

Antimicrobial Activity

Antibacterial activities of Kao-Mark pulp extracts and their slurries produced from Loog-Pang in Ayutthaya, Angthong, Lopburi and Saraburi Provinces against six enteropathogenic bacteria were summarized in Table 1 and 2. By using the disc diffusion method, pulp extract at a concentration of 10 mg/disc showed inhibitory effect to all tested bacteria (*Staphylococcus aureus*, *Salmonella typhi*, *Shigella boydii*, *Shigella flexneri*, *Shigella sonnei* and *Escherchia coli*). Pulp extract from Lopburi exhibited highest zone of inhibition (5.03 cm) against *Shigella boydii* and *Escherchia coli* whereas extract from Saraburi showed the lowest activity (Table 1). However, the slurry (10 µl) represented less effective and narrow spectrum of antibacterial ability, especially the data of slurry from

Angtong revealed that it cannot inhibit all tested bacteria. In Figure 1, antibacterial activities of pulp extract and slurry from Lopburi against six enteropathogenic bacteria were visible as inhibition zones in various diameters.

Table 2 Inhibition zone diameters of Kao-Mark pulp extracts (10 mg/disc) from Loog-Pang in the four provinces of Thailand against enteropathogenic bacteria

Province	Zone of inhibition (cm)					
	<i>Stap. aureus</i>	<i>Sal. typhi</i>	<i>Shig. boydii</i>	<i>Shig. flexneri</i>	<i>Shig. sonnei</i>	<i>E. coli</i>
Angtong	3.67 ± .577 _b	3.80 ± .200 ^b	4.47 ± .462 ^b	4.13 ± .231 ^a	3.93 ± .306 ^b	3.07 ± .611 ^c
Lopburi	4.47 ± .306 ^a	4.67 ± .321 ^a	5.03 ± .058 ^a	4.53 ± .666 ^a	4.20 ± .100 ^{ab}	5.03 ± .351 ^a
Ayutthaya	3.87 ± .231 ^{ab}	4.93 ± .115 ^a	4.13 ± .115 ^b	4.20 ± .200 ^a	4.53 ± .416 ^a	4.13 ± .115 ^b
Saraburi	2.27 ± .252 ^c	2.07 ± .115 ^c	2.30 ± .300 ^c	1.93 ± .115 ^b	2.03 ± .058 ^c	2.00 ± .000 ^d

The data are mean of three replicates ± standard error. Mean values of each column have different superscript letters indicate significant differences ($p < 0.05$) according to Duncan's new multiple's range test.

Table 3 Inhibition zone diameters of Kao-Mark slurry (10 µl/disc) from Loog-Pang in the four provinces of Thailand against enteropathogenic bacteria

Province	Zone of inhibition (cm)					
	<i>Stap. aureus</i>	<i>Sal. typhi</i>	<i>Shig. boydii</i>	<i>Shig. flexneri</i>	<i>Shig. sonnei</i>	<i>E. coli</i>
Angtong	-	-	-	-	-	-
Lopburi	1.33 ± .115 ^a	1.73 ± .115 ^a	1.87 ± .321 ^a	2.13 ± .058 ^a	-	2.17 ± .289 ^a
Ayutthaya	-	-	1.93 ± .115 ^a	1.80 ± .000 ^b	-	1.53 ± .115 ^b
Saraburi	-	1.93 ± .115 ^a	-	-	-	-

(-) = No inhibition zone was observed

The data were presented as mean of three independent experiments ± standard error. Mean values of each column have different superscript letters indicate significant differences ($p < 0.05$) according to Duncan's new multiple's range test.

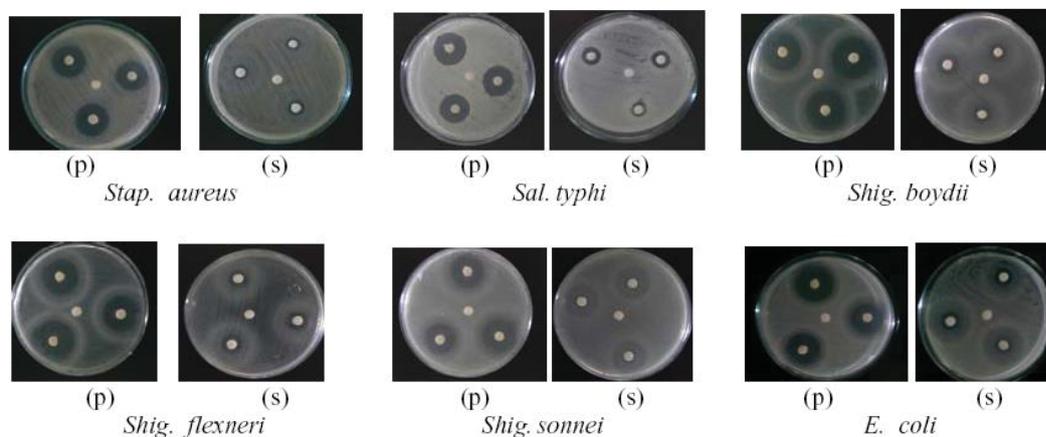


Figure 1 Inhibition zones indicated antibacterial activities of Kao-Mark pulp extract (p) and its slurry (s) that made from Loog-Pang in Lopburi against *Staphylococcus aureus*, *Salmonella typhi*, *Shigella boydii*, *Shigella flexneri*, *Shigella sonnei* and *Escherichia coli*

CONCLUSION

This study demonstrated diversity of microbes found in Loog-Pang Kao-Mark produced in Angtong, Lopburi, Ayutthaya and Saraburi provinces of Thailand. Another investigation presented that Kao-Mark products made from Loog-Pang in different provinces have various antibacterial properties on selected enteropathogenic bacteria. In the experiment, pulp and slurry of Kao-Mark were performed alcoholic evaporation before antibacterial tests hence herbs in Loog-Pang (a starter of Kao-Mark fermentation) may cause major antibacterial effects [6]. Moreover, the results showed that pulp extracts exhibited broad spectrum of antibacterial activity and higher effective. This study suggested that concentration of herb in Kao-Mark affected on antibacterial ability. The present investigation confirms that Kao-Mark could be usefully for reduction of enteropathogenic bacteria.

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Evaluation on Heat Tolerant of Cultivated Strawberry Plants (*Fragaria x ananassa* Duch)

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Abstract: Average global temperatures are expected continually to increase every year. It is well known that temperature is one of the most important factors for the growth of economic crops as well as strawberry plants. For strawberries, the temperature above 30°C is directly affected to reduce growth and yields. In the present study, the ability of heat tolerant in cultivated strawberry plants were examined. “Prarajchatan 60”, “Prarajchatan 80”, “Sachinoka”, No.329 and Driscoll’s strawberry cultivars were grown in heat room at 35°C for 7 days. An actual Photo System II efficiency (ØPSII), maximal efficiency of PSII photochemistry (Fv/Fm), percentage of ion leakage, Stomata conductance (gs), transpiration rate (E), net CO₂ assimilation rate (A) and leaf temperature determination method (Tl) were measured. Strawberry cultivar “Prarajchatan 60” had the markedly lower of Tl (33.9°C), percentage of ion leakage (13.86%) than those other remain cultivars. Among five strawberry cultivars Driscoll’s maintained the highest percentage of ion leakage. The results also revealed that there is a significant relationship between Fv/Fm and gs and E. Hence, it could be possible to use the percentage of ion leakage value together with other physiological indices for evaluating the heat tolerant in strawberry plants.

Keywords: Ion leakage, Photochemistry, Climate change, Heat stress

INTRODUCTION

Recently the average global temperatures are expected to increase every year. Heat stress becomes one of the major abiotics stress affecting agriculture worldwide. An effect of high temperature on crops production and physiology has been reported worldwide. High temperature reduces growth, reproductive and yield of many crops [8, 9, 12, 14]. At cellular membrane levels, heat stress results to disturb and injury some physiological activities in plants such as, denaturing of protein, metabolic imbalance and biochemical lesions.

The cultivated Strawberry (*Fragaria × ananassa* Duch) is one of the most economically small fruit crops in the world. It is widely grown in North and South America, Europe, Asia, and Australia [6]. Strawberry plants are classified as temperate crops with an optimum growth temperature range from 10 to 26 °C. However, in tropical countries such as Thailand, the cultivated strawberry plants can also be grown commercially in the highlands where temperatures range from 10 °C to 26°C [15]. For strawberry the main factors to induce flower formation for June-bearing strawberries are low temperature and shortened photoperiod [9]. The limiting factor for growing strawberry is high temperature more than 30° C. High temperature could be negatively affected to growth and yield of strawberry plants. The temperature rising higher than 30 ° C are directly affected to reduce number of inflorescences, flowers, fruits, pollen viability, fruit size, fruit weigh and overall plant growth of cultivated strawberries [8, 11, 12, 14]. Moreover, at 30 ° C the cells under suspension

cultures did not normally proliferate and grew very slow. However, information related to evaluate the heat tolerance ability of cultivated strawberry by simple and reliable method using physiological value remains obscure. Considering the implications of global climate change, it may become a serious problem in the near future for strawberry growing cultivation. Therefore, this study is aimed to evaluate the heat tolerance ability of cultivated strawberry by using electrolyte leakage value

MATERIALS AND METHODS

Plant Materials and Treatments

Five June-bearing cultivated strawberry cultivars were used in this study. Plug plants of “Akihime” “Parajchatan 60” “Sachinoka” “No.329” and “Discroll’s” were grown plastic pots (14 cm in height and 13 cm in diameter with 17.5 cm) containing coconut coir. Plants were grown under natural condition in plastic house for 4 weeks and irrigated by Half Hoagland nutrient solution twice a day. After that, eight plants of each cultivar were randomly transferred into high temperature room treatments set at 35 ± 2 °C and under control conditions at 25 ± 2 °C by placing on the plastics tray, 16/8 h photoperiods (day/night) with $100 \mu\text{moles m}^{-2} \text{s}^{-1}$ PPFD for seven days. To avoid from water stress, 1 cm height of water level in the tray were kept until the end of experiment.

Cell Membrane

Membrane thermostability was measured by modified method according to Sullivan (1972). Eight uniform fully expanded leave per treatments of each cultivar were cut into 0.5 cm in diameter. Ten Leaf discs of each cultivar from each treatment were placed into test tube and rinsed the samples with 10 ml double deionized water for three times. Each cultivar was represented by ten test tubes. Then, 10 ml of double deionized water were added to each tube and covered the test tube by aluminum foils. The samples were incubated at room temperature for 16 h. After that, electrical conductivity of each sample solutions were measured using a conductivity meter (SUNTEX conductivity meter SC-170), assigned as (E0). Subsequently, the test tubes with same solution were autoclaved to kill the leaf discs, and cooled down at 25 °C for 1 h. Total electrical conductivity (Et) was then measured. Percentage of electrolyte leakage was calculated as $(E0/Et) \times 100$.

Leaf chlorophyll fluorescence of young fully expanded leaflet at seven day of heat treatment were measured under 25 ± 2 °C and 35 ± 2 °C with $100 \mu\text{moles m}^{-2} \text{s}^{-1}$ PPFD. Leaf Chlorophyll fluorescence was measured with pulse-modulated fluorometer (Fluorescence Monitoring System [FMS-1] Hansatech Instruments Ltd., Norfolk, U.K.). Parameter for Initial chlorophyll fluorescence yield (F0), variable chlorophyll fluorescence yield, (Fv) and maximum chlorophyll fluorescence yield (Fm) were recorded from pulse-modulated fluorometer LCD display. These fluorescence parameters were used for determine maximum photochemical efficiency of the photosystem II in dark adapted leaves (Fv/Fm) using following equations:

$$\text{Photosystem II (Fv/Fm)} = (Fm - F0) / Fm$$

Data in this study were used to analyze the analysis for of variance, and means were compared by least significant difference (LSD). To examine Relationships between

percentage of ion leakage and photosystem II in dark adapted leaves (Fv/Fm), regression was analyzed.

RESULTS AND DISCUSSION

Membrane Injury

Membrane injury of cultivated strawberry plants were evaluated through out electrolite leakage from the leave cell. There were significant differences in percentage of inon leakage among the cultivars. Under high temperature stress at 35 °C, strawberry plants cultivar “Driscoll’s” had a significantly higger in the percentage of inon leakage than other cultivars. The significant lowest mean value for percentage of inon leakage was found in No.60, No.329 and Akihime, repectively. This result indicated that the strawberry cultivars of Prarajchatan 60 No.329 and “Akihime” have the best performance and were tolerant to heat stress better than those “Driscoll’s” and “Sachinoka”. Significant differences in percentage of inon leakage among straberry genotypes reported here may offer partial explanations for the degree of difference tolerance to heat stress observed in these cultivars. Although it can not be accurately indicated how much membrane capability may contibute to heat tolerance in strawberry plants, this result suggests that it may by an important component. The ion leakage have been used as index for evaluating abiotic stress to qualify cell thermostability in many plants species [9, 10].

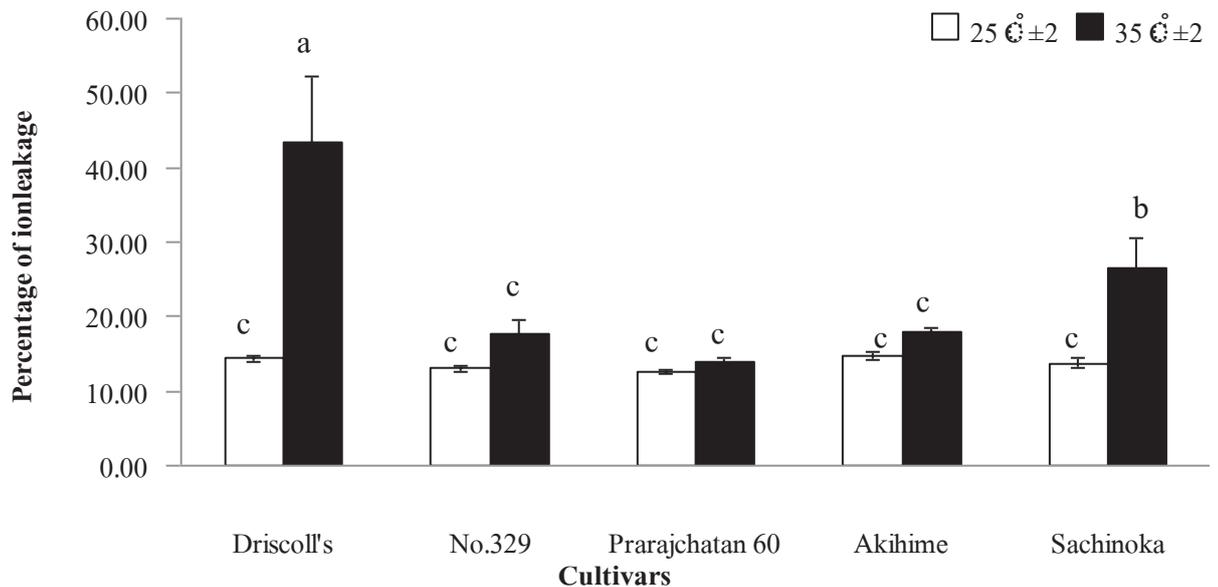


Figure 1 A Effects of heat stress on percentage of ion leakage in cultivated strawberry plants.

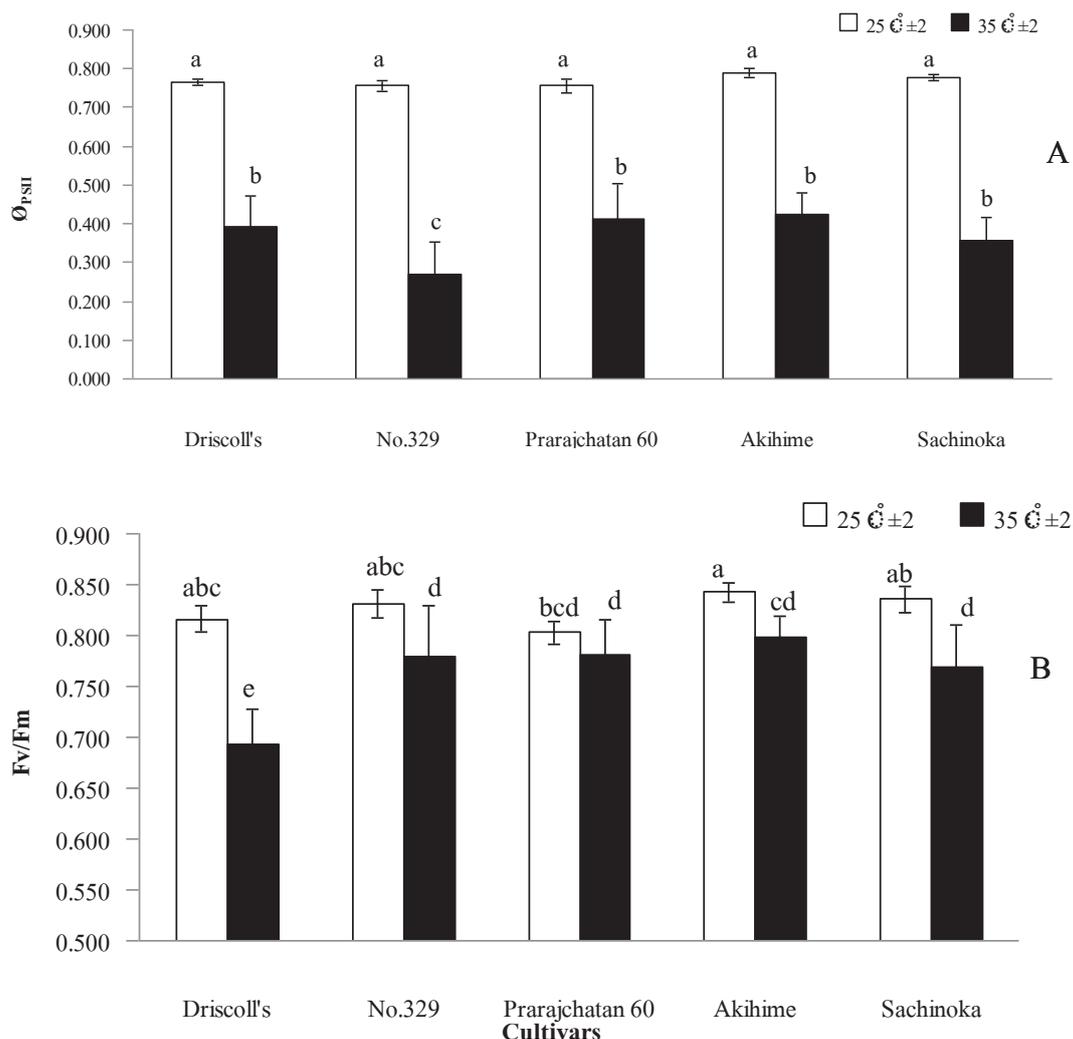


Figure 1 B Effects of heat stress treatment on photosystem II (PSII) and maximum fluorescence (Fv/Fm) in cultivated strawberry plants.

Effects of heat stress treatment on photosystem II (PSII) and maximum fluorescence (Fv/Fm) of five strawberry cultivars after explored to high temperature at $35 \pm 2^{\circ}\text{C}$ for seven days were shown in Figure 1 A. Both PSII and Fv/Fm explored to high temperature at $35 \pm 2^{\circ}\text{C}$ were significantly different among the cultivars. PSII under high temperature at $35 \pm 2^{\circ}\text{C}$ for all cultivars was significantly declined compared with plants under control ($25 \pm 2^{\circ}\text{C}$). The lowest PSII was observed in strawberry cultivar No.329. Decline in PSII efficiency for these five strawberry cultivars under heat stress condition might be attributed to the damage to oxygen-evolving apparatus [5] and impairment of electron transfer within PSII reaction centers [3, 4, 10]. There was significant change in Fv/Fm of five strawberry cultivars explored to high temperature. “Driscoll’s” had lowest of Fv/Fm among five strawberry cultivars (Figure 1 B). Our results showed that heat stress had effect to decrease in PSII and Fv/Fm. Decreasing of Fv/Fm during the heat stress suggested a reduction of the rate of energy-trapping by PSII centers, which might be the result of a damaging in PSII reaction center [7]. Significantly negative relationships between Fv/Fm and percentage of ion leakage was observed (Figure 2) for all cultivars. This result was consistent with Xu et al. (2008) found that percentage ion leakage from maize’s leaf under drought stress was significantly negative correlated with Fv/Fm.

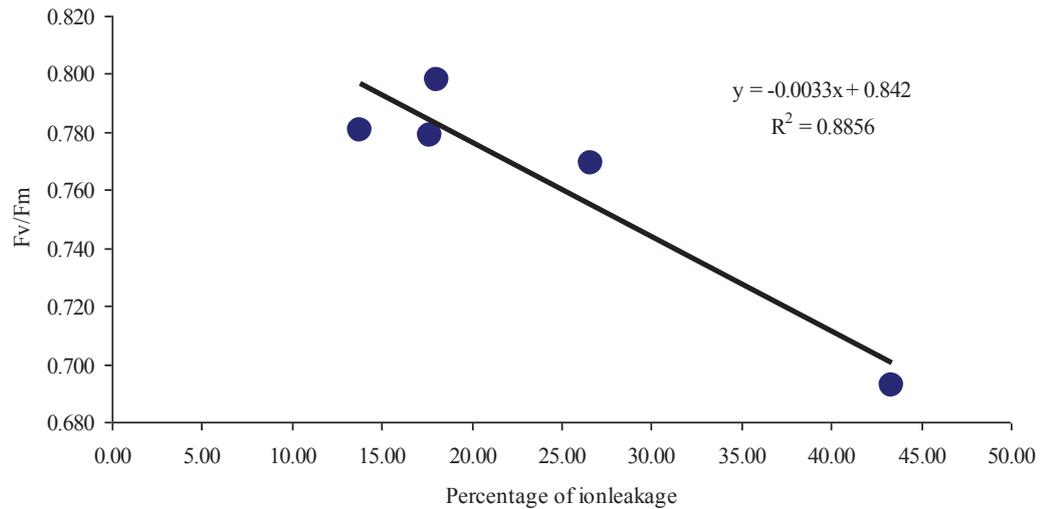


Figure 2 The relationships between fluorescence parameters and percentage of ion leakage in leaves of five cultivated strawberry.

CONCLUSION

The electrolyte leakage in leaf of five strawberry cultivars in this study can be used as one of parameter by combing with other physiological value such as Fv/Fm ratio and PS II values to evaluate the heat tolerance. Considering to parameter investigated, Driscroll's would be the most susceptible strawberry cultivar to heat stress (highest value for percentage and lowest decline in Fv/Fm ratio), whereas the highest tolerance to heat stress would be No.329 and 'Prarajchatan 60' (highest value in Fv/Fm and lowest value for percentage).

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Physiological Characters of Different Varieties of Lettuces in Relation to Heat Tolerance

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Abstract: Heat tolerance of lettuces varies between varieties, partly, due to the difference in their physiological characters. In this study, two physiological characters, namely percentage of ion leakage under high temperature condition and anthocyanin content, were studied in relation to heat tolerance of lettuce. It was shown that the percentage of ion leakage from leaf issue under high temperature was negatively correlated with relative growth of lettuce in mild heat stress condition. Moreover, anthocyanin content in lettuce leaves was found to correlate with some physiological parameters. Suggesting the possibilities of using these physiological characters for preliminary screening of heat tolerance lines during breeding process.

Keywords: Heat tolerance, Ion leakage, Anthocyanin content, Lettuce

INTRODUCTION

Heat stress is one of the major problems that limit global crop production, especially in tropical area. Breeding for heat tolerant crop is an important approach to mitigate the adverse effect of heat stress on crop productivity. However, conventional screening for heat tolerant genotype in an outdoor field has proved to be complicated due to the intervention of many biotic and abiotic environmental factors such as pest, insect and unpredictable weather. In addition, heat tolerance is a complex trait which is involved many physiological characters [1]. Therefore, it is an important to understand the physiological basis of heat tolerance and develop more effective screening method which can be used for selecting heat tolerance genotype.

It has been found that the differences in heat tolerance among plant genotypes is correlated with the stability of membrane under high temperature [2-3]. Indeed, high temperature causes change in lipid composition, fluidity and permeability of the cell membrane resulting in electrolyte leakage [1]. High temperature also increases intracellular production of free radical such as superoxide and hydrogen peroxide that can oxidize lipid in the membrane [4]. Oxidation of membrane lipid is a chain reaction which can seriously damage cell membrane and may contribute to ion leakage during heat stress [5-6]. Therefore, cell membrane thermostability has been used as an indicator for screening heat tolerant genotypes in plants. Evaluation of cell membrane thermostability can be done by measuring percentage of ion leakage which is a simple method and requires only small leaf segments from individual plants. Percentage of ion leakage under high temperature condition, in fact, it has been shown to be a reliable indicator of heat tolerance in many plant species such as cowpea [7], tomato [8], Kentucky bluegrass [9], Sorghum [10] and wheat [11].

Accumulation of anthocyanin pigment is a common trait found in a wide range of plant species. Based on many reviews and research works, there are 2 major hypotheses about the cellular functions of anthocyanin during stress. The first hypothesis suggest that

anthocyanin may have photoprotective role in plant [12]. It was found that, in maize, anthocyanin containing genotype has higher value of photosystem II quantum yield than anthocyanin deficient genotype under low temperature stress condition [13]. The second hypothesis supports antioxidative role of anthocyanin. It has been shown that red leaves has higher antioxidant activity than green leaves in Lettuce [14].

In this study, the correlation between heat tolerance and two physiological characters, namely percentage of ion leakage under high temperature condition and anthocyanin content, were studied. The results were obtained from this work will be used to evaluate the effectiveness of these physiological characters in screening for heat tolerant genotype of lettuce.

MATERIALS AND METHODS

Plant Materials and Growth Conditions

Seeds of 9 lettuce cultivars, namely Red Coral MJ2, Red Coral Baby MJ2-2, Green Oak MJ3, Green Oak MJ3-2, Cos MJ5, Red Oak MJ6 and Butterhead MJ7, were obtained from Division of vegetable technology, Department of horticulture, Maejo university. Lettuce seeds were first sowed in sponge filled with tap water for 12 days before they were transferred. For all experiments, lettuce seedlings were grown in hydroponic system using Hoagland nutrient solutions prepared followed Epstein and Bloom (2006). The growth condition were 16 h of light at $100 \mu\text{mol m}^{-2} \text{s}^{-1}$ at 28/25°C (day/night). For heat stress condition, plants were grown under the same condition except the temperature was set to 39/29°C.

Measurement of Ion Leakage under High Temperature

Percentage of ion leakage under high temperature was measured based on a protocol from Sullivan [10] with some minor modifications. Leaf discs at the same age of lettuce seedlings were harvested 16 days after sowing. Leaf discs were placed in test tube and washed 3 times in deionized water. Then, test tubes were incubated in water bath at 50°C for 30 min. After that, 10 ml of deionized water is immediately added into test tubes. The tubes were placed in the dark under room temperature for 3 hours to cool down before the electrical conductivity of solutions were measured. After That, test tubes were autoclaved for 20 minutes and the electrical conductivity of solutions were measured. Percentage of electrolyte leakage of each sample was calculated as following:

$$\% \text{ of electrolyte leakage} = (\text{EC before autoclaved} / \text{EC after autoclaved}) * 100$$

Anthocyanin Content Measurement

Anthocyanin content was measured as described by Giusti and Wrolstad [15]. About 30-50 mg of leaf samples from each lettuce cultivar were incubated in 0.1 M HCL and 95% ethanol for 3 hours. Then, 0.45 ml of extracted solutions were diluted with 2.55 ml of 0.025 M KCl pH 1.0 and 0.4 M KCl pH 4.0 (adjusted pH by HCl). Both diluted solutions were measured the absorbance at 530 and 700 nm. Absorbance is calculated by using formula:

$$A = (A_{530} - A_{700})_{\text{pH } 1.0} - (A_{530} - A_{700})_{\text{pH } 4.5}$$

Anthocyanin pigment concentrations of each sample were calculated by using formula:

$$\text{anthocyanin pigment (mg/liter)} = (A \times MW \times DF \times 1000) / (\Sigma \times 1)$$

where MW is molecular weight of Cyanidin-3-glu (449.2), DF is dilution factor (6.67) and Σ is molar absorptivity (26900).

ØPSII Measurement

ØPSII (quantum yield of PSII) was measured by using Fluorescence Monitoring System, FMS2, Hansatech. ØPSII is calculated as $(F_m' - F_s) / F_m'$ where F_m' is the maximal fluorescent under light adapted condition and F_s is the steady state fluorescent under actinic light.

Data Analysis

Data were analysed by using Duncan Multiple Range Test calculated by Sirichai 6.07. Significant difference was calculated based on $P < 0.05$.

RESULTS AND DISCUSSION

Membrane Thermostability and Growth

Membrane thermostability of different lettuce varieties was evaluated by measuring percentage of ion leakage after incubating leaf discs in 50°C water bath for 30 minutes. Green oak showed the highest leakage value (80.5 %) followed by Red Coral (77.1%) and Red Coral Baby (74.4%) respectively (Figure 1). On the other hand, Butterhead has the lowest leakage values (58.2%) followed by Cos (64.3%) and Red Oak (66.4%), respectively (Figure 1A). Membrane stability under high temperature condition was found to depend on lipid composition of the membrane [3]. Thus, the differences in membrane stability found in this experiment could be related to the variation in membrane lipid composition among lettuce genotypes. Percentage of ion leakage from leaf tissue has been shown to correlate with membrane damage and stress tolerance in some plant species such as cowpea [7] tomato [8] and wheat [11]. Therefore, it is possible that the results from this experiment might be correlated with other heat tolerant traits of lettuce.

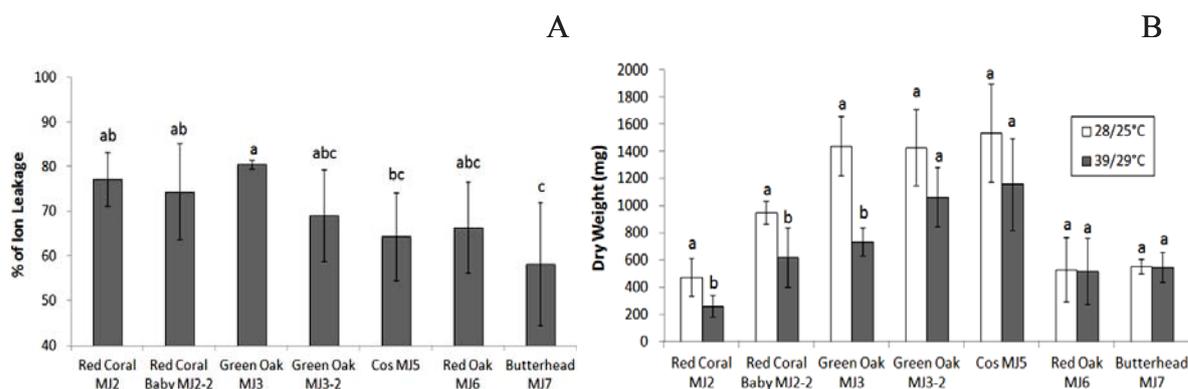


Figure 1 (A) Percentage of ion leakage from leaf discs collected from 16 day old lettuce plants . Samples were incubated under 50°C for 30 mins before measurement. (B) Shoot Dry weight of different lettuce genotypes after grown in indicated condition for 2 weeks. Standard deviation bars were shown (n = 4). Different letters indicate significant difference analysed by DMRT ($P < 0.05$). In case of shoot dry weight, different letters indicate significant difference only for the results from the same lettuce genotype.

To evaluate heat tolerant ability of different lettuce genotypes by using growth parameter, 16 day olds seedlings were transferred to 39/29°C condition for 2 weeks before the dry weight data were collected and calculated for relative dry weight (RDW) values by comparing to the control plant that were grown under 28/25°C alongside. Overall, the average dry weight of seedlings grown under 39/29°C conditions were lower than 28/25°C condition in all lettuce genotypes indicating the negative effect of high temperature on lettuce growth (Figure 1B). For RDW, the result showed that Green oak has the lowest RDW (51.2 %) followed by Red Coral (55.3%) and Red Coral Baby (65.5%), respectively. In contrast, Butterhead has highest RDW (98.4%) followed by Red Oak (97.6%), Cos (75.4%) and Green Oak 3-2 (74.3%), respectively. The RDW results was negatively well correlated with percentage of ion leakage values ($R^2 = 0.8162$) (Figure 2). This results was suggested that percentage of ion leakage value could be used as an physiological index to screen for heat tolerant genotype in lettuce.

The negative relationship between membrane stability and cumulative growth under high temperature could be explained by two reasons. First, high temperature could alter thylakoid membrane stability which was in turn, decreased photosynthetic efficiency. Photosynthesis is very sensitive to high temperature as it has been shown that increasing temperature from 40 to 42°C; can because complete inhibition of photosynthesis in spinach leaves [16]. Second, high temperature may induce accumulation of reactive oxygen species which can oxidize proteins and lipids in plant cell [4], in this situation can disturb overall biological processes and reduce plant growth.

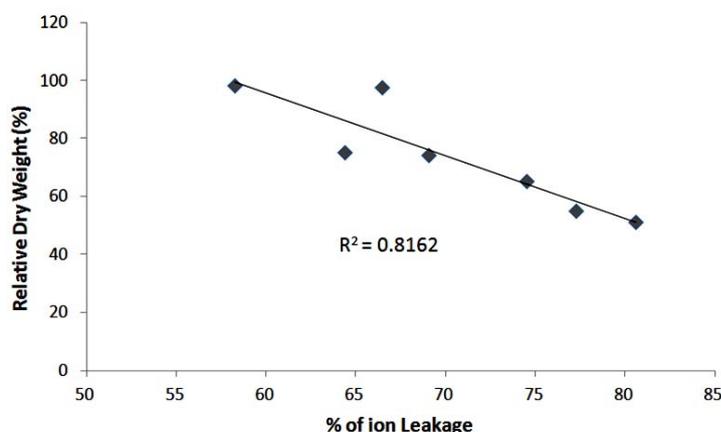


Figure 2 Correlation between relative dry weight of lettuce plant grown under 39/29°C for 2 weeks (dry weight of control plant grown under 28/25°C was used as 100%) and Membrane thermostability as indicated by percentage of ion leakage under high temperature condition.

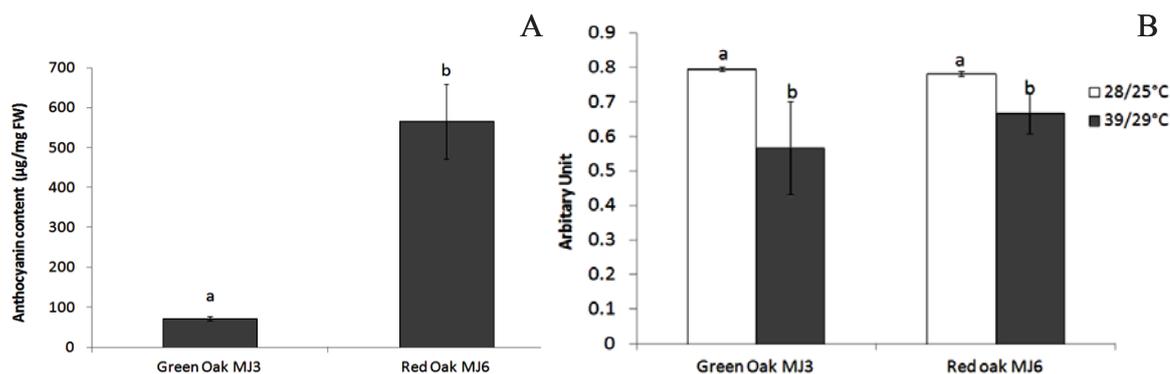


Figure 3 Anthocyanin content (A) and Quantum yield of PSII under indicated conditions (B) of Green Oak MJ3 and Red Oak MJ6 plants. Error bars indicate standard deviation ($n = 4$).

Additionally, the relationship between anthocyanin content and quantum yield of PSII (Φ PSII) under heat tolerance was also studied in this experiment. Two lettuce genotypes, Green Oak MJ3 and Red Oak MJ6, which belong to the same varieties but different in anthocyanin content were used for comparative study. Red Oak MJ6 has about 8 times anthocyanin content more than Green Oak MJ3 (Figure 3A). Φ PSII value of Green Oak MJ3 were slightly higher than Red Oak MJ6 under 28/25°C condition whereas, under 39/29°C, Green Oak MJ6 had much lower Φ PSII than Red Oak MJ6 (Figure 3B). The Φ PSII value was shown to positively correlate with electron transport rate through PSII and rate of CO₂ assimilation [17]. Consequently, the higher Φ PSII could indicate that photosynthesis in Red Oak MJ6 was more efficient than Green Oak MJ3 under high temperature condition.

CONCLUSION

Conventional screening for heat tolerant genotypes in open field system is a difficult and time consuming task due to the intervention of environmental factors and unpredictable weather condition. We have shown here that it is possible to use some physiological index, such as percentage of ion leakage under high temperature condition, to screen for heat tolerant genotypes under laboratory condition. Nevertheless, we do not suggest plant breeder to rely solely on a single physiological parameter, multiple parameters and field screening is still required to confirm the results.

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Heat Transfer Study of Turbulent Flow in a Heat Exchanger Tube with 45° V-baffles

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Abstract: The article presents an experimental study on heat transfer and friction characteristics of turbulent flow through V-shaped baffles placed periodically along the central core of a circular tube. In the present work, to achieve this purpose, the 45° V-baffles are mounted repeatedly on double-sides of a tape before inserting it into the tube. The use of the V-baffles is to generate counter-rotating vortex flows along the tube to increase the heat transfer rate. The experiment is conducted for the Reynolds number ranging from 5,000 to 25,000 under a uniform heat-flux applied on the outer-tube wall. Effects of four different baffle-pitch ratios ($PR=P/D=0.5, 1, 1.5$ and 2) with a single baffle height ($b/D=0.2$) on heat transfer and pressure drop are examined. The experimental results show that the use of smaller PR baffles leads to the considerable increase in Nusselt number and friction factor values in comparison with the plain tube with no insert. The optimum thermal enhancement factor is found to be about 1.24 at $PR=1$, indicating the merit of the V-baffled tape insert over the smooth tube.

Keywords: Heat transfer, Friction factor, Thermal enhancement factor, V-baffles

INTRODUCTION

A high performance heat transfer system is of great importance in many industrial applications. Therefore, the heat transfer enhancement techniques have been widely applied in heat exchanger systems, in order to improve the heat transfer coefficient [1–4]. Passive heat transfer augmentation is a method to enhance heat transfer without external power. Among the techniques used, insertion of twisted tape in a circular tube is one of the most effective approaches. The inserted twisted tape generates swirling flow and increases turbulence intensity which is major influencing factors for heat transfer enhancement. In fact, using twisted tape increases both desirable heat transfer rate and undesirable friction loss (pressure drop). An appropriate twisted tape modification is a challenge task as a proper design of twisted tape is a main key for heat transfer enhancement at a reasonable friction loss. Promvonge [5] presents experimental study of the influence of conical-nozzle turbulator inserts on heat transfer and friction characteristics in a circular tube. In his work, the turbulators were placed in the test tube with two different types: diverging- and converging-nozzle arrangement with various pitch ratios, $PR=2.0, 4.0,$ and 7.0 . Promvonge [6] also

investigated the effects of wires with square cross section forming a coil used as a turbulator on the heat transfer and turbulent flow friction characteristics and compared the experimental results with the results obtained from circular cross sectioned wire. Promvonge [7] again reported the employ of wire coil in conjunction with twisted tape for heat transfer augmentation in a tube. Bharadwaj et al. [8] examined the heat transfer and pressure drop in a spirally grooved tube with twisted tapes for laminar to turbulent regions.

Apart from the above, there are other turbulator devices, such as baffles, ribs and fins that have been applied in heat exchanger tubes. However, in these groups, there are very few compared to twisted-tapes and wire coils. Therefore, the main aim of the present work is to investigate the influence of the V-baffled tape on heat transfer and flow friction in the tube heat exchangers. The V-baffled tape is a newly enhanced device invented and proposed for thermal performance improvement in a tube by a combination of the twisted-tape and the wire-coil merits.

EXPERIMENTAL AND METHOD

Experiment Set-Up

A general schematic diagram of the experimental apparatus is shown in Figure 1. In the apparatus setting below, the copper test tube having inner diameter (D) of 50 mm and thickness of 2 mm was 4000 mm long included the test section length (L) of 2000 mm. The test tube was heated by continually winding flexible electrical wires providing a uniform heat-flux boundary condition. The outer surface of the test tube was well insulated to reduce convective heat loss to surroundings. The inlet bulk air from a 1.5 kW blower was directed through the orifice flow-meter and passed to the heat transfer test section in the turbulent region, Reynolds number from 5000 to 25,000. The airflow rate was measured by the orifice flow-meter, built according to ASME standard [9] and calibrated by using a hot-wire anemometer to measure flow velocities across the tube section. Manometric fluid was used in an inclined manometer with specific gravity of 0.826 to ensure reasonably accurate measurement of pressure drop. The volumetric airflow rates from the blower were adjusted by varying the motor speed through an inverter. The electrical output power of electric heater was controlled by a variac transformer. The inlet and outlet fluid temperatures in the tube were measured by K-type thermocouples while the surface temperatures (T_w) were measured by 56 thermocouples located along the test section. All of the temperatures getting from the system were consistently recorded using a data logger. The pressure drop across the test section was measured using a digital manometer.

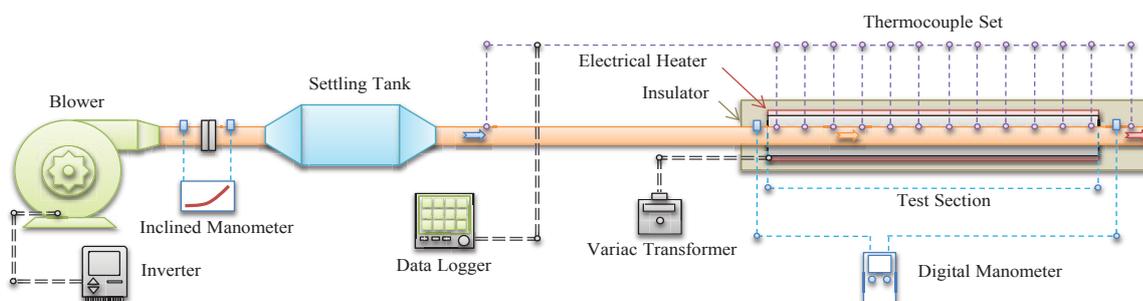


Figure 1 Schematic diagrams of experimental apparatus.

Figure 2 presents a detail of the V-baffled tape inserted in a tube. The V-baffle was made of 0.3 mm aluminum strip with the attack angle of 45°. In the experiment, the V-baffle strips placed repeatedly on both sides of a straight tape at a single baffle-height ($b/D=BR=0.2$) with four baffle-pitch ratios ($PR=P/D= 0.5, 1, 1.5$ and 2) while the straight tape made of aluminum sheet with its dimension of $45 \times 2000 \times 0.3 \text{ mm}^3$ was inserted into the tube as can be seen in Figure 2.

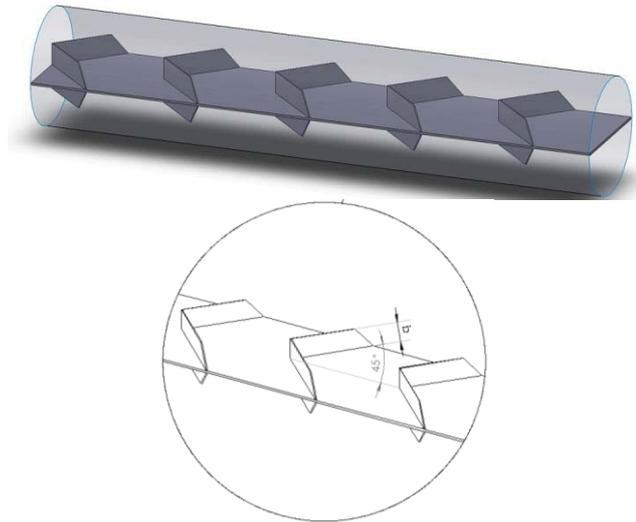


Figure 2 Test tube with 45° V-baffled tape insert.

Data Reduction

The Reynolds number (Re) based on tube diameter is given by

$$Re = UD / \nu \tag{1}$$

The friction factor (f) computed by pressure drop across the test section length (L) is

$$f = \frac{2}{(L/D)} \frac{\Delta P}{\rho U^2} \tag{2}$$

In the experiment, the steady state of the convective heat transfer rate is assumed to be equal to the heat loss from the test section. The average heat transfer coefficient (h) is estimated as

$$h = mC_{p,a}(T_o - T_i) / A(\tilde{T}_w - T_b) \tag{3}$$

The heat transfer is calculated from Nusselt number which can be obtained by

$$Nu = \frac{hD}{k} \tag{4}$$

From equal pumping power and the relationship between friction and Reynolds number, the thermal enhancement factor (TEF) can be written by

$$\text{TEF} = \frac{h_s}{h_p} \Big|_{pp} = \frac{\text{Nu}_s}{\text{Nu}_p} \Big|_{pp} = \left(\frac{\text{Nu}_s}{\text{Nu}_p} \right) \left(\frac{f_s}{f_p} \right)^{-1/3} \quad (5)$$

where h_p and h_s are the heat transfer coefficients for the plain tube and the inserted tube.

RESULTS AND DISCUSSION

Effect on Heat Transfer

The relationship between Nusselt number (Nu) and Reynolds number (Re) of the tube fitted with the V-baffled tapes is demonstrated in Figure 3(a). In the figure, the Nu increases with the increment of Re but with the decrease in the pitch ratio. The heat transfer of the tube with the V-baffled tape is found to be much better than that of the smooth tube, because the V-baffled tape inserted into the tube can help to induce an interruption of velocity/thermal boundary layer development, to increase the fast fluid mixing between the central core and the near-wall flows and to cause the heat transfer enhancement by increasing turbulence intensity.

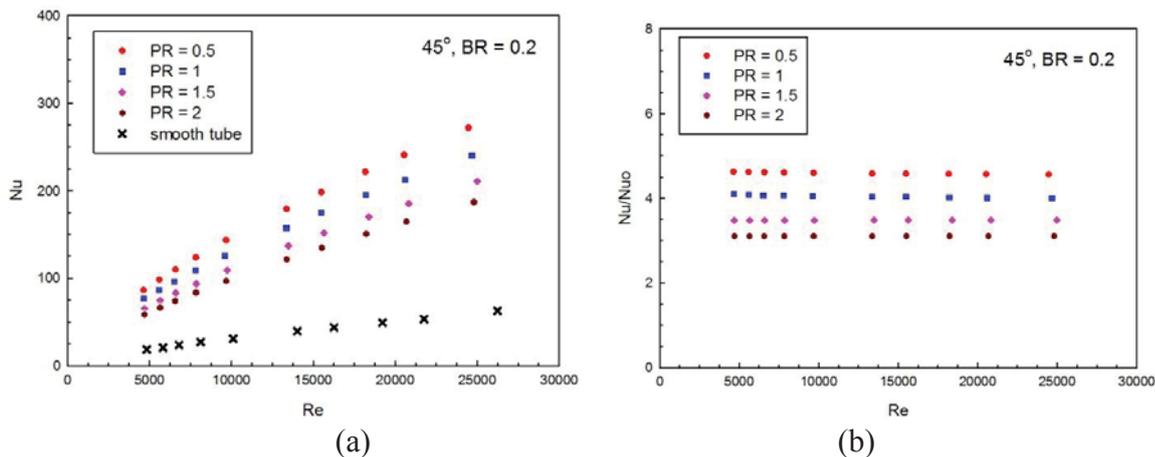


Figure 3 Variation of (a) Nu and (b) Nu/Nu₀ with Re for tubes fitted with 45° V-baffled tape.

The Nusselt number ratio (Nu/Nu₀) defined as a ratio of augmented Nusselt number to Nusselt number of smooth tube plotted against the Re is displayed in Figure 3(b). In the figure, the Nu/Nu₀ tends to slightly decrease with the rise of Re for all cases studied. Under the present experimental conditions, the increases in heat transfer for using the 45° V-baffled tapes are about 3.11-4.63 times higher than the smooth tube. The Nu/Nu₀ is reduced with the increase in PR value.

Effect on Friction Factor

Figure 4(a) shows the variation of the friction factor (f) with Re values obtained from using the 45° V-baffled tape inserts. It is observed that the f shows a decrease trend with the rise in the Re and the pitch ratio. The V-baffled tape gives rise to the f values higher than the smooth tube alone. This can be attributed to the flow blockage, higher surface area and the act caused by the reverse flow.

The variation of the friction factor ratio, f/f_0 with Re is presented in Figure 4(b). It is seen that the f/f_0 tends to increase with the increment of Re values. The V-baffled tape provides the higher f/f_0 at about 21.75-76.28 depending on Re and PR values.

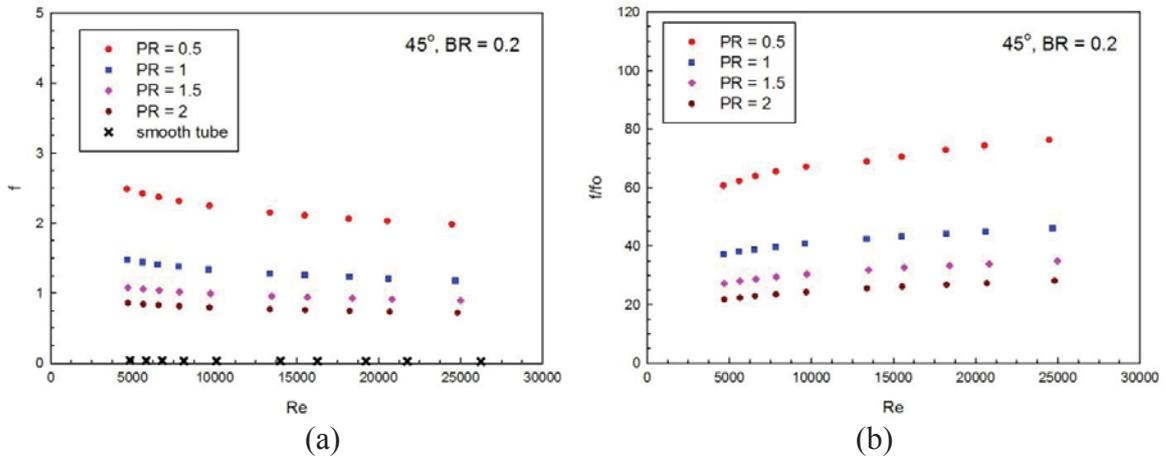


Figure 4 Variation of (a) f and (b) f/f_0 with Re for tube fitted with 45° V-baffled tape.

Effect on Thermal Enhancement Factor

Figure 5 shows the variation of the thermal enhancement factor (TEF) with Re values. It can be seen in the figure that the TEF values generally are above unity, indicating that the use of the V-baffled tape is advantageous over the smooth tube. The TEF tends to decrease with the increment of Re and PR values. The maximum TEF for the 45° V-baffled tape is found to be about 1.24 at PR = 1 and lower Re.

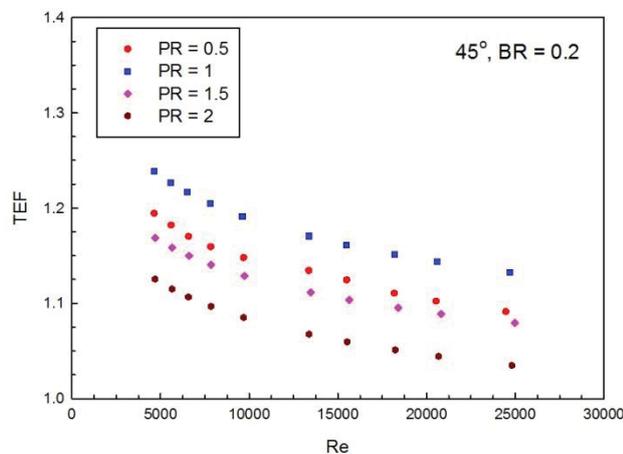


Figure 5 Variation of TEF with Re for 45° V-baffled tape.

CONCLUSION

An experimental study has been conducted to examine an influence of the 45° V-baffled tapes inserted into a heating tube at several pitch ratios (PR=0.5, 1, 1.5 and 2) on the Nu, f and TEF characteristics. The following conclusions can be drawn in the present investigation.

- The V-baffled tape insert yields higher Nu rate up to 4.63, 4.10, 3.48 and 3.11 times above the plain tube, while gives f up to 76.28, 45.96, 34.94 and 28.13 times at PR = 0.5, 1, 1.5 and 2, respectively.

- The TEF is found to be higher than unity for all the 45° V-baffled tape inserts. The maximum TEF values for each the 45° V-baffled tape case are around 1.19, 1.24, 1.17 and 1.13 at PR=0.5, 1, 1.5 and 2, respectively. The optimal V-baffled tape at PR=1 is suggested.

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Analysis of Laminar Flow and Heat Transfer in a Circular Tube with Angled Orifices

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Abstract: A numerical study of turbulent periodic flow and heat transfer in a three-dimensional constant heat flux-surfaced circular tube placed with angled orifice with two pitch ratios (1.5 and 2.0) and two blockage ratios (0.5 and 0.1) is presented. The fluid flow and heat transfer characteristics were presented for Reynolds numbers ranging from 5,000 to 20,000. The computation based on the finite volume method and the SIMPLE algorithm had been implemented. Effects of angled orifices on heat transfer and friction factor in the tube were studied and their results of the orifices of 45° attack angle were also compared with smooth tube. It was found that the angled orifice provided higher heat transfer rate and friction factor than the smooth tube for all Reynolds number values. The increase of the blockage ratio led to an increase in the Nusselt number and friction factor, while trend of increasing pitch ratios was opposite.

Keywords: Turbulent flow, Circular tube, Angled orifice, Heat transfer, Friction factor

INTRODUCTION

The heat transfer enhancement technique is very important and needed in engineering thermal processes in order to reduce the cost and energy consumption in thermal systems. For decades, turbulators such as ribs, fins, grooves, and baffles have been extensively employed in many applied engineering works due to their high thermal loads and decreased dimensions. The cooling or heating fluid is supplied into the ducts mostly mounted with several ribs to increase the degree of cooling or heating levels and this configuration is often used in the design of heat exchangers. Therefore, rib spacing, angle of attack and height are among the most important parameters in the design of duct heat exchangers.

The concept of periodically fully developed flow was first introduced by Patankar *et al.* [1] to investigate numerically the heat transfer and flow characteristics in a duct. Since then, the periodically fully developed flow condition has been widely used to study thermal characteristics in ribbed ducts with different rib heights and pitch spacing lengths [2, 3].

A numerical investigation of laminar forced convection in a three-dimensional channel fitted with baffles for periodically fully developed flow and with a uniform heat flux in the top and bottom walls was conducted by Lopez *et al.* [4], Sripattanapipat and Promvonge [5] numerically studied the laminar periodic flow and thermal behaviors in a two dimensional channel fitted with staggered diamond shaped baffles and reported that the diamond baffle with half apex angle of 5–10° performs slightly better than the flat baffle. Promvonge *et al.* [6] also examined numerically the laminar heat transfer in a square channel with 45° angled baffles placed repeatedly on one wall and found that a single streamwise

vortex flow occurs and induces impingement jets on the wall of the interbaffle cavity and the baffle-end-attached sidewall.

Most of the previous investigations have considered the laminar flow and heat transfer characteristics for the angled baffle in square duct only. Therefore, the angled rib or orifice in the circular tube has rarely been reported. In the present work, the numerical computations for three dimensional laminar periodic tube flows over a 30° angled orifice mounted in a round tube are conducted to examine the changes in the flow structure and its thermal performance.

MATHEMATICAL FOUNDATION

The numerical model for fluid flow and heat transfer in a circular tube was developed under the following assumptions: steady, three-dimensional, laminar, incompressible fluid flow and constant fluid properties. Body forces, radiation heat transfer and viscous dissipation are ignored. Based on the above assumptions, the tube flow is governed by the continuity, the Navier-Stokes equations and the energy equation. In the Cartesian tensor system these equations can be written as follows:

Continuity equation:

$$\frac{\partial}{\partial x_i}(\rho u_i) = 0 \quad (1)$$

Momentum equation:

$$\frac{\partial(\rho u_i u_j)}{\partial x_j} = -\frac{\partial p}{\partial x_i} + \frac{\partial}{\partial x_j} \left[\mu \left(\frac{\partial u_i}{\partial x_j} + \frac{\partial u_j}{\partial x_i} \right) \right] \quad (2)$$

Energy equation:

$$\frac{\partial}{\partial x_i}(\rho u_i T) = \frac{\partial}{\partial x_j} \left(\Gamma \frac{\partial T}{\partial x_j} \right) \quad (3)$$

where Γ is the thermal diffusivity and is given by $\Gamma = \mu / \text{Pr}$.

All the governing equations were discretized by the QUICK scheme, coupling with the SIMPLE algorithm and solved using a finite volume approach [7]. The solutions were considered to be converged when the normalized residual values were less than 10^{-5} for all variables but less than 10^{-9} only for the energy equation.

Four parameters of interest in the present work are the Reynolds number, friction factor, Nusselt number and thermal enhancement factor. The Reynolds number is defined as

$$\text{Re} = \rho \bar{u} D / \mu \quad (4)$$

The friction factor, f is computed by pressure drop, Δp across the length of the periodic tube, L as

$$f = \frac{(\Delta p / L) D}{\frac{1}{2} \rho \bar{u}^2} \quad (5)$$

The heat transfer is measured by local Nusselt number which can be written as

$$\text{Nu}_x = \frac{h_x D}{k} \quad (6)$$

The area-averaged Nusselt number can be obtained by

$$Nu = \frac{1}{A} \int Nu_x \partial A \tag{7}$$

The thermal enhancement factor (TEF)

$$TEF = \frac{h}{h_0} \bigg|_{pp} = \frac{Nu}{Nu_0} \bigg|_{pp} = (Nu/Nu_0)/(f/f_0)^{1/3} \tag{8}$$

where Nu_0 and f_0 stand for Nusselt number and friction factor for the smooth tube, respectively.

FLOW CONFIGURATION

Angled Orifice Geometry and Arrangement

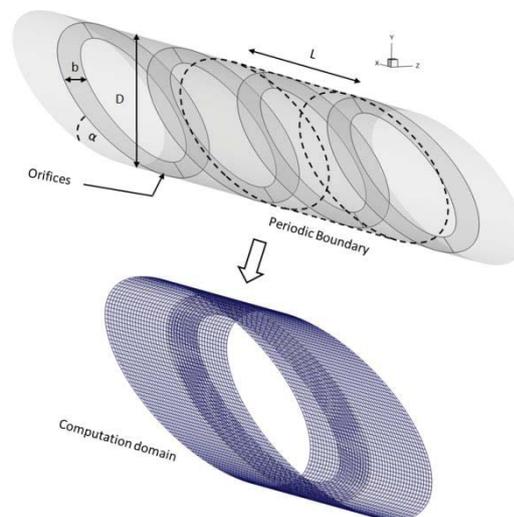


Figure 1 Circular tube and computational domain of periodic flow module

The system of interest is a circular tube with 30° angled orifices placed into the circular tube in tandem as shown in Figure 1. The flow under consideration is expected to attain a periodic flow condition in which the velocity field repeats itself from one cell to another. The concept of periodically fully developed flow and its solution procedure has been described [1]. The air enters the tube at an inlet temperature, T_{in} , and flows through the angled orifices where b is the size of the orifice, D set to 0.05 m is diameter of the tube and b/D is known as the blockage ratio, $BR = 0.10$ to 0.25 . The axial pitch, L or distance between the orifice cell is set to $L = 2.5D$ in which L/D is defined as the pitch ratio, $PR = 2.5$

Boundary Conditions

Periodic boundaries are used for the inlet and outlet of the flow domain. Constant mass flow rate of air with 300K ($Pr = 0.7$) is assumed in the flow direction rather than constant pressure drop due to periodic flow conditions. The inlet and outlet profiles for the velocities must be identical. The physical properties of the air have been assumed to remain constant at average bulk temperature. Impermeable boundary and no-slip wall conditions have been implemented over the tube walls as well as the orifice. The constant temperature of the tube wall is maintained at 310K while the orifice plate is assumed to be adiabatic wall conditions.

Verification of Smooth Tube

Verification of the Nu and f of the smooth tube without orifice is performed by comparing with the previous values as depicted in Figure 2a and b, respectively. The current numerical result is found to be in excellent agreement with the exact solution obtained from the open literature [8] for both the Nu and f , less than $\pm 0.25\%$ deviation. The exact solutions of the Nu and f for laminar flow over the smooth tube at constant wall temperature are, respectively, $Nu_0 = 3.66$ and $f_0 = 64/Re$.

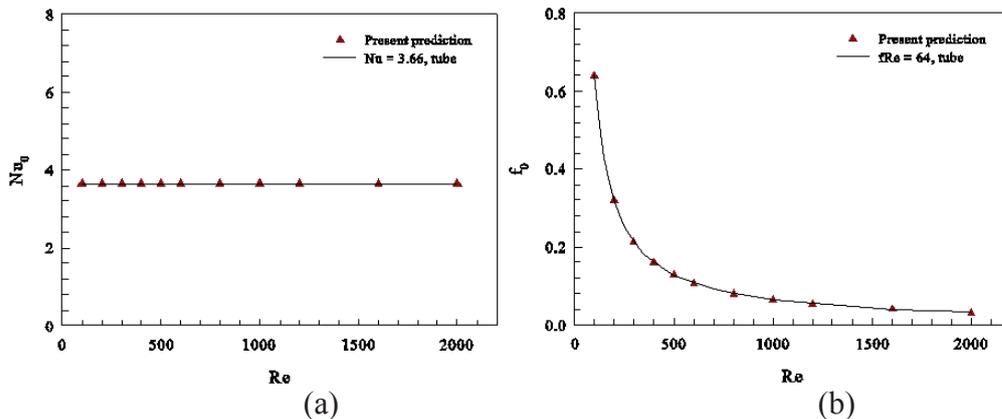


Figure 2 Verification of Nusselt number and friction factor for smooth tube

RESULTS AND DISCUSSION

Flow Structure

The flow and vortex coherent structure in the circular tube with angled orifices can be displayed by considering the streamline plots as depicted in Fig. 3. Here the streamlines of the angled orifice are presented at $Re = 800$, $BR = 0.20$ and show that two main counter-vortex flows can be induced by the presence of the orifice and occur behind the angled orifice. The common-flow-down vortices provide impingement flow on the lower tube wall region leading to substantially increase the heat transfer in the tube. The two vortex cores (eye of the vortex) will move along the inter-orifice cavity as can be seen in Fig. 3.

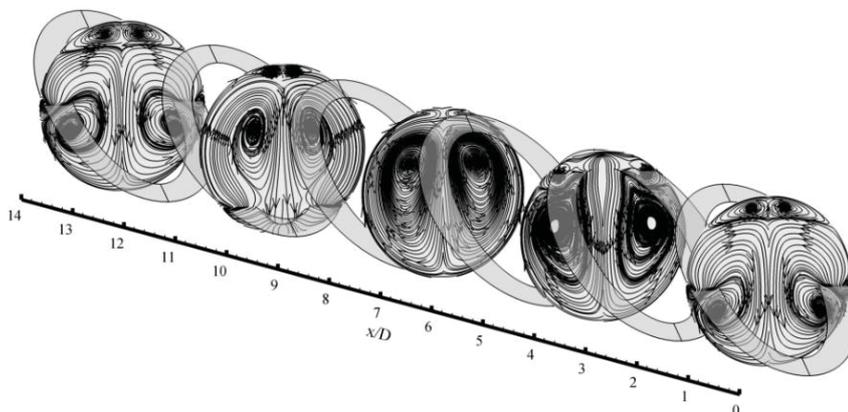


Figure 3 Streamline in transverse for $BR = 0.20$, $Re = 800$

Heat Transfer, Pressure Loss and Performance Evaluation

The plot of local Nu_x contours for the tube with the angled orifice at $BR = 0.20$, $Re = 800$ is presented in Figure 4. In the figure, it appears that the region of higher Nu_x values for the orifice-mounted tube is seen in the bottom area. The peaks are observed at the impingement areas on the lower wall.

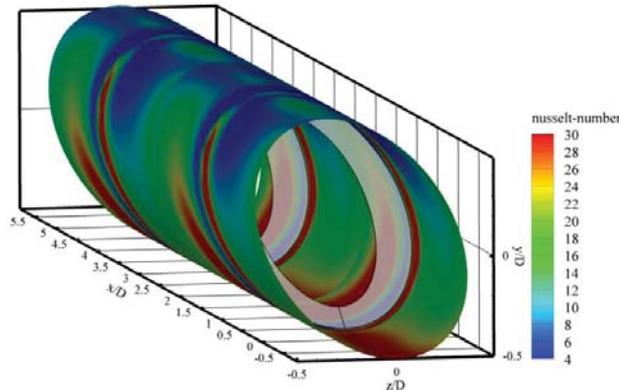


Figure 4 Nu_x contour for orifice-mounted tube at $BR = 0.20$, $Re = 800$.

The variation of the Nusselt number ratio, Nu/Nu_0 ratio with Reynolds number at different BRs is displayed in Fig. 5a. It is worth noting that the Nu/Nu_0 tends to increase with the increment in Reynolds number. The higher BR value leads to the increase in the Nu/Nu_0 . The highest Nu/Nu_0 for the angled orifice at $BR = 0.25$ is found to be about 6.8 times. The angled orifice in this work yields the heat transfer rate of about 1.0 – 6.8 times higher than the smooth tube alone.

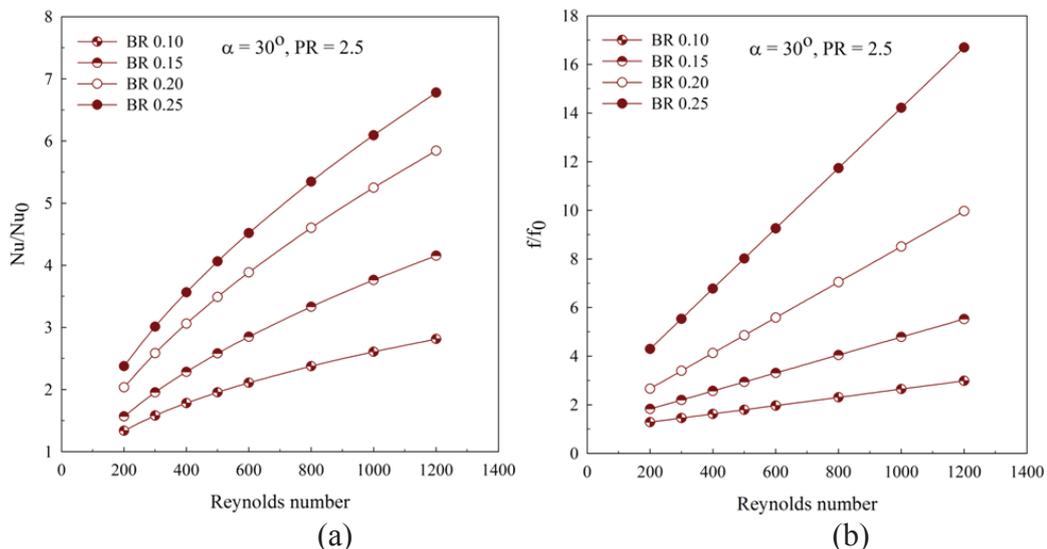


Figure 5 Variation of (a) Nu/Nu_0 and (b) f/f_0 with Reynolds number at various orifice BRs

Figure 5b presents the variation of the friction factor ratio, f/f_0 with Reynolds number for various BRs. In the figure, it is noted that the f/f_0 tends to increase considerably with the rise of Reynolds number, especially for larger BR. The use of the angled orifice leads to considerable increase in friction factor in comparison with the smooth tube with no orifice. The increasing the BR gives the higher friction factor. The f/f_0 for the angled orifice is found to be about 1.1 – 16.7 times depending on the BR and Reynolds number values.

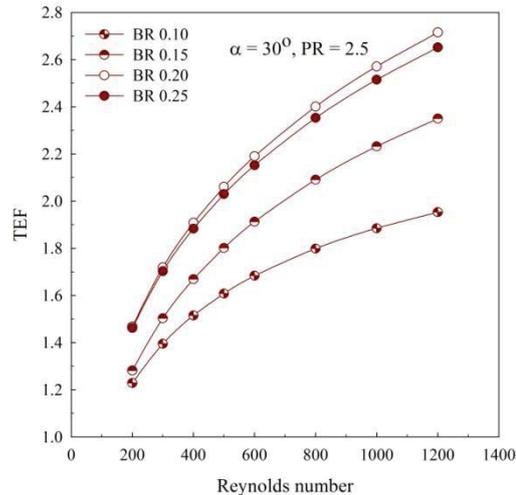


Figure 6 Variation of TEF with Reynolds number at various orifice BRs

Figure 6 exhibits the variation of thermal enhancement factor (TEF) with Reynolds number for various BRs. It is visible that the TEF trend is increased with the rise in Reynolds number. The TEF for using the angled orifice at all BRs is found in a range of 1.00 – 2.7, depending on the BR and Re values. The maximum TEF is about 2.7 for using the orifice at BR=0.2 and Re = 1200.

CONCLUSION

A numerical investigation has been conducted to examine laminar periodic flow and heat transfer characteristics in a circular tube placed periodically with 30° angled orifices. The counter-vortex flows created by the angled orifices exist and help to induce impingement flows on the lower wall leading to drastic increase in heat transfer rate in the tube. The order of enhancement is about 1.0 – 6.8 times above the smooth tube for the angled orifice at BR = 0.1 – 0.25 and PR = 2.5. However, the heat transfer augmentation is associated with the enlarged pressure loss ranging from 1.12 to 16.7 times. The highest thermal enhancement factor for the angled orifice with BR = 0.20 is found to be about 2.71 at the highest Re.

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Utilization of Longan Waste Residue in Northern Thailand

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Abstract: Thailand produces enormous amounts of organic waste such as waste residue from an economic fruit plant called longan in the northern area. Longan waste residues, both agricultural and industrial have been used as components for solid composting, liquid compost, biogas, and briquette. In this paper, various types of waste utilization schemes are described some best practices that can be used for waste utilization are proposed alternatives for communities and related agencies to cope with the waste problem in the northern part of Thailand as well as in ASEAN countries.

Keywords: Longan waste residue, Waste utilization, Northern Thailand

INTRODUCTION

Thailand produces enormous amounts of organic waste such as longan waste residues (LWR) from agricultural and industrial sectors. Longan is a major economic fruit plant in the northern Thailand. It was found that there was about 525,230 tons of longan yield and 176,752 tons of biomass from the longan farm in 2010 [1]. Mostly, LWR occurred from longan fruit harvest which create many particularly those environmental problems, such as air pollution and waste disposal. Some LWR are difficult to dispose occurred from the factory of dried longan fruit processing. The open burning of these wastes partially caused the first haze crisis in Chiang Mai and the upper northern area during the end of winter to the early hot season in 2007 [2]. To cope with these problems and energy crisis, many ideas to minimize or eliminate pollution and transform waste-to-energy conditions came up.

This paper presents the green technology or clean technology using LWR. This technology is an application of both environmental science and engineering to monitor and conserve the natural environment and resources as well as to curb the negative impacts of human involvement [3]. Based on the concept of waste minimization to prevent the cause of pollution and the adverse effect and increase the value added yield [4], environmental technologies using LWR have been studied. It was conducted to develop and produce useful products like solid and liquid compost, biogas, and biomass briquette. In addition, some proper techniques were proposed as alternatives for best practice, suitable for local communities both in northern Thailand and in ASEAN countries that are experiencing similar problems.

MATERIALS AND METHODS

LWR consist of leaves, petioles, and branches are used as raw material to produce solid and liquid composts and biogas. LWR that consist of seed and peel of longan fruit

residues as well as leaves and branches of LWR are used as a raw material to produce biomass briquette by densification technique. The obtained products were tested and compared with the related standard methods of organic fertilizer, waste water, biogas, and calorific value [5-8].

RESULTS AND DISCUSSION

Development of LWR Utilization

To develop LWR utilization, three kinds of environmental technology were adopted to transform these residues to obtain more value added yields based upon the type of LWR. The techniques of these technologies were the following.

Firstly, compost technology that focused on open window technique was studied due to its simplest method on reducing air pollution and waste disposal. The volume of leaves and petioles and branches of LWR could be reduced by 70% within 64 days by weekly turning composting pile with the maintenance of moisture content inside the pile during the composting process. Moreover, some waste residue such as mushroom bed materials can be used as a mixture for composting [9]. Besides, aeration technique could be used to reduce much more volume of LWR in shorter period (45 days) [3]. The quality of compost yield obtained in terms of essential nutrients; N:P:K met the standard of organic compost in 2005 (N:P:K =1:0.5:0.5) [5].

Secondly, biogas technology that focused on anaerobic digestion was also studied even it's more difficulty to operate. It could generate high percentage of methane (CH₄) yield (about 65%) in the low rate digester size 200 L by mixing leaves and petioles of LWR with spent wash liquor and a starter from the pig farm sludge [10]. Moreover, LWR can mix with food waste and a starter to produce biogas. This yield could be used as an renewable energy source for cooking in the household. In addition, the good liquid compost was also obtained and used as organic fertilizer [10].

Thirdly, briquette technology that focused on a mould and pressure technique called densification was studied to introduce for biomass briquette application. In fact, not only seed and peel but also leaves and petioles and branches of LWR (80:20 mixture) were also used to produce the briquette [11]. Moreover, LWR can be mixed with other waste residues like bamboo to produce briquette. This technology could convert those loose LWR into compact solid bio-fuel which is convenient to transport, store, and lighten. In particular, it is easy to get high heating value (16,618 J/g) with low pollution due to the capability of carbon balance preservation in the nature cycle.

The obtained LWR products from these technologies could be classified into 2 levels; 1) implementing via demonstration, knowledge and technology transfer project by training and workshop, campaign project, pilot project, and community-based learning center and 2) developing under laboratory experiment and testing. All LWR products can help to improve the quality of life and protect the environment as well as the development of innovative technologies, which enhance an economic self-sufficiency and growth philosophy of King Bhumibol Adulyadej, and may contribute to long-term employment for the commercial use. Moreover, technologies for LWR utilization could be used as one of alternatives for the best practice option in proper local communities by continuous supporting at the local and national level.

The Best Practice of LWR Utilization

“Best practice” means the application of these technologies for LWR utilization to protect the environment in the form of saving resources, and avoiding waste by providing effective and sound information and education. It is obvious that no technology is perfect. Pros and cons of the techniques and practices used for LWR utilization are shown in Table 1.

Table 1 Advantage and disadvantage of proposed technology for LWR utilization

Technology	Advantage	Disadvantage
1. Compost	<ul style="list-style-type: none"> - Reduce volume of waste - Decrease air pollution from burning of LWR - Increase more value added product such as compost and income from commercial use 	<ul style="list-style-type: none"> - Require power man and space for mass production of compost for open windrow technique - Require energy for aeration technique
2. Biogas	<ul style="list-style-type: none"> - Reduce volume of waste - Decrease air pollution from burning of LWR - Increase more value added product such as biogas and liquid compost - Decrease cost for cooking fuel like LPG 	<ul style="list-style-type: none"> - Require maintenance for mass biogas production - Require cost for equipment and investment
3. Briquette	<ul style="list-style-type: none"> - Reduce volume of waste - Decrease air pollution from burning of LWR - Increase more value added product such as biomass briquette for cooking fuel like wood or charcoal with low pollution 	<ul style="list-style-type: none"> - Require device/machine for grinding and pressing for mass production - Require proper formula for the better biomass briquette

Application and R&D for LWR Utilization

According to the technologies developed for LWR utilization, some application and R&D could be performed as shown in Table 2. For application in community, time and willingness of community participation were found to be the major barriers in local implementation. In addition, the continuous support from the national policy to the related local agencies are essential to enhance the sustainable use of those technologies for LWR utilization in communities.

Table 2 Application and R&D for LWR Utilization

Technology	Application	R & D
1. Compost	-Demonstration, knowledge and technology transfer project, and learning center in the related agencies	-Increase aeration technique by using some shape and structural material like bamboo [12]
2. Biogas	-Publication, knowledge and technology transfer in community	-Increase more techniques for improving biogas yield like two-stage digestion
3. Briquette	-Knowledge and technology transfer in community	-Require other waste materials for mixing and developing new formula of biomass briquette

CONCLUSION

To develop LWR utilization, three proposed environmental technologies were useful for the best practice of LWR utilization in local communities at different level due to some disadvantages and barriers. The choice of technology for LWR utilization should be made on the potential of local communities and local condition in the form of participation and acceptance for implementation based on the continuous support of the national policy. The best compromise would be to choose those technologies for LWR utilization that could be used to solve the problem of environmental pollution, energy crisis, and waste management and to generate income and jobs that help to upgrade the quality of life at the same time.

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Heat Transfer Augmentation in a Solar Air Heater Channel with Wavy Baffles

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Abstract: Heat transfer and pressure drop characteristics in a solar air heater channel fitted with wavy-baffles was investigated. The experiments were carried out by varying airflow rate for Reynolds number ranging from 5,000 to 25,000 in the test section with a constant wall heat flux on the upper channel plate which is similar to a solar air heater channel or solar absorber. The wavy baffles with transverse and streamwise pitch spacing equal to two times of channel height and with the attack angle of 30 deg were mounted repeatedly on the upper plate only. The effects of four ribs to channel height ratios or blockage ratios ($b/H=HR$) of 0.1, 0.15, 0.2 and 0.25 on heat transfer in terms of Nusselt number and friction loss in the form of friction factor were also investigated. It was shown that the wavy baffle with $BR=0.25$ provided higher heat transfer and friction factor values than other wavy baffles, but the one with $e/H=0.2$ yielded the best thermal performance at lower Reynolds number.

Keywords: Solar air heater, Augmentation, Blockage ratio, Wavy baffle, Heated transfer, Nusselt number

INTRODUCTION

One type of thermal collection equipments which extensively used is solar air heater. It has a low convective heat transfer coefficient. This can be improved by creating the artificial roughness on heat transfer surface such as rib, groove, fin and baffle in order to enhancing the heat transfer rate from the heat transfer surface bringing to compact the size of heat exchanger and increasing its efficiency. The turbulators fitted on the channel wall are used to generate the periodic flow interruption for heat transfer enhancement. These turbulators increase not only the rate of heat transfer but also substantial the pressure drop. Especially, the Baffle geometry, the baffle to channel height ratio, and the baffle pitch to height ratio and the baffle angle are the parameters that affect the thermal performance.

Several experimental works have been carried out to investigate the effect of relevant parameters of turbulators on heat transfer and friction factor for the roughened channel surface. Wright et al. [1] investigated the heat transfer distributions and frictional losses in rotating ribbed channels with an aspect ratio of 4:1. Angled, discrete angled, V-shaped, and discrete V-shaped ribs were investigated, as well as the newly proposed W-shaped and discrete W-shaped ribs. In all cases, the ribs were placed on both the leading and trailing surfaces of the channel, and they were oriented 45 deg to the mainstream flow. The rib height-to-hydraulic diameter ratio e/H was 0.078, and the rib pitch-to-height ratio P/e was 10. The channel orientation with respect to the direction of rotation was 135 deg. The range of flow parameters included Reynolds number ($Re=10,000-40,000$). It was determined that the

W-shaped and discrete W-shaped ribs had the superior heat transfer performance in both non-rotating and rotating channels. The angled rib configuration resulted in the worst performance of the six configurations of the present study.

Promvonge and Thianpong [2] studied the thermal performance of wedge ribs pointing upstream and downstream, triangular and rectangular ribs with $e/H=0.3$ and $P/e=6.67$ mounted on the two opposite walls of a channel with $AR=15$. They found that the inline wedge rib pointing downstream performed the highest heat transfer but the best thermal performance is the staggered triangular rib. Promvonge et al. [3] studied the numerical computations for three dimensional laminar periodic channel flows over a 45° inclined baffle mounted only on the lower square-channel wall and found that the 45° baffle with $BR=0.4$, the enhancement of heat transfer is about 2–3 folds higher than that for the 90° baffle while the friction loss is some 10–25% lower. An extensive literature review over hundred references on various rib turbulators was reported by Varun et al. [4].

In this experimental study is to investigate the heat transfer and friction characteristics in the channel with 30° wavy baffles fitted on the upper plate and heated at the same plate of the channel. The experimental data is available on various blockage ratio, $e/H = 0.1, 0.15, 0.2$ and 0.25 with $PR = 2$. The experiment results using air as the test fluid are presented in turbulent channel flows in a range of Reynolds number from 5000 to 25,000 in this experiment.

MATERIALS AND METHODS

Experimental Apparatus

A schematic diagram of the experimental apparatus is presented in Figure 1 while the details of 30° wavy baffles array on the rectangular channel used in the heat transfer experiments are depicted in Figure 2. In Fig.1, a circular pipe was used for connecting a high-pressure blower to a settling tank, in which an orifice flow meter was mounted in this pipeline while a rectangular channel including a calm section and a test section was employed following the settling tank. In the test section, the rectangular channel configuration was characterized by the channel height, H of 30 mm while the baffles had both longitudinal and transverse pitches equal to two times of the channel height (pitch ratio, $PR=P/H=2$) with the attack angle of 30° . The overall length of the channel was 2000 mm in which the test section was 400 mm with the width, W , of 300 mm. Each of the principle channel walls was fabricated from 6 mm thick aluminum plates, 300 mm wide and 400 mm long (L). The baffle strip dimensions were 3, 4.5, 6 and 7.5 mm high (e) and 0.3 mm thick (t).

Methods

The AC power supply was the source of power for the plate-type heater, used for heating the upper-plate of the test section only to maintain uniform surface heat flux. A conducting compound was applied to the heater and the principal upper wall in order to reduce contact resistance. Special wood bars, which have a much lower thermal conductivity than the metallic wall, were placed on the inlet and exit ends of the upper and lower walls to serve as a thermal barrier at the inlet and exit of the test section.

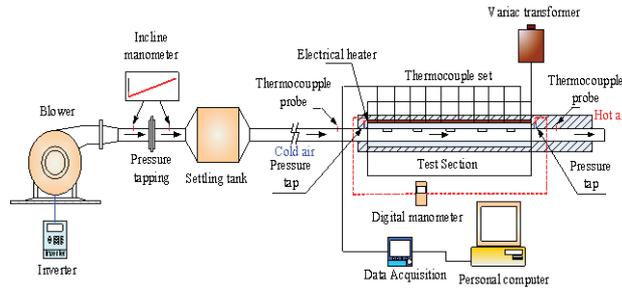


Figure 1 Schematic diagram of experimental apparatus.

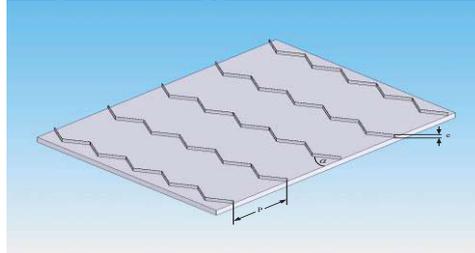


Figure. 2 Test section with 30° wavy baffles.

Air as the tested fluid in both the heat transfer and pressure drop experiments, was directed into the systems by a 1.45 kW high-pressure blower. The blower operating speed was varied by using an inverter to provide desired air flow rates. The air flow rate in the systems was measured by an orifice plate pre-calibrated by using hot wire and vane-type anemometers (Testo 445). The pressure across the orifice was measured using inclined manometer. In order to measure temperature distributions on the principal upper wall, ten thermocouples were fitted to the wall. The thermocouples were installed in holes drilled from the rear face and centered of the walls with the respective junctions positioned within 2 mm of the inside wall and axial separation was 40 mm apart. All thermocouples were K-type, 1.5 mm diameter wire. To measure the inlet bulk temperature, two thermocouples were positioned upstream of duct inlet. Both of these thermocouples were RTD PT 100, 1.5 mm diameter wire. The thermocouple voltage outputs were fed into a data acquisition system (Fluke 2650B) and then recorded via a personal computer.

Two static pressure taps were located at the top of the principal channel to measure axial pressure drops across the test section, used to evaluate average friction factor. These were located at the centre line of the channel. One of these taps is 120 mm downstream from the leading edge of the channel and the other is 50 mm upstream from the trailing edge. The pressure drop was measured by a digital differential pressure manometer connected to the 2 mm diameter taps and recorded via a personal computer.

To quantify the uncertainties of measurements the reduced data obtained experimentally were determined. The uncertainty in the data calculation was based on Ref. [6]. The maximum uncertainties of non-dimensional parameters were $\pm 5\%$ for Reynolds number, $\pm 8\%$ for Nusselt number and $\pm 10\%$ for friction. The uncertainty in the axial velocity measurement was estimated to be less than $\pm 7\%$, and pressure has a corresponding estimated uncertainty of $\pm 5\%$, whereas the uncertainty in temperature measurement at the channel wall was about $\pm 0.5\%$.

Data Reduction

The goal of this study is to investigate the Nusselt number in the channel. The Reynolds number based on the channel hydraulic diameter, D_h , is given by

$$Re = UD_h / \nu, \tag{1}$$

where U and ν are the mean air velocity of the channel and kinematics viscosity of air, respectively. The average heat transfer coefficient, h , is evaluated from the measured temperatures and heat inputs. With heat added uniformly to fluid (Q_{air}) and the temperature difference of wall and fluid ($T_w - T_b$), the average heat transfer coefficient will be evaluated from the experimental data via the following equations:

$$Q_{air} = Q_{conv} = \dot{m}C_p(T_o - T_i) = VI - \text{heat loss}, \tag{2}$$

$$h = \frac{Q_{conv}}{A(\tilde{T}_s - T_b)}, \tag{3}$$

in which,

$$T_b = (T_o + T_i) / 2, \tag{4}$$

and

$$\tilde{T}_s = \sum T_s / 10 \tag{5}$$

The term A is the convective heat transfer area of the heated upper channel wall whereas \tilde{T}_s is the average surface temperature obtained from local surface temperatures, T_s , along the axial length of the heated channel. The terms \dot{m} , C_p , V and I are the air mass flow rate, specific heat, voltage and current, respectively. Then, average Nusselt number, Nu , is written as:

$$Nu = \frac{hD_h}{k}. \tag{6}$$

The friction factor, f , is evaluated by:

$$f = \frac{2}{(L/D_h)} \frac{\Delta P}{\rho U^2}, \tag{7}$$

where ΔP is a pressure drop across the test section and ρ is density. All of thermo-physical properties of the air are determined at the overall bulk air temperature, T_b , from Eq. (4).

For equal pumping power,

$$(\dot{V}\Delta P)_0 = (\dot{V}\Delta P), \tag{8}$$

in which \dot{V} is volumetric air flow rate and the relationship between friction and Reynolds number can be expressed as:

$$\begin{aligned} (f Re^3)_0 &= (f Re^3), \\ Re_0 &= Re(f/f_0)^{1/3}. \end{aligned} \tag{9}$$

The thermal enhancement factor (TEF) defined as the ratio of heat transfer coefficient of an augmented surface, h to that of the smooth surface, h_0 , at the same pumping power:

$$TEF = \frac{h}{h_0} \Big|_{pp} = \frac{Nu}{Nu_0} \Big|_{pp} = \left(\frac{Nu}{Nu_0} \right) \left(\frac{f}{f_0} \right)^{-1/3} \tag{10}$$

RESULTS AND DISCUSSION

Verification of Smooth Channel

The experimental results on heat transfer and friction characteristics in a smooth wall channel are first validated in terms of Nu and f . The Nu and f obtained from the present

smooth channel are, respectively, compared with data from the correlations of Dittus-Boelter and Blasius found in the open literature [6] for turbulent flow in ducts.

Correlation of Dittus-Boelter,

$$Nu = 0.023 Re^{0.8} Pr^{0.4} , \quad \text{for heating.} \quad (11)$$

Correlation of Blasius,

$$f = 0.316 Re^{-0.25} \quad \text{for } 3000 \leq Re \leq 20,000 \quad (12)$$

Figure 3a and 3b shows, respectively, a comparison of Nusselt number and friction factor obtained from the present work with those from correlations of Eqs. (11) and (12). In the figure, the present results agree very well within $\pm 3\%$ for Nu and f correlations.

Effect of Baffle Height

The experimental results on thermal characteristics in a uniform heat-fluxed absorber plate with 30° wavy baffles placed on the upper plate only are presented in the form of Nu and f . The Nu values for all cases are depicted in Fig. 4a. In the figure, the wavy baffles provide considerable heat transfer enhancements with a similar trend in comparison with the smooth channel. The Nu increases with the rise of Re. This is because the baffles interrupt the development of thermal boundary layer thickness of the fluid flow and help to increase the turbulence degree of flow. It is worth noting that the wavy baffle with PR=2 and $e/H=0.25$ provides the highest Nu while the one with $e/H = 0.2$ performs better than the $e/H = 0.15$ and 0.1. This means that the wavy baffle with $e/H=0.25$ interrupts the flow and diverts its direction, thus promote higher level of mixing.

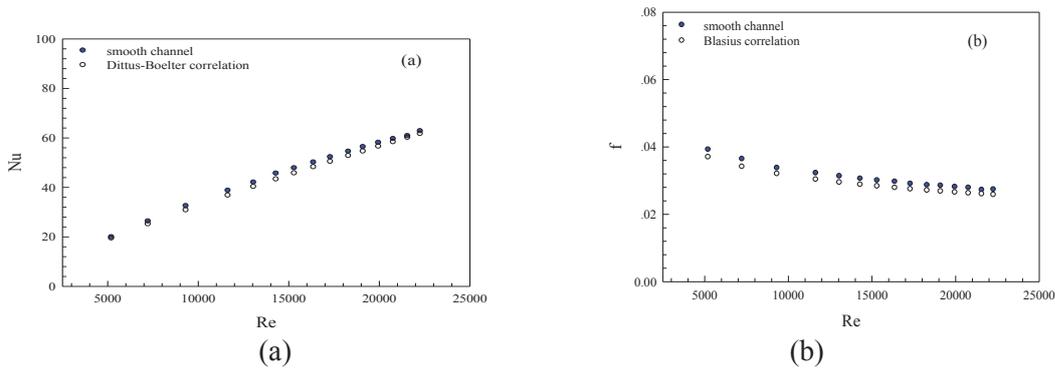


Figure 3 Verification of (a) Nu and (b) f for smooth channel.

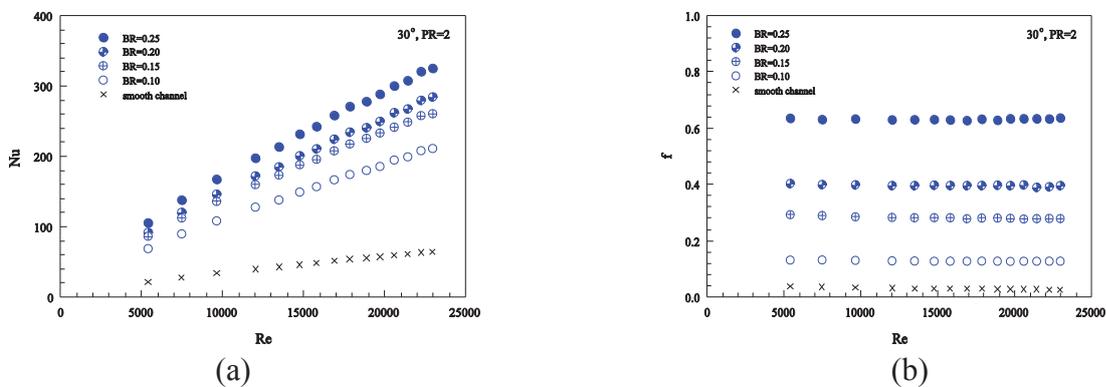


Figure 4 Variation of (a) Nu and (b) f with Re for various baffle heights.

The effect of the wavy baffle on the isothermal pressure drop across the tested channel is presented in Fig. 4b. The variation of the pressure drop is shown in terms of f with Re. In the figure, it is apparent that the use of the wavy baffle leads to a substantial increase

in f over the smooth channel. This can be attributed to flow blockage, higher surface area and the act caused by the reverse flow. As expected, the f of the $e/H=0.25$ baffle is considerably higher than those of the $e/H=0.2, 0.15$ and 0.1 ones. The increase in f for the $e/H = 0.25$ is in the range of 160% and 495% over the $e/H = 0.2, 0.15$ and 0.1 . The losses mainly come from the dissipation of the dynamical pressure of the air due to high viscous losses near the wall, to higher friction of increasing surface area and the blockage ratios because of the presence of the baffles.

Performance Evaluation

The Nusselt number ratio, Nu/Nu_0 , defined as a ratio of augmented Nusselt number to Nusselt number of smooth channel plotted against the Re is depicted in Fig. 5a. In the figure, the Nu/Nu_0 tends to be nearly uniform with the rise of Re from 5000 to 25,000 for all cases of $e/H = 0.25, 0.2, 0.15,$ and 0.1 . The mean Nu/Nu_0 values are found to be 5.01, 4.36, 4.05 and 3.24, respectively.

The variation of isothermal friction factor ratio, f/f_0 , with Re is shown in Fig. 5b. In the figure, the f/f_0 is found to be increased with increasing the Re and the blockage ratio. The mean f/f_0 values are around 21.33, 13.38, 9.49, and 4.31 for the wavy baffles with $e/H=0.25, 0.2, 0.15$ and 0.1 , respectively. This indicates that the use of lower e/H can help to reduce the pressure loss considerably.

Figure 5c displays the variation of the thermal enhancement factor (TEF) with Re . For all, the data obtained by Nu and f values are compared at similar pumping power. The TEF tends to decrease with the rise of Re values for all cases. It is seen that the baffle with $e/H=0.1$ performs the highest value of the TEF. The mean TEF values are around 1.99, 1.92, 1.84 and 1.58 at $e/H=0.1, 0.15, 0.2,$ and 0.25 , respectively. This can be attributed to considerably lower friction loss for using the lower blockage ratio baffle.

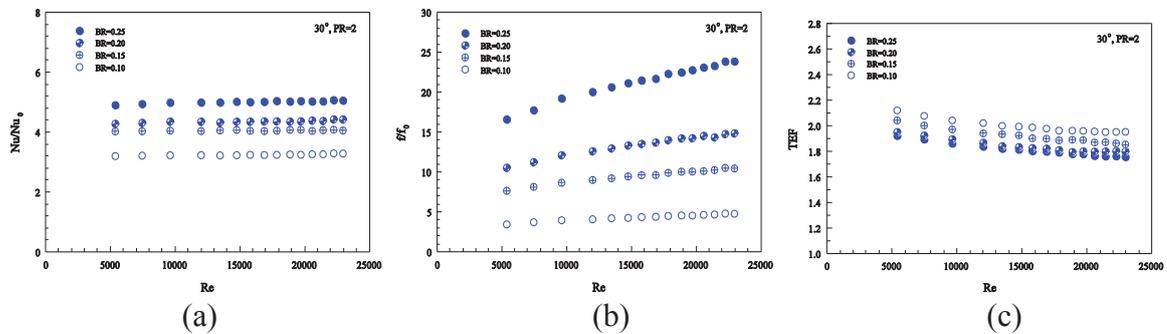


Figure 5 Variation of (a) Nu/Nu_0 , (b) f/f_0 and (c) TEF with Re .

CONCLUSION

An experimental investigation has been carried out to study heat transfer and pressure drop characteristics in a channel ($AR=10$) fitted with 30° wavy baffles on the upper plate wall at different flow blockage ratios in the turbulent regime, Reynolds number of 5000-25,000. The wavy baffle with $e/H=0.25$ causes a very high pressure drop increase and also provides considerable heat transfer augmentations, $Nu/Nu_0=5.01$. The Nu augmentation tends to increase with the rise of Re . In comparison, the use of the 30° wavy baffle leads to the higher heat transfer rate and the $e/H=0.1$ provides the highest TEF due to lowest friction loss.

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Tree Condition and Streamflow Trend in a Protected Old Growth Forest: Implications for Ecological Integrity and the Sustainability of Water Supply

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Abstract: The impacts of excessive productivity on the ecological integrity of forests: high tree density, overcrowding, closed canopy forests, self-thinning and density-induced mortality, as a result of excessive energy inflow into open systems such as unmanaged old growth forests and watershed reserves in protected areas, could lead to degradation and loss of vital watershed functions-water supply and purification. Therefore, the lack of site-specific information on the status of vegetation and trends in hydrology may result in the underestimation of water budget allocation for public water supply and precludes effective management prescription and facts-based policy action. Tree condition and streamflow trend in a mixed dipterocarp forest at the Pasonanca Natural Park in Zamboanga City, Philippines were investigated. Using the direct inventory of trees, ≥ 5 cm dbh in 18 circular fixed plots were located by stratified random sampling. Very high mean basal densities and variability at 56.08 (± 31.07 SD), 65.46 (± 35.89 SD) and 39.42 (± 8.59 SD) m² ha⁻¹, for lowland (LMD), hill (HMD), and hill secondary forest (HSF), were obtained respectively. Snags occurred in clusters in HMD affecting saplings and pole-sized trees. Lowland tree-size structure, dominated by medium to very large trees, was significantly different ($p < 0.001$) from sapling and pole-dominated structure of both hill forest sites. Canopy cover was continuous at 105% and organic litter was abundant in LMD and HMD. On the other hand, the observed decreasing trend in seasonally-adjusted stream flow time series (1983-2008), despite increasing precipitation trend for the same period, could be attributed to excessive water withdrawal of large lowland trees implying that their unrestricted access could potentially exacerbate low flows and deplete ground water supply during drought conditions. This study underscores the importance of ecological integrity as an endpoint objective in sustainable water resource management.

Keywords: Old growth forest, Streamflow, Protected area, Ecological integrity, Sustainability

INTRODUCTION

The belief that old growth forests (also virgin or primary) with high biomass and great species diversity will persist in equilibrium when left undisturbed under a protected area management regime where any form of human intervention is prohibited also reinforced by another traditional belief that forests act as giant sponge to soak up water when rain falls to be released during dry season. The issues of forest and water have been understood but local

appreciation and practical applications are problematic due to lack of site specific information [1].

Old growth forests are complex and have inherently high carrying capacity. The overlapping canopy and substantial production of organic litter impacts on water quality. Forest productivity has been attributed to several factors. First, optimal conditions driven by substantial input of energy maintains favorable temperature, sufficient soil moisture, microbes and a suite of nutrients in balanced proportions [2, 3, 4] Second, old growth forests have very high natural regeneration potential because seedlings survive the suppressed conditions under the canopy. Delissio (2002) [5] noted that as many as 50% of seedlings in the 1986 inventory were still present ten years later. Finally, forest ecosystems are inherently self-regulating and self-organizing. The energy-driven oscillation between equilibrium-disequilibrium states (referred to as steady state or dynamic equilibrium) is a self-regulating mechanism to manage natural or human-induced disturbances [6, 7] thus forests productivity may at any time be either increasing [8] decreasing [9, 10] or stable [11].

Forests are major reservoirs of water. While heavy rainfall contributes substantially to recharge the watershed on a seasonal basis, however, the diurnal and nocturnal patterns of evapotranspiration are considered hydrological losses in water budget estimation [12, 13, 14]. Trees are extravagant users of water more than any other type of vegetation through various mechanisms of water use and storage. First, deep-rooted trees are acquire unrestricted access to groundwater supply by hydraulic lift [15]. Next, large trees redistribute hydraulically lifted water to drier soils surrounding the plant roots by capillary action [16, 17]. Finally, the rate of evapotranspiration from canopy leaves, stems and branches is controlled by climatic variables [18], and structural variability of forest vegetation largely controlled by the trees [16, 19, 20, 21].

Streamflow and water yield were critical issues in water resource management. However, site specific information precludes effective management of watershed reserves. Estimate of the magnitude of hydrologic loss on account of trees can be scaled to the watershed level. In addition, early detection of potential stress will allow for adjustments to be implemented and for policy modifications to be proposed forsecuring the sustainability of water supply. To fill this information gap, we investigated for the first time the Pasonanca Natural Park, and the following questions were propose: 1) what is the carrying capacity of the Pasonanca Natural Park?, 2) does the Park's current structure exhibit characteristics of a system in a steady state condition?, and 3) what has been the trend in rainfall and streamflow? Consistent with these problems, this study aims to: 1) estimate the magnitude and variability in basal area density; 2) examine the size distribution; 3) assess the occurrence and distribution of snags; 4) estimate canopy and ground covers and 5) evaluate streamflow and rainfall trends. In addition, we provided a short discussion on the implications of strict protection category to watershed reserves and it impact to ecological integrity and sustainability of water supply.

METHODS

Description of the Study Site

The study area (12, 107 ha) is located within the strict protection zone of the Pasonanca Natural Park (6⁰57' – 7⁰9' north latitude, 122⁰00' -122⁰08' east longitude, 50-1364 masl) in Zamboanga City, Philippines. Annual rainfall was measured at the International Airport (PAGASA) is 1281mm with dry months from December to May (mean 64mm) and

wet the rest of the year (150mm). The Pasonanca Natural Park is a drinking water source area and abstraction by run-of-river scheme has been the mode of water withdrawal since 1914.

Tree Sampling

The stratified random design was employed following these groups: the lowland mixed dipterocarp (96-350 masl), the hill mixed dipterocarp (350-750 masl) and the hill secondary forest (350-750 masl) hereafter simply referred to as LMD, HMD and HSF, respectively. Both LMD and HMD are undisturbed old growth while HSF is a secondary forest with history of intensive logging prior to 1992. Five circular fixed plots (15-m radius) in LMD, 7 in HMD and 6 in HSF, each group constituted a stand. We inventoried trees ≥ 5.0 cm dbh (diameter at breast height, 1.3m above the ground or above buttress at 2.5m maximum). All standing trees (live and dead) were mapped, identified to species level and measured for girth (nearest 1cm and average of 3 readings). Snags (standing dead tree) were assessed as evidenced by exfoliation, senescence or missing cambium. Canopy and ground covers were estimated by line intercept and point intercept methods following the procedure described by Lutes et al., (2006) [22], taking into account overlapping canopies. Trees that were rooted outside but whose canopies were within the plot were considered for purposes of estimating canopy cover only.

Rainfall and Streamflow Data

Monthly rainfall at the airport and Tumaga River streamflow data were obtained from the Philippine Astronomical Geophysical and Seismological Authority (PAGASA), Zamboanga City and from the Zamboanga City Water District, respectively. Measurements were converted to the standard cumecs (m^3s^{-1}). This study considered that bias may have been introduced due to errors committed in gage reading but we assumed that these errors were non-systematic and would not substantially alter the results. Nevertheless, we still conducted confirmatory interview with the Water Treatment Plant Division manager, Zamboanga City Water District to validate our observations here.

Calculation and Analysis

This study was used expansion factors to derive per hectare measurements. Basal area (BA) was calculated from girth measurement (converted to diameter in cm) of each tree using the area formula ($\text{BA} = \pi * D^2 \div 4$). Basal area density was used as a surrogate measure of tree biomass (Carey et al., 2001). The size distributions were classified as follows: saplings (≤ 12.5 cm dbh), poles (12.5 to < 25 cm dbh), medium trees (25 to < 50 cm dbh), large trees (50 to < 80 cm dbh) and very large trees (> 80 cm dbh). Canopy and ground covers were calculated as percentage of the transect length in accordance with the procedure described by Lutes and associates (2006)[22].

We used two methods for trend estimation of stream flow and rainfall data: the method of least squares model with adjustment for seasonality using the multiplicative model to determine trend and the Mann-Kendall (streamflow) or the seasonal Kendall test (rainfall, $\alpha=0.05$) to determine level of significance of the detected trend.

We tested the linear, exponential and quadratic equations to determine the best fit using first, second and percentage difference. The linear model provided a perfect fit. For linear equation $y=mx+b$, we assumed $m \leq 0.00015$ and $m \geq -0.00015$ as stable. We further investigated the direction of trends on a shorter duration by analyzing separately a third or half of the data. Chi-squared test and large sample Wilcoxon rank sum test were performed

(95% confidence interval) to detect significant differences in tree size distribution, basal area, canopy and ground covers. All statistical summaries, graphs and tests were performed in Excel 2007 (Microsoft Corporation, USA).

RESULTS AND DISCUSSION

Stand density and Size Distribution

A total of 116, 265, and 327 stems were enumerated in LMD, HMD and HSF, respectively. The results are presented in Table 1. Stand density was very high in all stands. Maximum plot basal area density was 94.7 and 129.3 m² ha⁻¹ for undisturbed LMD and HMD, respectively, and 53 m²ha⁻¹ for HSF. There was very high variability in plot density (CV=55%) in undisturbed stands. Basal density distribution in LMD was negatively skewed because of the presence of a relatively low density stand (19.38 m²ha⁻¹), whereas HMD and HSF basal density distributions were positively skewed. The difference in median densities in all three stands was significant (p<0.001). Lowland density appears to be stable (low mortality) compared with the transitional state exhibited by both stands in the hill elevations (high mortality).

Table 1 Summary of tree density, snag and size distribution at the Pasonanca Natural Park.

STAND PARAMETERS	LMD*	HMD*	HSF*
Basal Area, BA (m ² ha ⁻¹)**a	56.08(±31.07SD)	65.46(±35.89SD)	39.42(±8.59)
Min – Max Plot BA (m ² ha ⁻¹)	19.48-94.7	32.89 – 129.3	29.44-53.21
Trees per hectare (TPH)**	328	536	771
RTBA***	0.94	0.92	0.12
Snag density (m ² ha ⁻¹)	0.68	2.56	2.71
Snags TPH**	6	34	21
Median stand diameter (cm) ^a	21.36	12.10	12.73
Median stand height (m) ^b	15	13	14

*LMD- lowland mixed dipterocarp; HMD- hill mixed dipterocarp; HSF- hill secondary forest.

** Based on expansion factor of 2.829, 2.021 and 2.358 for LMD, HMD and HSF, respectively.

*** RTBA – ratio of tree basal area to stand basal area. ‘Tree’ refers to all trees except saplings and poles.

^a Significant at p<0.01

^b not significant

The mean values (56.07 and 65.46 m² ha⁻¹) were almost twice the value (less than 40 m²ha⁻¹) of those reported in the literature for lowland old growth forests in Malaysia, Sarawak, Borneo and Brunei [9, 10]. Rice et al. (1998) [23] noted that for mature hardwoods of uneven-aged stands in temperate forests, a basal density of about 35 m² ha⁻¹ would ensure sufficient site occupancy, enhance stand health and vigor, and would therefore be an ideal maximum stocking density before imminent mortality sets in. However, Means et al. (1999) [24] in using large footprint scanning airborne lidar found very high basal density for mature (57 m²ha⁻¹) and old growth (92m²ha⁻¹) forests in Oregon, USA. At the PNP, productivity in hill forest was higher compared with the lowland, contrary to the general observation that productivity declines with elevation [25] but this condition could be transient as evidenced by clustering and abundance of snags. Subsequent monitoring is important.

Size frequency distribution and basal area medians within the stands were significantly different (p<0.001). Diameter class (reverse J-shape) and basal class had inverse relationship for both undisturbed stands. HSF size distribution and basal area were predominant in sapling and pole classes (Figure 1). Space allocation for LMD was highest and lowest at HSF. Space allocation is an indicator of competition.

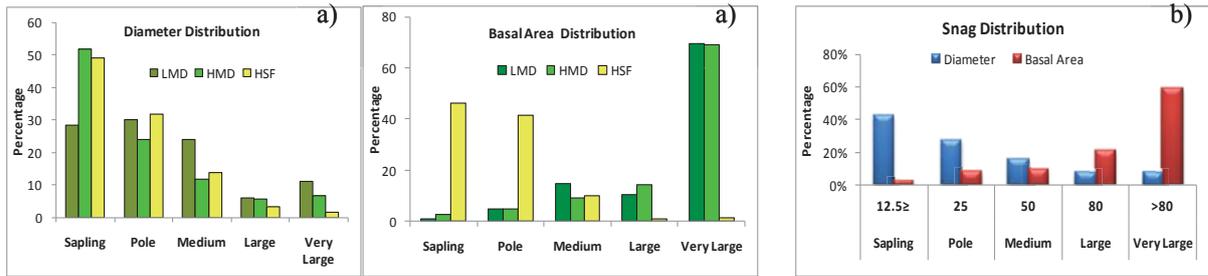


Figure 1 Diameter and basal area distribution of live tree and snags. a) Higher diameter distribution of saplings and poles for both HMD and HSF than in LMD. Basal area for LMD and HMD was highest in the very large category. Saplings and poles dominate in both diameter and basal area in HSF. b) Diameter and basal area for snags show reverse relationship in HMD and HSF.

Basal density was contained in the bigger trees in both undisturbed areas as shown by their root to basal area ratio (RTBA 94 and 92%) whereas basal density and size distribution were predominantly in the smaller trees at HSF (RTBA 12%). The very high density of bigger trees in both lowland and hill stands (RTBA >90%) suggests very high water use. Dawson (1996) investigated tree water use by size and reported that larger trees exclusively transpired only from groundwater supply whereas small trees rely on soil water. It can be observed that HMD trees were shorter than LMD trees, and by implication, had relatively shallower root system than the latter. On the other hand, the water table has been known to follow the topography but during prolonged drought condition, the zone of saturation could recede farther deep into soil profile beyond the reach of large roots in HMD. The latter then would have to rely on soil water at the expense of smaller trees, thus mortality is a natural consequence of persistent water stress. The high mortality stock at hill elevation are consistent with observations in studies elsewhere [20, 26].

The dominance of very large trees in the canopy ensured high degree of overlapping of canopy trees (105%) as well as a steady supply of organic litter. Ground cover consisted mainly of litter (62%) and herbaceous vegetation (14%). While organic matter contributes to soil stabilization, overland flow during extreme rainfall could overwhelm the filtering capacity of herbaceous vegetation, thus increasing the concentration of organic matter in streams. Natural organic matter present in raw water reacts with chlorine in the water treatment process to produce disinfection by products which have been associated with several cancers [27].

Trend in Rainfall and Streamflow (1983-2008)

The general trend for streamflow and rainfall was decreasing and increasing, respectively, for the period 1983-2008 (Figure 2). A closer analysis of streamflow indicated a stable trend during the first half of the period from 1983-1996. A significant decline ($p < 0.05$) was observed after 1996. It is worth noting that this period also coincided with the era of strict protection which began in 1992. On the other hand, rainfall showed an initial decline during the first decade but eventually increased significantly ($p < 0.01$) after 1992. The increasing trend in rainfall apparently did not redound to a positive impact on streamflow. Therefore results in this study do not support the common belief that more trees improve water supply. Evapotranspiration and watershed recharge could have equalized the effect of rainfall considering that streamflow response is dependent on antecedent conditions. Kume et al. (2009) measured as much as $1323 \text{ mm year}^{-1}$ of evapotranspiration in a forest in Malaysia,

implying that at lower intensity, rainfall may not contribute at all to streamflow. As a consequence, several silviculture prescriptions have been adopted to increase water yield as well as to reduce the risk of insect outbreak and accidental fires, for example, by thinning or cutting (Rice, et al., 1999; Fajvam, 2008).

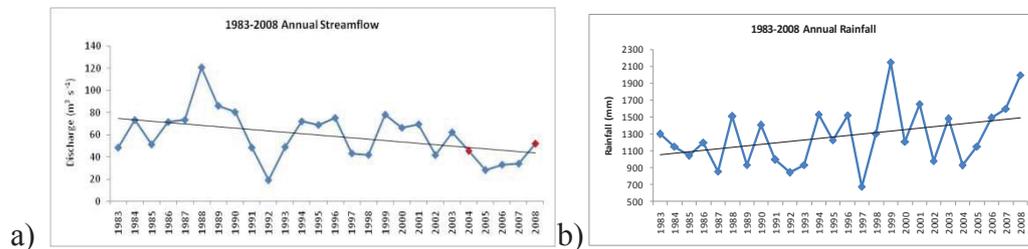


Figure 2 1983-2008 Annual streamflow discharge (dam outlet) and annual rainfall (Airport Monitoring station). a) Significantly decreasing streamflow ($p < 0.05$) occurred during the second half of the period. Red dot indicates estimated value of missing (2004) or incomplete (2008) data. b) Rainfall trend significantly increasing ($p < 0.01$). Implications for Ecological Integrity and Sustainability of Water Supply

Sustainability of public water supply implies the unhampered delivery of watershed services such as water supply and purification. When the ecosystems provide services for the benefit of human well-being, then that ecosystem possesses ecological integrity (Millennium Ecosystem Assessment, 2005). An ecosystem is stressed or degraded when vital functions or services decline or is lost altogether [29, 30]. Under the protected area regime, the Pasonanca Natural Park cannot avail of any human interventions that have been known to restore stressed ecosystems. If the situation persists, water supply services would most likely be affected. Degradation and loss of ecological integrity is imminent.

The main objective of protected areas is for biodiversity protection (RA 7586 or the NIPAS Act of 1992). On the other hand, watershed reserves are forest lands maintained to enhance water quality (PD 705, Revised Forestry Code). Inevitably, practices geared towards the control of erosion and improve water quality are necessary tasks to achieve this objective. It was understood from the IUCN recommends less restrictive category (IV-VII) for watershed reserves in protected areas (Dudley, 2008).

CONCLUSION

The Pasonanca Natural Park had very high carrying capacity with mean basal density of around $56 \text{ m}^2 \text{ ha}^{-1}$. Lowland forests appeared in steady state condition as evidenced by low mortality. Hill density stands were very high but apparently in transition moving towards more sustainable carrying capacity- this self-regulating process could take more than a lifetime to stabilize. The decline in streamflow trend is expected to persist unless human intervention or some large scale disruption will reduce forest stock significantly. In addition, a large section of the hill forest is unsuccessfully recovering from years of indiscriminate exploitation. The growing stock implies increasing water use and creates additional pressure to already declining streamflow.

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Labor-intensive Harvesting Practices for Malapapaya (*Polyscias nodosa*)

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Abstract: A study was conducted on labor-intensive harvesting practices for Malapapaya (*Polyscias nodosa*). Malapapaya is one of the most economically useful and promising lesser-used species. It is an excellent source of wood for plywood, wooden shoes, decorative and utility boxes, crates, chopsticks, ice cream/lollipop/popsicle sticks, pencil slats and toothpicks. Further, it has great potential to provide sustainable livelihood opportunities for the rural people. The study involved time and motion study and cost analysis of harvesting practices including cutting, bucking and hauling using various tools and techniques. Carbon emission was also qualitatively assessed in the study. Data shows that chainsaw is more cost-effective than handsaw. Felling and bucking by chainsaw can produce 1.89 m³ of malapapaya trees at a cost of US\$19.95 per m³ while handsaw has 1.18 m³ at a cost of US\$24.94 per m³. Thus, using chainsaw in felling is cheaper by US\$4.99 per m³. Calculations show that carabao (water buffalo) skidding is cheaper than hauling by horse by US\$13.78 per m³. This is based on carabao skidding rate of 0.47 m³ per day at US\$19.95 per m³ compared to hauling rate by horse of 0.35 m³ per day at US\$32.92 per m³. Based on the results of the study, the existing practices in the study sites offer cost-effective and climate-adaptive practices for harvesting, transporting and delivering malapapaya trees. In particular, animal hauling results in lower carbon emission compared to motorized transport. Specifically, carabao skidding provides a more cost-effective means of transporting harvested malapapaya from the cutting site to the roadside. The animal can haul more logs compared to the horse. However, hauling by horse results in comparatively less environmental damage than carabao skidding.

Keywords: Labor-intensive, Timber harvesting, Time and motion study, *Polyscias nodosa*

INTRODUCTION

Malapapaya (*Polyscias nodosa*) is one of the most economically useful and promising lesser-used species. It is an excellent source of wood for plywood, wooden shoes, decorative and utility boxes, crates, chopsticks, ice cream/lollipop/popsicle sticks, pencil slats and toothpicks.

It has great potential to provide sustainable livelihood opportunities for the rural people. Unfortunately, current harvesting, delivery and transport practices are economically inefficient and ecologically unsound due to low product recovery and inappropriate use also application of harvesting, delivery, transport tools and techniques.

As such as study to identify cost-effective and ecologically-sound harvesting, delivery and transport systems for Malapapaya to maximize the benefits, and could provide to local communities. This was done by assessing and comparing their respective productivity rates and costs and their environmental impacts. The knowledge on sustainable harvesting,

delivery and transport systems could then be promoted among Malapapaya farmers through effective advocacy campaign and technology transfer schemes.

MATERIALS AND METHODS

Time and Motion Study

The study was conducted in selected coconut-based agroforestry farms in the towns of Atimonan and Lopez in Quezon Province. Specifically, the study was undertaken at SitioIpit, Barangay Balubad and SitioTabon, Barangay Kilait in Atimonan, Quezon and Barangay Lalaguna, Lopez, Quezon. A total of four harvesting crews were involved in the two sites. In particular, labor-intensive harvesting and transport systems were assessed based on productivity and cost factors. Three of the crews use medium sized chainsaw as harvesting tool while only one uses hand saw.

Primary and secondary data were collected through time and motion studies and interviews to determine productivity rates and production cost of felling/bucking, flitching, sawing, and hauling. The study team went with the harvesting crews to observe and document actual operations. A stopwatch was used to measure the time involved in each activity. Observations including the type of activity, tool(s) used, number of laborers involved, working condition, and time involved were recorded. Assessments were made on the damage to the forest floor and residual vegetation by the activities. The data collected related to tool type used include acquisition cost, useful life, depreciation and fuel and/or material requirement. The number of laborers involved was also noted. The trees felled were measured as to their respective small-end diameter, big-end diameter, and length. The time it took to cut down a given trees were recorded. Auxiliary activities like cleaning, positioning, repairs, rest time, travel from tree to tree were likewise recorded. The data collected on animal hauling included the acquisition cost of the animal, cost of hauling accessories, service life, depreciation, labor cost, hauling volume, hauling distance and hauling time. In manual hauling, the data included labor cost, hauling volume, hauling distance, and hauling time. GIS maps were used in terrain analysis and determination of hauling distance.

Indicative Environmental Impact

A general assessment of the environmental impacts of harvesting methods was done at selected study sites. Site conditions such as soil erosion and vegetation were noted in relation to the type of harvesting method employed in the site. They were recorded on survey forms during field work.

Productivity Rates

Productivity rates were measured in terms of the average computed daily output per activity and tool used. The average computed daily outputs per activity were determined by taking the mean of individual computed daily output per tree. The computed daily output per tree was based on the estimated volume of trees of the same dimension and volume that can be produced for an eight-hour working day (i.e. felled and bucked) given the time it took to produce the sample tree.

This was determined using the formula:

$$\text{daily output} = \log \text{ volume} \times (60/\text{prod'n time}) \times 8 \text{ hrs}$$

where: $\log \text{ volume} = \text{Smalian's formula} = (0.7854 \times d^2 + D^2)/2 \times \text{length}$

The total production time included the main activity plus the auxiliary activities such as preparation, cleaning, positioning of equipment, rest time and travel from one tree to another in the case of felling and bucking. The individual computed daily outputs per tree were then be averaged to approximate the productivity rate of a given activity and tool/equipment per day at varying tree sizes. Actual productivity rates were estimated to be 70% of the computed productivity rate. It was assumed that about 30% of the time is lost due to delays which usually occur during normal harvesting operations.

Production Cost

Production cost computation included labor, depreciation and materials. Labor cost was computed based on the prevailing minimum wage and the number of laborers involved in the activity. Depreciation was computed based on the purchase value of the equipment and its useful life. Depreciation was based on 120 effective working days which is assumed to correspond to the total number of days and hours when harvesting is actually done considering work stoppages, delays, equipment breakdowns, holidays, day-offs, resttime/breaktimes, and other “unproductive” days. Material cost was only considered in the case of chainsaw which required fuel and oil. Production cost per unit volume was determined by dividing the average daily production by the cost incurred per day.

RESULTS AND DISCUSSION

Felling and Bucking

Chainsaw is the preferred tool for felling and bucking malapapaya trees in the study sites. Based on data collected a harvesting crew can cut and buck an average of about 1.89 m³ per day on an 8-hour shift. A brand new unit of chainsaw costs around US\$823.53 while a second-hand or used unit can be bought at US\$352.94 a piece. The average useful life of a brand new unit is around 10 years while that of used unit is 1 to 3 years. One liter of premium gasoline can be used to cut an equivalent of 0.94 m³. For maintenance, the crew spends on motor oil US\$3.29/liter at 1 liter per 10 liters of gasoline, guide bar oil (US\$1.18 for 2 months), contact point (US\$4.00 for 1-2 years), file (US\$3.29 for 5 years) and blade (US\$16.47 for 3 years). Labor cost for chainsaw operator US\$9.98 per m³ and helper at US\$2.00 per m³. Data shows that the felling cost by chainsaw is about P 848 per m³.

Only one harvesting crew, who is operating in Atimonan site, was found to be using the handsaw which is locally known as “kabig”. Data shows that the crew can cut and buck about 1.18 m³ of malapapaya trees. One piece of hand saw can be bought for US\$2.35 with a useful life of 5 to 6 years. The only cost incurred in maintaining the saw is the file used to sharpen its blade. Labor cost for tree feller using handsaw is US\$23.94 per m³. One file costs US\$3.29 each and can be used for more than five years. Calculation was indicates that felling by handsaw costs US\$24.94 per m³.

Data shows that chainsaw was more cost-effective than handsaw. Felling and bucking by chainsaw can produce 89 m³ of malapapaya trees at a cost of US\$19.95 per m³ while handsaw has 1.18 m³ at a cost US\$24.94 per m³. Thus, using chainsaw in felling is cheaper by US\$4.99 per m³.

Hauling/Transport

Horse hauling was the preferred mode of transporting harvested malapapaya trees from the cutting site to the road site in Atimonan site. Hauling involves tying up the cut logs

or bolts into a saddle attached on the back of the horse. A horse can haul an average of 0.35 m³ per day. Calculation shows that the hauling rate by horse is US\$2=32.92 per m³

Carabao skidding is the preferred mode of transporting harvested malapapaya trees from the cutting site to the road site in Lopez site. Skidding involves loading the cut bolts in a sledge pulled by the animal. A carabao can skid an average of 0.47 m³ per day. Calculation shows that the skidding rate by carabao is US\$19.95 per m³.

Calculations were demonstrated that carabao skidding is cheaper than hauling by horse US\$ 12.97 per m³ This is based on carabao skidding rate of 0.47 m³ per day at US\$19.95 per m³ compared to hauling rate by horse 0.35 m³per day at US32.92 per m³.

Table 1 below summarizes the results of the time and motion study.

Table 1 Summary table of the results of time and motion study.

ACTIVITY	RATE (m ³ day ⁻¹)	COST (US\$) per m ³
Felling and bucking (handsaw)	1.18	24.94
Felling and bucking (chainsaw)	1.89	19.95
Hauling (horse)	0.35	32.92
Hauling (carabao)	0.47	19.95

Indicative Environmental Impacts

Based on ocular observations made in the study sites, the harvesting operations do not have significant environmental impacts. In particular, felling and bucking operations do not result in damage to nearby vegetation owing to the skills of the harvesting crew in selecting the direction of fall to avoid hitting adjacent vegetation when the trees being cut fall. Likewise, the negligible damage can be attributed to the relatively small size of the malapapaya trees being felled. However, it should be noted that chainsaw uses fossil fuel and emits carbon dioxide and other air pollutants that somehow contribute, no matter how negligible compared to total global emission.

Similarly, hauling does not result in significant environmental disturbance due to the scale of the operation compared to commercial logging that employs heavy equipment. In particular, hauling by horse does not have adverse impacts to the site except for soil compaction that occurs along hauling trails. However, since of the routes used are existing trails, the impacts could not solely be attributed to the operation. In the case, of carabao skidding, the operation causes more damage than hauling by horse due to the resulting scouring and compaction of soil along skidding trails. Scouring is caused by the sledge while being pulled by the animal while compaction is caused by the animal and the harvesting crew. However, the impact cannot be solely attributed to the operation because the routes used are existing trails in the site.

CONCLUSION

Based on the result of this study, the existing practices in study sites offer cost-effective and ecologically-sound systems for harvesting, transporting and delivering malapapaya trees. In particular, the use of chainsaw in felling and bucking provides a cheap and efficient means of harvesting malapapaya trees. Use of chainsaw allows higher felling volume at a lower cost when compared to handsaw. With regard to hauling, carabao skidding provides a more cost-effective means of transporting harvested malapapaya from the cutting

site to the roadside. The animal can haul more logs compared to the horse. General observations indicate that labor-intensive timber harvesting methods like animal skidding has a comparatively lower environmental damage than mechanized timber harvesting methods like tractor skidding and yarding. Logging sites where carabao hauling is employed were found to be less disturbed when compared to sites where mechanized methods are used. Indicative economic assessment shows that labor-intensive harvesting methods have better economic trade-offs than mechanized methods. The application of labor-intensive harvesting methods should be promoted and institutionalized. A policy should be implemented to prescribe the adoption of the technology in malapapaya plantations and community-based forest management areas. Labor-intensive methods fit well into the community-based management scheme and therefore the government should hasten the formulation of guidelines prescribing the use of appropriate labor-intensive timber harvesting methods for a given type of timber harvesting operation. More in-depth studies should be made on the economic efficiency and environmental impacts of labor-intensive harvesting methods.

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Reversing Clogging in Imhoff Tanks by Catalyzed Hydrogen Peroxide Treatment

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Abstract: One of the most frequently encountered operational problems of imhoff tank (IT) is clogging. Traditionally, the restoration procedure is to remove the clogged rocks and replace it with clean material. This method is costly and may require the facility to be closed for a period of time. Recently, a more radical approach has been tested on a number of lab-scale and pilot-scale set-ups which consisted of an aggressive oxidation of organic matter by means of catalyzed hydrogen peroxide (CHP). Results indicated that after treatment, clogging was substantially reduced and CHP did not appear to have negative effect on effluent compliance. The outcomes of full scale tests were discussed.

Keywords: Imhoff tank, Clogging reversing, Catalyzed hydrogen peroxide

INTRODUCTION

Imhoff tank system (IT) is one of the common traditional sewage treatment systems in the areas without centralized sewage treatment facilities in Malaysia. The system consists of a filter media tank filled with rocks as filter media. Sewage is applied intermittently over the media. Microorganisms become attached to the media and form a biological layer. Organic matter in the sewage diffuses into the film, where it is metabolized by microorganism. Oxygen is supplied to the attached biological layer from the air when the sewage diffuses to the media. It is a simple and an economical method that has proven to remove soluble BOD from sewage effectively.

However, one of the disadvantages of the system is clogging caused by the associated biological growth on the surface of the media and accumulation of solids from influent. This condition may inhibit treatment process and cause hydraulic failure of the system. The traditional restoration procedure is to remove the clogged rocks and replace it with clean material. However, this method is costly and may require the facility to be closed for a period of time. Over the years a wide variety of chemicals have been used in an effort to improve IT clogging but there was no effective solution to control the extent of clogging of the system.

One important mechanism of sludge clog cleaning is to oxidize and destroy the accumulated solid and remove it from the media. Several methods can be used to oxidize and destroy sludge including, oxidative, thermo-chemical and biological processes [1-2]. For oxidative processes, among the available oxidants, hydrogen peroxide appears to be effective for degrading many pollutants and decomposes simply into water and oxygen. Moreover, it is stable and easy to handle. Misael's [3] finding of sludge solubilization was 50% using hydrogen peroxide. Lee [8] demonstrated that solubilization of waste activated sludge can be performed using catalyzed hydrogen peroxide (CHP).

CHP is formed using hydrogen peroxide and the catalyst which is known as Fenton's reagent [9]. It is often used to reduce organic load or toxicity of different wastewaters [5-6]. CHP is a stronger oxidant compared to hydrogen peroxide because it can generate hydroxyl free radicals with a high electrochemical oxidant potential (2.8 V vs. normal hydrogen electrode) which could react with organics and break them down into smaller fragments with higher biodegradation potential [7]. Furthermore, CHP is a non-toxic chemical and there is no energy involved in the process, thus it is easy to use and control. In this study, we investigated the effectiveness of CHP on accumulated solid segregation and IT plant clogging restoration.

MATERIALS AND METHODS

Accumulated Solid Characterization

Samples of accumulated solids used in this study were collected from an IT plant. The solid had water content of 99% and dry mass of 9,213 mg/L. The sample passed through a sieve to remove large debris. Then it was thickened and adjusted to obtain initial total solid concentration of 10,000 mg/L, 15,000mg/L and 20,000mg/L, respectively and stored at 4°C before use.

Equipment and Measurement Apparatus

Two distinct approaches were utilized to gather accurate information regarding CHP treatments. The first was an examination of the studies of the effects of CHP on laboratory scale experiment to predict the performance of solid segregation. The second approach involved field experience with CHP to determine the mechanisms of filter media clogging restoration.

The experimental set up consisted of 49 one-liter measuring cylinders. A one liter sample of solid was placed in each cylinder. The CHP was added to individual cylinder. The CHP ranged from 0 to 8mg per 1 liter of solid with concentration of 10,000mg, 15,000mg and 20,000 mg, respectively. The CHP consisted of 50% H₂O₂ and solid FeCl₃.6H₂O. H₂O₂ : Fe³⁺ ratio was 100:1 [8]. All cylinders were standing for 60 minutes before the CHP treatment. The experiment was repeated three times and the average of the segregation rate was used to assess the accumulated solid removal efficiency.

The measurement of dry solid content was carried out according to the national water and wastewater monitoring standard methods. The measurements were recorded before and after 30 minutes of CHP treatment.

Data Analysis

The solid segregation efficacy of accumulated solid was calculated by using the following equation:

$$\text{Solid segregation rate (\%)} = \frac{S}{S_0} \times 100$$

Where, S = quantity of total solid segregated on the top
 S_0 = quantity of total solid before CHP treatment

Pilot Plant Condition

An IT plant located at Sek 17 PJ Selangor with treatment capacity of 56 m³/d was selected for the field study. The size of filter media tank was 100m³. Due to filter media clogging, the permeability failed and was fully covered by water. In this study, the permeability of the filter media and the condition of flow from the outlet of the tank were used to determine the effectiveness of clogging restoration. The CHP dosing rate was 50Kg/day and it was applied onto the filter media.

RESULTS AND DISCUSSION

Laboratory scale study results showed that after the CHP treatment the sludge was effectively loosened and suspended from the bottom of the cylinder. 20 minutes later, the reaction subsided and suspended particles gradually segregated on the top of the water (Figure 1). This was apparently caused by CHP penetration in the solid and decomposition of gas bubbles within the solid. The solid was with air bubble and separated from the water in an upward direction. This is due to the fact that the solid particles have a specific gravity lower than water when the bubble is attached.

Figure 2 shows the effects of CHP dosage and the solid segregation rate. In the concentration from 0.5 to 1mg/L CHP, the solid was continuous slow effervescence with a progressive volume expansion and 10% to 20% of suspended particles were segregated on top of the water. The segregation rate was greatly increased at the dosing of 3 to 4mg/L CHP, the solid segregation rate was 20% to 80%. The solid completely segregated to the top when CHP dosage was at 5mg/L and above.

For different solid concentrations the reactions varied. The measuring cylinder with 10,000mg/L solid was completely segregated to the top at 5mg/L CHP, the measuring cylinder with 15,000mg/L and 20,000mg/L solid needed 6.5 mg/L and 7.5mg/L CHP, respectively.

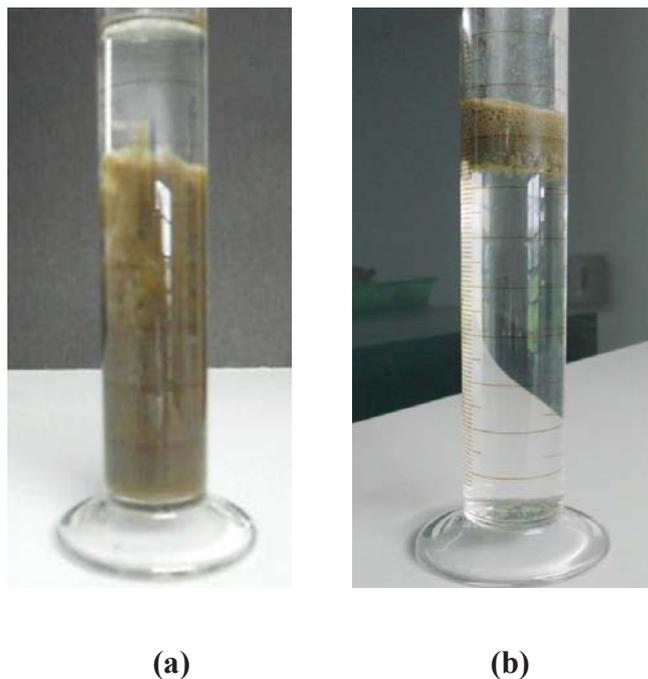


Figure 1 Before and after CHP treatment. a) Solids settling in the bottom of measuring cylinder; b) Solids segregated on the top of the water.

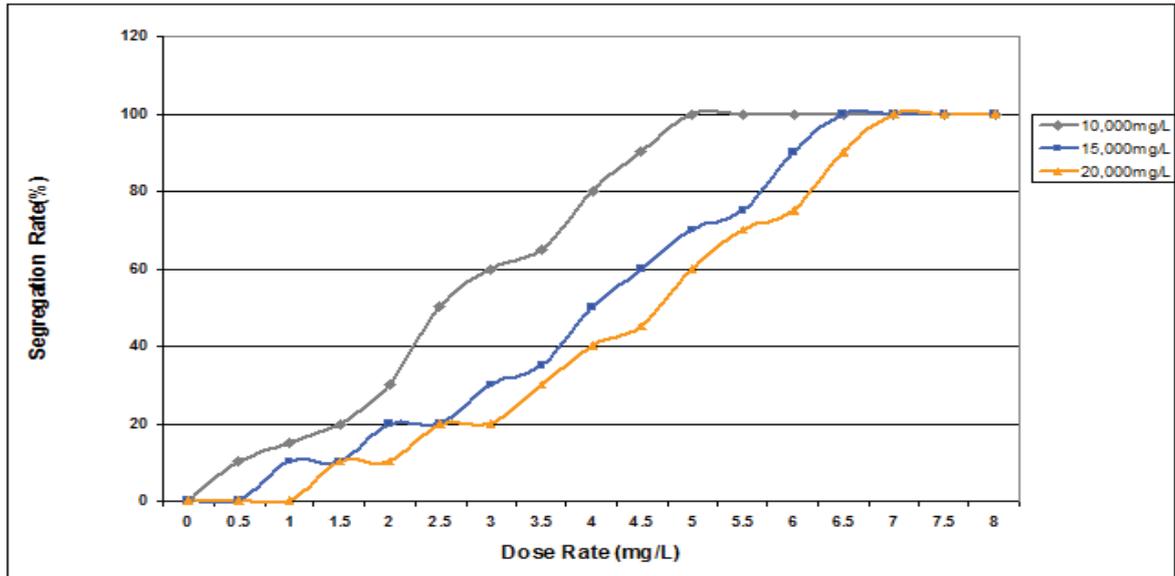


Figure 2 Solid segregation rate and CHP dosing rate

In the field study, a total of 200Kg CHP was used to attempt restoration of a clogged filter media. The CHP treatment resulted in a remarkable solid segregation on the top of the filter media tank. The clogging was restored within 5 days after CHP treatment. Figure 3 presents the condition of filter media tank before and after the CHP treatment.



(a) Before CHP treatment, filter media was clogged and covered by sewage water.

(b) Clogging sludge was cleared after CHP treatment.

Figure 3 The condition of the filter media tank before and after the CHP treatment

The mechanisms involved in the effectiveness of CHP to restore these solids clogged in the filter media tank is similar to those observed in the laboratory experiment. It was conjectured that the CHP decomposes the solids clogged in the filter media by oxidation and in addition the impulse originated by the formation of bubbles due to the decomposition of the CHP and the impingement of the bubbles strip away the solid materials from the filter

media, thus the solid material was removed and segregated on the upper surface of the tank. Although, the percentage of solid could not be calculated and compared to the laboratory scale experiment, sewage passed through the filter media smoothly. This demonstrated that the solid has been removed and confirmed that CHP is possible to restore a clogged filter media.

CONCLUSION

This study demonstrated the efficacy of the sludge segregation and permeability of failed IT restoration using CHP. Based on the results, the following conclusion can be made.

- Accumulated solids can be effectively segregated using CHP.
- The CHP treatment has been proven to be effective in clogging restoration for IT system.

Further research to study the mechanism of CHP on filter media clogging restoration is required to confirm the findings.

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Pull-Out Strength of Steel Anchors Embedded in Autoclaved Aerated Concrete Mixed with Sugar Sediment

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Abstract: In a framework to develop a prefabricated thermal insulation wall system assembled by Autoclaved Aerated Concrete (AAC) mixed with sugar sediment wall with thermal insulation and architectural cladding, this paper reported the feasibility of the wall system by investigating pull-out strength of steel anchor embedded in AAC mixed with sugar sediment with and without cement plaster on its surface. Horizontally, the wall system was designed to withstand wind load 100 kg/m². Three samples of each steel thread with diameters of 8, 10, 12 and 16 mm were embedded at the center 200x200 mm AAC by a polyester adhesive resin was tested for their short-term pull-out strength with pulling rate 1 mm/min. Without cement plaster, anchors were embedded at 60 mm depth in AAC. With 9.4 mm thick cement plaster on the surface of AAC, anchors were embedded at 70 mm depth in AAC. Without cement plaster on the surface, the average maximum pull-out forces from steel anchor with diameters of 8, 10, 12 and 16 mm were 116.5, 189.8, 210.2 and 249.6 kg respectively. With cement plaster, the average maximum pull-out forces were 268.8, 321.4, 360.8 and 405.4 kg for anchor with diameters of 8, 10, 12 and 16 mm respectively. With their statistical standard deviations, 5% quantile values were derived as their characteristic strengths. Afterwards the design strength was proposed by dividing the characteristic strength by suggested factor of safety 3.5. Eventually the design pull-out strengths were 22, 40, 53 and 59 kg for AAC without cement plaster and 69, 77, 90 and 103 kg for AAC with cement plaster for steel anchor with diameter of 8, 10, 12 and 16 mm respectively per one anchor. It was shown that steel stud anchor with diameter of 10 mm was capable to withstand the required loads and was the most economically suitable as an anchor for distance arrangement at 500x500 mm.

Keywords: Pull-Out Strength, Autoclaved Aerated Concrete, Prefabricated Wall

INTRODUCTION

Energy usage in Thailand has steadily raised with energy consumption in commercial and residential sectors reached 22 % in 2012 [1]. Official buildings held the largest 35 % share on energy demand in medium and large buildings. For residential buildings, 52 % of energy was used for convenience in 2010. To efficiently use of energy, Thailand set one of the targets in national energy reserve plan to reduce the overall thermal transfer value (OTTV) of building envelop from 60 W/m² in 2012 to 20 W/m² in 2033 [2]. In general, building walls in Thailand are not insulated. This paper reported the feasibility study to improve ACC wall with cement plaster by installation thermal insulation, facade and anchor

to improve thermal performance of existing wall. The scope of this study was to investigate the pull-out strength of anchor embedded in AAC by polyester adhesive and to compare it with the design wind load.

Traditionally, installation of facade on wall could be done by using metal frame as shown in Figure 1. Using adhesive tape to attach facade, the system in Figure 2 also supported facade by metal frame. Nevertheless, both systems were required expensive metal frame.

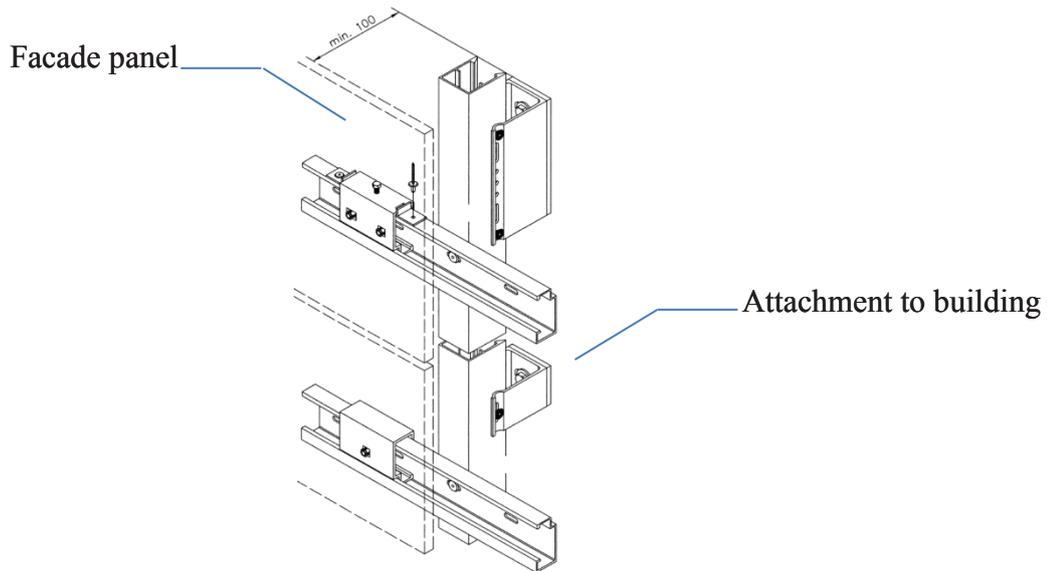


Figure 1 Metal frame attached to building to support facade [3]

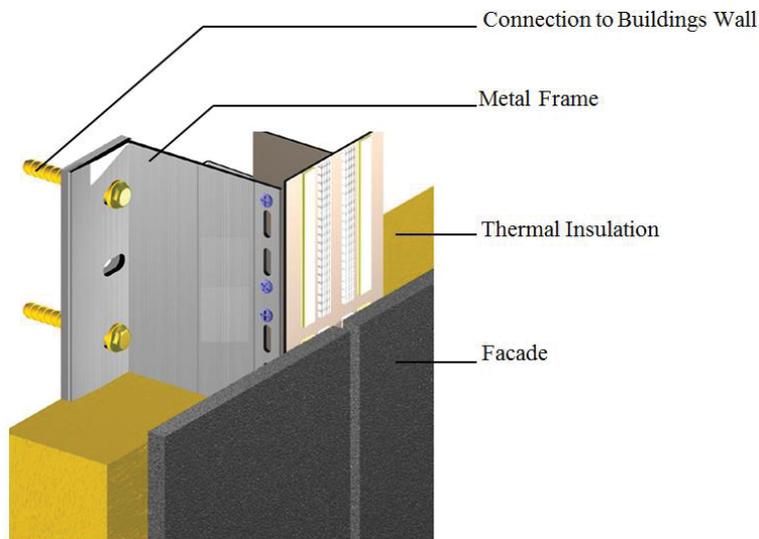


Figure 2 Aluminium frame supporting facade [4]

To reduce the cost of facade-supporting frame, this report has been studied the usage of steel thread rods as anchors. Anchor array would be embedded in AAC wall as shown in Figure 3. The predetermination in this study comprised 20 mm facade panel made of natural stone or high strength concrete, 20 mm gap ventilation, 50-100 mm thermal insulation, 400 x 400 mm steel thread rod as array anchors and 150 mm AAC wall. The maximum design wind load was 100 kg/m².

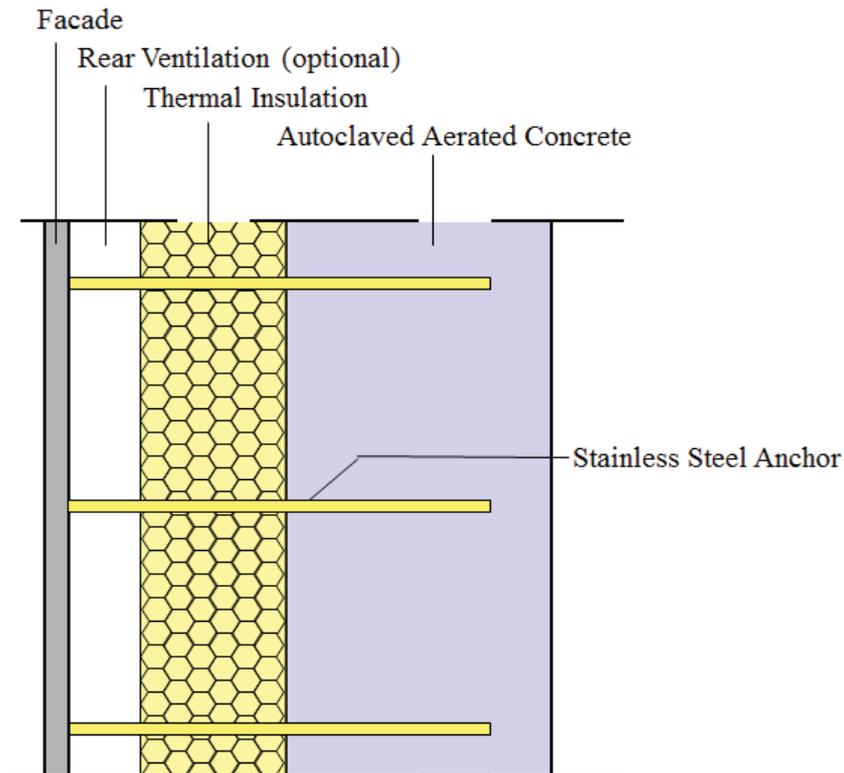


Figure 3 Wall system concept

The limitation was to study short-term pull-out strength of the anchor embedded to AAC with and without cement plaster. Anchors were embedded by polyester resin adhesive.

MATERIALS AND METHODS

AAC specimens were 200 x 200 x 70 mm. When 9.4 mm thick cement plaster applied on one surface of AAC, the size became 200 x 200 x 79.4 mm. Steel thread rods or bolts with diameter 8, 10, 12 and 16 mm as anchors were embedded 60 mm in AAC and 70 mm in AAC with cement plaster. Anchor and AAC were glued together by a Polyester adhesive with compressive strength of 50 N/mm² and tensile strength of 15 N/mm². The properties of AAC mixed with 20 % sugar sediment by weight were 5 N/mm² compressive strength, 0.089 W/m.K thermal conductivity, 25 % water absorption with density of 655 kg/m³. Cement plaster having compressive strength of 2.5 N/mm² and 3.5 N/mm² at 7 and 28 days. Steel anchor was achieved strength of 240 N/mm² and Young's modulus of 200,000 N/mm². Pull-out test was shown in Figure 4, when ages of AAC and cement plaster were 60 and 21 days consecutively. Short-term pull-out test with speed 1 mm/min was performed. During pilot experiments, the free distance control fixtures allowing non-clamp distance of 360, 260, 160 and 100 mm were applied and shown in Figure 5. It was found that the free distance 360, 260 and 160 mm yielded bending failures of sample shown in Figure 6 in sample. Only 100 mm free distance yields pull-out failure in sample. Therefore, the 100 mm fixture was selected for the pull-out experiment.

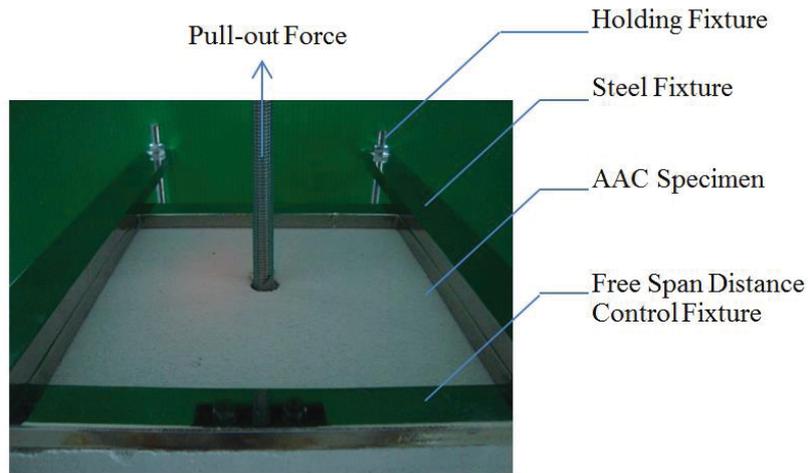


Figure 4 Pull-out test configuration



Figure 5 preliminary test configuration



Figure 6 Bending failure in test specimen

RESULTS AND DISCUSSION

For AAC sample, the average maximum pull-out force for 8, 10, 12 and 16 mm anchor were 116.5, 189.8, 210.2 and 249.6 kg as shown in Table 1. The characteristic strength of material resistance was defined by the 5 % quantile value of the pull-out force with the confidence interval $(1-\alpha)$ 90%. The characteristic strength was later divided by the material safety factor 3.5 [5], which subsequently became the design resistance of material. The design resistance for anchor diameter 10, 12 and 16 mm were embedded in AAC, 7, 36 and 33 kg consecutively.

Table 1 Pull-out strength of anchor embedded in AAC

Thread Diameter	Max Pull-out Force				Standard Deviation	5% Quantile	Factor of Safety	Design Resistance
	Sample 1	Sample 2	Sample 3	Mean				
(mm)	(kg)	(kg)	(kg)	(kg)	(kg)	(kg)		(kg)
8	91.4	140.4	117.6	116.5	24.52	N/A	3.5	N/A
10	177.1	225.3	166.9	189.8	31.20	24.1	3.5	7
12	223.6	214.4	192.7	210.2	15.87	126.0	3.5	36
16	277.0	245.0	226.7	249.6	25.46	114.4	3.5	33

For AAC sample with 9.4 mm cement plaster at the surface, the average maximum pull-out force for 8, 10, 12 and 16 mm anchor were 268.8, 321.4, 360.8 and 405.4 kg as shown in Table 2. The design resistance for anchor diameter 8, 10, 12 and 16 mm embedded in AAC with cement plaster were 52, 45, 62 and 72 kg respectively.

Table 2 Pull-out strength of anchor embedded in AAC with cement plaster

Thread Diameter	max Pull-out Force				Standard Deviation	5% Quantile	Factor of Safety	Design Resistance
	Sample 1	Sample 2	Sample 3	Mean				
(mm)	(kg)	(kg)	(kg)	(kg)	(kg)	(kg)		(kg)
8	254.9	286.8	264.7	268.8	16.34	182.0	3.5	52
10	337.1	286.1	340.9	321.4	30.60	158.8	3.5	45
12	376.5	329.6	376.2	360.8	26.99	217.4	3.5	62
16	382.2	400.0	434.0	405.4	26.32	265.6	3.5	76

The larger diameter of anchor resulted in higher average maximum pull-out force. Cement plaster applied on the surface of AAC yield higher pull-out force.

Possibility to use Anchor in AAC for Facade Resisting the Design Wind Load of 100 kg/m²

With the anchor arrangement of 400 x 400 m for the facade system in Figure 3, the design wind load of 100 kg/m² would yield design pull-out force 25 kg per anchor. By comparison of design pull-out resistance of material with design pull-out load, there would be possibility to use 12 mm anchor embedded in AAC with polyester adhesive to resist the design wind load. For the AAC wall with cement plaster, there would be feasibility to install facade resisting wind load of 100 kg/m² by using 8 or 10 mm anchor. The facade could be installed with thermal insulation to improve thermal performance of the wall.

CONCLUSION

In a framework to develop a prefabricated thermal insulation wall system assembled by Autoclaved Aerated Concrete (AAC) mixed with sugar sediment wall with thermal insulation and architectural cladding. This paper was reported the feasibility of the wall system by investigating pull-out strength of steel anchor embedded in AAC mixed with sugar sediment with and without cement plaster on its surface. Horizontally, the wall system is designed to withstand wind load 100 kg/m^2 . Three samples of each steel thread diameters 8, 10, 12 and 16 mm embedded at the center $200 \times 200 \text{ mm}$ AAC by Polyester adhesive resin were tested for their short-term pull-out strength with pulling rate 1 mm/min . Without cement plaster, anchors were embedded 60 mm depth in AAC. With 9.4 mm thick cement plaster on the surface of AAC, anchors were embedded 70 mm depth in AAC. Without cement plaster on the surface, average maximum pull-out forces from steel anchor diameters 8, 10, 12 and 16 mm were 116.5, 189.8, 210.2 and 249.6 kg consecutively. With cement plaster, average maximum pull-out forces were 268.8, 321.4, 360.8 and 405.4 kg for anchor diameters 8, 10, 12 and 16 mm consecutively. With their statistical Standard Deviations, 5% quantile values were derived in their characteristic strengths. Afterwards, the design strength was proposed by dividing the characteristic strength by suggested factor of safety 3.5. Eventually, the design pull-out strengths were N/A, 7, 36 and 33 kg for AAC without cement plaster and 52, 45, 62 and 76 kg for AAC with cement plaster for steel anchor diameter 8, 10, 12 and 16 mm consecutively. From the view of pull-out strength, the results showed that steel anchor diameter 10 mm was possessed the possibility to withstand the design load when installed in AAC with cement plaster at the distance arrangement $400 \times 400 \text{ mm}$. The steel anchor diameter 12 mm could possibly be employed for installation of facade in AAC without cement plaster. The thermal insulation could be installed together with facade.

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Fresh Lime Preservation in Household Packaging and Consumer Acceptance

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Abstract: The objective of this research was to examine the extension of fresh lime storage life using an assortment of household containers and to survey the consumers' acceptance of fresh lime packaging. Lime samples were divided into four groups of 16-each group was stored in each type of containers: paper container, foam container, clear plastic tray and plastic storage bag. All samples were kept in a refrigerator at 8-10 degrees Celsius and observed every week, for five weeks. It was found that in the fifth week's time, the lime's physical property had changed and could not be maintained further. The limes stored in a plastic bag exhibited little physical change, but the taste changed. The result of this experiment was later adapted into a survey to assess the consumer's acceptance of the lime's packaging. It was found that most consumers agree with the use of appropriate packaging to lengthen the limes' shelf life, which also led to the convenience in storing and choosing limes.

Keywords: Shelf life extension, Consumer acceptance, Packaging

INTRODUCTION

Lifestyles and living habits of today's generation change according to societal trends, which have been increasingly influential. The food would last as long as possible. Nowadays, consumers are facing problems of high lime prices due to falling lime output. This year 2013, for example, lime is very expensive; retail prices in open-air markets have soared to 10 to 11 baht each and consequence of last year's floods in lime-growing areas, particularly in Phichit, where floods destroyed all lime groves. Many farmers have since switched to rice growing, as government-subsidized, lucrative rice prices present a better incentive. Moreover, lime-growing areas in Samut-Sakhon have declined and been transformed into groves for other vegetation. Data from the Office of Agricultural Economics indicates that total lime yield in 2010 was 141,450 tons and 120,141 tons in 2011. Consequently, lime prices have risen steadily since November 2011 [1]. Packaging and preserving the quality of the produce until it reaches the hands of consumers.

Therefore, this research aims to study the extension of lime's storage life using various packaging materials as well as consumer acceptance of new lime packaging. Packaging plays a key role in preserving lime's freshness whilst the produce is being shipped from farmers via transporters to consumers. However, vegetables and fruits are difficult to store due to constant postharvest biochemical changes. Choosing the right type of packaging for a particular kind of fruit or vegetable can help forestall. And influence, the effects external alterations were directly on fresh produce, which will ultimately extend the shelf life; lime freshness can also be preserved [2].

Lime was chosen as the subject of this study on using household containers to lengthen the produce's shelf life and public opinion towards packaging for lime. In addition, consumers are facing high lime prices due to declining numbers of lime farmers and low yields during the dry season. The application of this study should be able to help reduce postharvest damages, especially during lime surpluses, which is one of the ways to sustainably solve problems for both farmers and consumers.

MATERIALS AND METHODS

For the experimental study on lime storage in containers made of different materials, Acid lime samples from Nakhon Pathom were selected for their qualities. They were cleaned and stored in containers made of four different materials: paper container, foam container, a clear plastic tray and a Ziploc storage bag. They were stored in a produce drawer of the researcher's, 5.5-cubic-foot household refrigerator for five weeks at 8 to 10 degree C .elsius d weekly Any physical changes occurring to these limes were recorded.

Statistical Analysis

The study was done using the non-probability sampling method because the exact number of population was unknown. Convenience or accidental sampling method: samples were selected based on no particular criteria at the researcher's convenience. Samples could be anyone who cooperated with the researcher and was willing to participate in a survey. These 384 samples were randomly chosen around product exhibition areas at Tesco Lotus Ratchadapisek and Carrefour Ratchadapisek (now Big C Ratchadapisek) in Bangkok, Thailand. The data were collected through a survey research method using a questionnaire, over a period of three days or until the anticipated number of samples & 384 were reached.

Having analyzed the data collected, it was evident such data yielded a skewed distribution, meaning they did not statistically produce a normal curve. Therefore, the analysis was done using non-parametric methods.

1) Consumer demographics, including sexes, ages, occupations, income levels and educational levels, were analyzed using frequencies and percentages.

2) Consumer acceptance of the new lime packaging, researched through the use of a questionnaire, was analyzed using frequencies and percentages.

3) Levels of consumer acceptance were analyzed using averages and standard deviations.

4) The correlations between consumer demographics and levels of consumer acceptance was analyzed using the chi-square test.

RESULTS AND DISCUSSION

Experimental study on lime storage in containers made of different materials

Lime was kept fresh the longest in the Ziploc storage bag, and less fresh in foam, plastic and paper containers, respectively.



Figure 1 Experimental study on lime storage in containers made of different materials. During the first week of storage, limes in each container seemed fresh and juicy.



Figure 2 In a follow-up study on day 14, limes still looked fresh and succulent with no observable changes.



Figure 3 On day 21, there were visible changes, especially with the ones stored in a paper carton; their skins were browning and losing moisture.

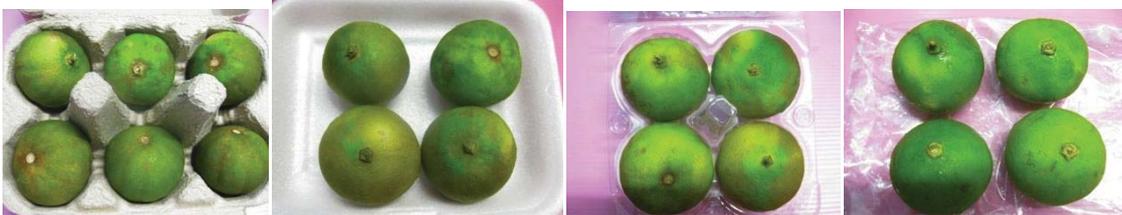


Figure 4 On the fifth week, all limes were spoiled.

Study on Consumer Acceptance of New Lime Packaging

The data analysis is divided into four parts:

1. Basic statistical analysis on general consumer information
2. Basic statistical analysis on consumers' consumption behavior
3. Basic statistical analysis on consumer acceptance
4. Basic statistical analysis on the correlation between consumer acceptance levels and demographics using the chi-squared test.

Basic statistical analysis of 384 surveyed samples sourced from the crowd at hyper markets revealed that most of them were females less than 25 years old. The second most fall within 25 to 30 years old. The majority of the questionnaire respondents work at private companies earning approximately 10,001 – 15,000 baht a month, followed by general contractors earning between 5,001 – 10,000 baht a month. In terms of education, most of the samples received a Bachelor's degree.

The majority of them likes consuming sour food. As for their consumption behaviors, the majority of these consumers prefers buying prepared food to eat at home for the sake of convenience. A smaller number would do some ingredient shopping and cook at home 2 to 3

times per week if they have time. Lime juice is a popular way of adding sourness to food; not only does lime give piquant tartness, it also gives the pleasant aroma of its skin. In terms of consumers' opinions on fresh lime having a packaging, most consumers believe it adds convenience to storing and preserving lime's freshness.

General data on consumer acceptance of lime packaging shows most surveyed individuals moderately agree that lime with a packaging reflects better quality than lime sold without a packaging. They also strongly agree that limes sold in supermarkets have been carefully selected. In addition, they think lime packaging should provide nutritional information for the benefit of consumers. In terms of consumer acceptance of lime packaging, respondents moderately accept that fresh limes having a packaging is convenient, will keep lime fresh longer and will attract more buyers. Lastly, they moderately accept of that, in the future, limes with a packaging will be more accepted than lime without a packaging as shown in Table 1.

Table 1 Consumer acceptance of new lime packaging

Questions	Average	SD.	Level
Do you agree that limes sold in a packaging are of superior quality to those ?sold without a packaging	2.84	1.11	Moderate
Do you think limes sold in supermarkets are carefully selected by the producers ?prior to being sold in the markets	3.36	0.98	High
Do you agree that limes sold in supermarkets are priced quite similarly to ?air markets-the ones sold in open	2.83	1.03	erateMod
Do you think limes sold in supermarkets free than -are more hygenic and pesticide ?air markets-the ones sold in open	3.09	1.01	Moderate
Do you agree that limes in a packaging with printed preservation instruction will .be more attractive to consumers	3.48	1.06	Moderate
You think lime packaging should provide nutritional information for the benefit of .consumers	3.56	1.10	High
Do you agree that limes in a packaging is more convenient to buy than those without ?a packaging	3.05	1.08	Moderate
Do you agree that packaging will ?contribute to longer storage time for limes	3.25	1.10	Moderate
Do you agree that packaging helps persuade you to pick one fresh lime over ?another	3.14	1.09	Moderate
Do you think, in the future, limes in a packaging will be more accepted than ?limes wihtout a packaging	3.11	1.05	Moderate
Total	3.17	0.70	Moderate

Note The averages were interpreted according to the following criteria:

- The average between 5.00 to 4.50 means highly agree.
- The average between 4.49 to 3.50 means very much agree.
- The average between 3.49 to 2.50 means moderately agree.
- The average between 2.49 to 1.50 means disagree.
- The average between 1.49 to 1.00 means highly disagree.

Basic Statistical Analysis on the Correlation between Consumer Acceptance Levels and Demographics using the Chi-Squared Test

Table 2 Analysis on the correlation between the level of consumer acceptance and sex

Sex	Acceptance Level			P- value	Chi-square
	Least	Medium	Most		
Male				1.073	0.585
	Number of respondents	21	62	52	
	Percentage	36.84	32.63	37.96	
Female					
	Number of respondents	36	128	85	
	Percentage	63.16	67.37	62.04	

Applying the chi-square test to assess the correlation between consumer acceptance level and sex, it was found that consumers of different sexes display dissimilar levels of acceptance, with statistical significance of 0.05.

Table 3 Analysis on the correlation between the level of consumer acceptance and age

Age	Acceptance Level			P- value	Chi-square
	Least	Medium	Most		
Under 25 years				9.306	0.317
	Number of respondents	12	57	42	
	Percentage	21.05	30.00	30.66	
years 30-25					
	Number of respondents	11	57	35	
	Percentage	19.30	30.00	25.55	
years 40-31					
	Number of respondents	21	46	30	
	Percentage	36.84	24.21	21.90	
years 50-41					
	Number of respondents	10	24	24	
	Percentage	17.54	12.63	17.52	
Over 50 years					
	Number of respondents	3	6	6	
	Percentage	5.26	3.16	4.38	

Applying the chi-square test to assess the correlation between consumer acceptance level and age, it was found that consumers of different age groups display dissimilar levels of acceptance, with statistical significance of 0.05.

Table 4 Analysis on the correlation between the level of consumer acceptance and occupation

Occupation	Acceptance Level			P- value	Chi-square
	Least	Medium	Most		
Students				9.385	0.670
Number of respondents	7	31	18		
Percentage	12.28	16.32	13.14		
Private company employees					
Number of respondents	19	78	49		
Percentage	33.33	41.05	35.77		
Government employees					
Number of respondents	2	11	13		
Percentage	3.51	5.79	9.49		
employees State enterprise					
Number of respondents	5	11	5		
Percentage	8.77	5.79	3.65		
Teachers/Educators					
Number of respondents	1	1	1		
Percentage	1.75	0.53	0.73		
General contractors					
Number of respondents	13	32	31		
Percentage	22.81	16.84	22.63		
Business owners					
Number of respondents	10	26	20		
Percentage	17.54	13.68	14.60		

Applying the chi-square test to assess the correlation between consumer acceptance level and occupation, it was found that consumers of different occupations groups display dissimilar levels of acceptance, with statistical significance of 0.05.

Table 5 Analysis on the correlation between the level of consumer acceptance an income level

Monthly Income	Acceptance Level			P- value	Chi-square
	Least	Medium	Most		
than 1001 baht Less				28.468	*0.005
Number of respondents	2	4	4		
Percentage	3.51	2.11	2.92		
baht 5000-1001					
Number of respondents	3	8	8		
Percentage	5.26	4.21	5.84		
baht 10000-5001					
Number of respondents	13	47	38		
Percentage	22.81	24.74	27.74		
baht 15000-10001					
Number of respondents	6	50	49		
Percentage	10.53	26.32	35.77		
baht 25000-15001					
Number of respondents	10	41	21		
Percentage	17.54	21.58	15.33		
-2500150baht 000					
Number of respondents	16	28	14		
Percentage	28.07	14.74	10.22		
More than 50001 baht					
Number of respondents	7	12	3		
Percentage	12.28	6.32	2.19		

Note: *Statistical significance of the correlation is at 0.05

Applying the chi-square test to assess the correlation between consumer acceptance level and income level, it was found that consumers belonging to different income brackets display dissimilar levels of acceptance, with statistical significance of 0.05.

Table 6 Analysis on the correlation between the level of consumer acceptance and education level

Educational Level	Acceptance Level			P- value	Chi-square
	Least	Medium	Most		
Lower than 12th grade				18.122	*0.020
Number of respondents	3	28	30		
Percentage	5.26	14.74	21.90		
Vocational certificate/12th grade					
respondents Number of	8	36	24		
Percentage	14.04	18.95	17.52		
Vocational diploma/Diploma					
Number of respondents	6	11	14		
Percentage	10.53	5.79	10.22		
Bachelor’s degree/Equivalent					
Number of respondents	33	107	59		
Percentage	57.89	56.32	43.07		
Master’s degree/Equivalent					
Number of respondents	7	8	10		
Percentage	12.28	4.21	7.30		

Note: *Statistical significance of the correlation is at 0.05

Applying the chi-square test to assess the correlation between consumer acceptance level and educational level, it was found that consumers belonging to different educational levels display dissimilar levels of acceptance, with statistical significance of 0.05

Hypothesis

- 1) Consumers of different sexes display dissimilar levels of acceptance towards the new lime packaging
- 2) Consumers of different ages display dissimilar levels of acceptance towards the new lime packaging
- 3) Consumers of different occupations display dissimilar levels of acceptance towards the new lime packaging
- 4) Consumers of different levels of income display dissimilar levels of acceptance towards the new lime packaging
- 5) Consumers of different educational levels display dissimilar levels of acceptance towards the new lime packaging

CONCLUSION

This research demonstrated suitable type of packaging can best preserve lime’s freshness and consumers’ attitude towards new lime packaging. Packaging manufacturers can build upon the experimented household containers and commercially produce appropriate packaging for limes. New packaging can help to keep limes fresh longer, which can reduce postharvest losses, especially when there is a surplus. It is perhaps one of the most sustainable ways to solve issues related to lime prices for both farmers and consumers.

ACKNOWLEDGEMENT

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Antimicrobial Properties and Phytochemical Constituents of the Root of *Stemona curtisii*

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Abstract: Phytochemical studies of the dried root of *Stemona curtisii* from two different habitats were carried out. Their crude extracts were made by partitioning with different solvents (hexane, petroleum spirit, chloroform, ethyl acetate and dichloromethane) and then some of the pure compounds were isolated. Their structures were determined from analysis-tocopherol, stigmaterol, g of their spectroscopic data. Dehydro-stemocurtisinol, stemofuran F, J, K and a new benzofuran, stemofuran L were isolated from *S. curtisii* in Trang Province. Meanwhile, oxystemokerrin, oxystemokerin-N-oxide, oxyprotostemonine and a new benzofuran, stemofuran S were isolated from *S. curtisii* in Petchaboon Province. The antimicrobial activities of the compounds were carried out by the broth dilution method. The results showed that the inhibitory effect of stemofuran J against *Cryptococcus neoformans* and methicillin-resistant *Staphylococcus aureus* (MRSA) were at the minimal g/mL, m inhibitory concentration (MIC) values of 7.8 and 15.6-tocopherol, stigmaterol, g respectively. Dehydro-stemocurtisinol, oxystemokerrin, oxystemokerin-N-oxide, oxyprotostemonine, stemofuran F, K, L and S displayed moderate g/mL, m inhibitory activity with MIC values ranging from 15.6 to 125.

Keywords: *Stemona curtisii*, Phytochemical study, Antimicrobial activity

INTRODUCTION

Natural products are preferred for biologically screening based on ethno-medical use of a plant. Many infectious diseases are known to have been treated with herbal remedies [1]. The plants used in traditional medicine are still a large source of natural antioxidants, antimicrobial anti-cancer agents that might serve for the development of novel drugs [2]. The *Stemona* genus is distributed mainly in Southeastern Asia and Northern Australia [3, 4]. The roots of various *Stemona* species have been shown to be responsible for several therapeutic activities such as antimicrobial, insecticides, anti-cancer, antitussive agents and acetylcholinesterase inhibitory [5-7]. Therefore, in this present study we were interested to determine the phytochemical composition of the *S. curtisii* root extract. In addition, the antimicrobial activity of the isolated compounds was also investigated.

MATERIALS AND METHODS

General Experimental Procedures

Optical rotations were measured using a JASCO DIP-370 polarimeter. ¹H (300 or 500 MHz), ¹³C (75 or 125 MHz), and 2D NMR spectra were recorded on Varian Mercury 300 and Varian Unity 500 spectrometers. High resolution EIMS were recorded on a Fison/VG Autospec-TOF-0a mass spectrometer (70 eV). High resolution ESIMS (for MH⁺) were obtained with a Micromass Q tof 2 mass spectrometer using a cone voltage of 30 V and polyethyleneglycol (PEG) as an internal reference. TLC was performed on aluminium-backed Merck 60 GF254 silica gel and bands were detected by UV light (λ 254 nm) or by staining with Dragendroff's reagent and ammonium molybdate reagent. Column chromatography was performed using Merck GF254 flash silica gel (40-63 μ m).

Plant Material

Two different samples, the roots of *S. curtisii* were collected at Tumbol Kaunmao, Amphur Rasda, in the North of Trang Province, Thailand, in November 2008. While, roots of *S. curtisii* were collected at Tumbol Bo Thai, Amphur Nong Phai, Petchaboon Province, Thailand, in May 2010. The specimens were identified by Mr. James F. Maxwell and kept as voucher specimens (number 17581) and (number SC-1), respectively at CMU Herbarium, Department of Biology, Faculty of Science, Chiang Mai University, Thailand.

Extraction and Isolation

The dry ground roots of *S. curtisii* from Trang Province (1.0 kg) were extracted with 95% ethanol (3 x 3,000 mL) for 4 days at room temperature. The ethanol extracts were evaporated under reduced pressure to give a dark brown sticky residue (123.1 g). A portion of the crude extract (100.0 g) was dissolved in distilled water (200-300 mL). The resulting aqueous solution was first extracted in petroleum spirit (2 x 200 mL) to yield 7.27 g followed by chloroform and ethyl acetate, respectively. The combined chloroform solutions were extracted with 3% aqueous hydrochloric acid solution, dried over with Na₂SO₄ and filtered. The solvent was removed under reduced pressure to yield a non-alkaloid crude mixture (3.58 g). The aqueous solution was basified with aqueous ammonia to pH 10 and further extracted with ethyl acetate. The combined ethyl acetate solutions were washed with a saturated solution of NaCl, dried over Na₂SO₄, filtered and the solvent was removed to afford the crude alkaloid mixture (1.71 g).

The non-alkaloid crude mixture (3.22 g) was separated by flash column chromatography, using silica gel (300 mL) and gradient elution from 100% dichloromethane to 50% methanol/dichloromethane, 15 fractions were obtained from the separation. Fraction 6 (23.0 mg) was further separated by preparative TLC using 100% dichloromethane as eluting solvent to give a new benzofuran, **stemofuran L** (4.0 mg) and **stemofuran K** (3.0 mg). Fraction 8 (176.0 mg) was further purified on a silica gel column using gradient elution with dichloromethane-methanol (100:0 to 97:3, v/v) to yield 6 fractions (fractions 8.1-8.6). Further purification of fraction 8.5 (27.0 mg) by preparative TLC (100% CH₂Cl₂) gave **stemofuran J** (4.0 mg). Fraction 9 (105.0 mg) was also purified by column chromatography using gradient elution with dichloromethane-methanol (100:0 to 97:3, v/v) to afford 6.0 mg and 15.0 mg of mixtures of fatty acids (fraction 9.3 and fraction 9.5 respectively). Fraction 12 (273.0 mg) was further purified by column chromatography with gradient elution with dichloromethane-

methanol (100:0 to 97:3, v/v) to yield 6 fractions (fractions 12.1-12.6). Fraction 12.1 (45.0 mg) was purified by preparative TLC (100% CH₂Cl₂) to give **stemofuran F** (4.0 mg) plus a small amount of impurity. Fraction 13 (130.0 mg) was further purified by column chromatography using gradient elution with dichloromethane-methanol (100:0 to 95:5, v/v) to afford **stemofuran F** (2.0 mg). Fraction 15 (311.0 mg) was further purified by column chromatography using gradient elution with dichloromethane-methanol (100:0 to 95:5, v/v) to yield 4 fractions (fractions 15.1-15.4). Further purification of fraction 15.3 (71.0 mg) by column chromatography with gradient eluent with dichloromethane-methanol (100:0 to 96:4, v/v) afforded **stemocurtisinol** (44.0 mg)

The petroleum spirit crude extract (7.12 g) was separated by flash silica gel column chromatography (600 mL) using gradient elution (100% petroleum spirit to 100% dichloromethane/20% methanol) to give 13 fractions. Fraction 5 (105.8 mg) was purified by column chromatography using gradient elution with petroleum spirit - dichloromethane (100:0 to 0:100, v/v) to yield 10 fractions (fractions 5.1-5.10). Further purification of fraction 5.7 (54.5 mg) by preparative TLC, using 5% ethyl acetate/petroleum spirit as the eluent, gave **dehydro-γ-tocopherol** (16.3 mg). Fraction 9 (174.0 mg) was purified by recrystallisation from ethanol to give **stigmasterol** (17 mg).

The dry ground roots of *S. curtisii* from Petchaboon Province (2.5 kg) were extracted with 95% ethanol (3 x 3,000 mL) for 4 days at room temperature. The ethanol extracts were evaporated under reduced pressure to give a dark brown sticky residue (259.89 g). A portion of the crude extract (50.0 g) was dissolved in distilled water and methanol (8:2, v/v, 100 mL). The resulting mixture was extracted in dichloromethane (4 x 200 mL) to yield, 4.403 g of crude material after drying with Na₂SO₄ and evaporation. A portion of the dichloromethane crude extract (2.776 g) was separated by flash column chromatography, using silica gel (200 ml) and gradient elution (100% dichloromethane to 100% methanol), 6 fractions were obtained from the separation.

Fraction 3 (361.0 mg) was further purified by silica gel column chromatography using a gradient elution with dichloromethane-methanol (100:0 to 90:10, v/v) to yield 4 fractions (fractions 3.1-3.4). Fraction 3.3 (169.0 mg) was further purified by column chromatography with gradient elution (100% dichloromethane to 100% methanol) to yield 2 fractions (fractions 3.3.1 and 3.3.2). Further purification of fraction 3.3.1 (66.0 mg) by preparative TLC (hexane: ethyl acetate, 30:70, v/v) gave a new compound, **stemofuran S** (30 mg). Further purification of fraction 3.3.2 (48.0 mg) by preparative TLC was carried out, using ethyl acetate/hexane (1:9) as eluent to give **oxystemokerrin** (9.0 mg).

Fraction 4 (1,774.0 mg) was also separated by flash column chromatography, using silica gel (200 ml) and gradient elution (100% dichloromethane to 100% methanol). Five fractions were obtained from the separation (fractions 4.1-4.5). Fraction 4.1 (1,514.0 mg) was further purified on silica gel column using gradient elution with dichloromethane-methanol (100:0 to 80:20, v/v) to yield 9 fractions (fractions 4.1.1-4.1.9). Fraction 4.1.6 (125.0 mg) was further purified by column chromatography using gradient elution (hexane-ethyl acetate 50:0 to 0:50, v/v) to yield 2 fractions (fractions 4.1.6.1 and 4.1.6.2). Further purification of fraction 4.1.6.2 (26.0 mg) by preparative TLC (methanol: ethyl acetate: NH₄OH, 10:89:1, v/v) gave **oxystemokerrin-N-oxide** (4.0 mg) and **oxyprotostemonine** (6.0 mg). Fraction 4.1.7 (357.0 mg) was further purified on a silica gel column, using gradient elution with ethyl acetate-methanol (50:0 to 0:50, v/v) to yield 3 fractions (fractions 4.1.7.1-4.1.7.3). Further purification of fraction 4.1.7.3 (40.0 mg) by preparative TLC was carried out, using methanol/ethyl acetate (1:4) as eluent to give **oxystemokerrin-N-oxide** (7.0 mg). Fraction 4.1.7.2 (252.0 mg) was purified by column chromatography using gradient elution with ethyl acetate-methanol (100:0 to 0:100, v/v) to yield 2 fractions (fractions 4.1.7.2.1 and 4.1.7.2.2).

Fraction 4.1.7.2.2 (85 mg) was further separated by preparative TLC using methanol/ethyl acetate (1:9) as the eluting solvent to give **oxystemokerrin-N-oxide** (15.0 mg).

Antimicrobial Assay

Studies of the antimicrobial activities of the isolated compounds from *Stemona* species against *Escherichia coli*, *Klebsiella pneumoniae*, *Staphylococcus aureus*, Methicillin-resistant *Staphylococcus aureus* (MRSA), *Streptococcus pyogenes*, *Candida albicans* and *Cryptococcus neoformans* were carried out by the broth dilution method [8]. Sterile 96-well microplates were used for the assay (0.5 mL volume, Fisher Scientific). Test samples were dissolved in a minimal amount of ethanol for stock solutions (1,000 µg/mL). Samples were diluted to twice the desired initial test concentration with TSB. All wells, except the first, were filled with TSB (50 µL). Test samples (100 µL) were added to the first well and serial two-fold dilutions were made down to the desired minimum concentration. Day-old cultures of bacteria grown were suspended in TSB until turbidity was equal to a 0.5 McFarland Standard. The plates were inoculated with the bacterial suspension (50 µL per well) and incubated at 37 °C overnight. Antibiotics, gentamicin and amphotericin B were used as positive controls in the test. The MIC was determined as the lowest sample concentration (signifying live growth) that gave rise to a clear solution.

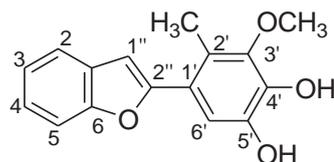
RESULTS AND DISCUSSION

Identification

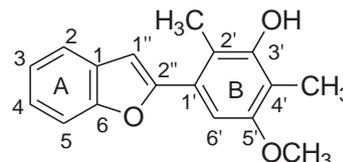
Phytochemical studies of the dried root of *Stemona curtisii* from two different origins were investigated. Various chromatographic methods were led to isolation of some pure compounds. One new stemofuran, stemofuran L together with three known stemofurans, stemofuran F, J, K and one known alkaloid, stemocurtisinol were isolated from the non-alkaloid crude extract of *S. curtisii* from Trang Province whereas, dehydro-γ-tocopherol and stigmasterol were isolated from the petroleum spirit crude extract. One new stemofuran i.e. stemofuran S along with three known alkaloids, oxystemokerrin, oxystemokerrin-N-oxide and oxyprotostemonine were obtained from the dichloromethane crude extract of *S. curtisii* from Petchaboon Province. The known compounds were identified by comparison of their spectroscopic data [9-14].

Stemofuran L was isolated as a light brown gum; HRMS analysis (EI, m/z [M^{+}] 268.1095, calcd 268.1099) indicated that this compound had the molecular formula $C_{17}H_{16}O_3$. This benzofuran compound was characterized by two independent aromatic systems separated by the furan ring of the benzofuran moiety. The connectivities of the directly coupled protons were determined using H/H-COSY experiments, and the positions of methyl and methoxy groups in ring B were elucidated by NOESY experiments. The 1H NMR showed resonances for five benzofuran, protons at 7.62 (d, 1H, $J = 7.5$ Hz, H-2), 7.50 (d, 1H, $J = 8.0$, H-5), 7.30 (ddd, $J = 8.0, 8.0, 1.5$ Hz, 1H, H-4), 7.28 (ddd, $J = 8.0, 8.0, 1.5$ Hz, 1H, H-3) and 6.63 (s, 1H, H-1'') ppm. The substituted phenyl group showed a singlet aromatic proton signal at 6.51 (s, 1H, H-6') ppm, a hydroxyl resonance at 5.20 (s, 1H, 3'-OH) ppm and resonances for a methoxy group at 3.78 (s, 3H, 5'-OCH₃) ppm and two aromatic methyl groups 2.01 (s, 3H, 2'-CH₃) and 1.98 (s, 3H, 4'-CH₃) ppm. The positions of these substituents were established from NOESY and HMBC NMR experiments. In particular the diagnostic NOESY correlations were between, H-1'' and the 2'-CH₃, H-6' and the 5'-OMe and 4'-CH₃ and the 3'-OH and the 5'-OCH₃.

Stemofuran S was isolated as a dark brown amorphous powder; HRMS analysis (EI, m/z $[M-H]^+$ 270.0870, calcd 270.0892) indicated that this compound had the molecular formula $C_{16}H_{14}O_4$. The 1H NMR showed resonances for five benzofuran protons at 7.62 (d, 1H, $J = 5.0$ Hz, H-2), 7.52 (d, 1H, $J = 5.0$, H-5), 7.28 (m, 1H, H-4), 7.22 (m, 1H, H-3) and 6.90 (s, 1H, H-1'') ppm. The substituted phenyl group showed a singlet aromatic proton signal at 7.18 (s, 1H, H-6') ppm and a singlet resonance for a methoxy group at 3.81 (s, 3H, 3'-OCH₃) ppm. Additionally, an aromatic methyl group resonance was observed at 2.39 (s, 3H, 2'-CH₃) ppm and OH correspond to the C-3' position of stemofuran L.



stemofuran S



stemofuran L

Antimicrobial Activities

From this study, of the antimicrobial activities of the results showed that almost of the tested compounds were less active than the positive control. However, stemofuran J could effectively inhibit *Cr. neoformans* and in particular MRSA at the MIC of 7.8 and 15.6 $\mu\text{g/mL}$, respectively. Whereas, dehydro- γ -tocopherol, stigmaterol, stemocurtisinol, oxystemokerrin, oxystemokerin-*N*-oxide, oxyprotostemonine, stemofuran F, K, L and S displayed moderate inhibitory activity with MIC values ranging from 62.5 to 125 $\mu\text{g/mL}$ as shown in Table 1. The previous study was showed that a variety of stilbenoids from the roots of *S. sessilifolia* exhibited antibacterial activities against *S. aureus* and *S. epidermidis* [15]. Moreover, Pacher *et al.* [9] reported that stemofuran B had the highest antifungal activity against the four parasitic fungi, *Alternaria citri*, *Fusarium avenaceum*, *Pyricularia grisea* and *Botrytis cinerea* with MIC₅₀ values ranging from 50-200 $\mu\text{g/mL}$ but only weak effects against *Cladosporium herbarum*. In addition, Lin *et al.* [16] indicated that dihydrostilbene displayed strong antimicrobial activity against *Bacillus pumilus* with MIC₅₀ values ranging from 12.5–25 $\mu\text{g/mL}$. Meanwhile, this compound exhibited moderate activity against *Klebsiella pneumoniae* with a MIC₅₀ value of 50 $\mu\text{g/mL}$. The present study could be concluded that the antimicrobial activities of these stilbenoids is dependent upon the types and position of substituents.

Table 1 The minimum inhibitory concentrations (MIC) values of isolated compounds from *Stemona curtisii*

Isolated compounds	Minimum inhibitory concentrations (MIC) µg/ml						
	<i>E. coli</i>	<i>K. pneumoniae</i>	<i>S. aureus</i>	MRSA	<i>Str. pyogenes</i>	<i>C. albicans</i>	<i>Cr. neoformans</i>
Stemofuran F	125	62.5	62.5	62.5	62.5	62.5	31.3
Stemofuran J	62.5	62.5	62.5	15.6	62.5	31.3	7.8
Stemofuran K	125	62.5	62.5	62.5	62.5	31.3	31.3
Stemofuran L	125	62.5	62.5	62.5	62.5	31.3	31.3
Stemofuran S	62.5	62.5	62.5	62.5	-	15.6	15.6
Dehydro-γ-tocopherol	125	62.5	62.5	62.5	62.5	31.3	31.3
Stigmasterol	125	62.5	62.5	62.5	62.5	31.3	31.3
Stemocurtisinol	125	62.5	62.5	62.5	62.5	31.3	31.3
Oxystemokerrin	62.5	125	125	62.5	-	31.1	15.6
Oxystemokerrin-N-oxide	62.5	62.5	62.5	62.5	-	31.1	15.6
Oxyprotostemonine	62.5	62.5	125	62.5	-	31.1	15.6
Gentamicin	11.3	11.3	22.5	45	5.6	-	-
Amphotericin B	-	-	-	-	-	15.6	3.9

CONCLUSIONS

The results obtained from this study indicated that the roots of *S. curtisii* contain many medicinal useful phytochemicals including, alkaloids, stilbenoids, steroids and phenolic compounds. Some pure compounds could be used as an alternative source for medicinal purposes and might be effectively used in pharmaceutical applications.

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Preharvest peel degreening by ethephon in ‘Pattavia’ pineapple

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Abstract: Mature, green pineapples harvested during the summer are undesirable for fresh consumption due to their failure in peel degreening. This research aimed to investigate how ethephon, an ethylene-released substance, effects the peel coloration and fruit quality during the harvest of the ‘Pattavia’ pineapple. The experiment in CRD with 3 replications was conducted at a pineapple plantation in Prachub Kirikhan Province, Thailand (12.3971N, 99.9762E) during the warm, rainy season (August-October). A week prior to commercial harvesting, the fruits from each plant were sprayed with 50 ml ethephon at 0, 500, 1000 or 1500 ppm. During the harvest, the fruit samples were evaluated by means of peel color, external and internal fruit qualities. The ethephon-fruit exhibited more yellowish peel than the control. The higher the concentration of ethephon applied, the more degreened peel area (up to 60%). The external fruit attributes such as fruit size and crown weight were similar to the control fruit. The higher ethephon doses increased flesh translucency but decreased firmness. The total soluble solids in the ethephon-fruit were higher compared to the control fruit, but the titratable acidity were similar in all treatments. This indicates that ethephon can induce peel degreening in ‘Pattavia’ pineapple with positive changes in internal fruit qualities. To acquire ¼ yellowish fruit in summer harvest, 1,000 ppm-ethephon should be applied over the fruit at a week prior to designated harvesting.

Keywords: Smooth cayenne, Ethylene, Shell coloration, Fruit quality

INTRODUCTION

Pineapple production in Thailand has been grown and harvested all year round resulting in a leader of global pineapple canning exporters. Most of pineapple grown in the country is ‘Pattavia’ belong to Smooth Cayenne type which probably owing to its environmental adaptability and high yield. This cultivar is appropriate for both canning and fresh consumption. Fruit consumers generally prefer a pineapple fruit with ¼ to half yellowing peel to assure the ripening and taste [1]. The ‘Pattavia’ fruit harvested during summer appears dark green peel at fully maturation which is unfavorable to the consumers although internal flesh already develops.

The peel chlorophyll content increases during fruit development until a few weeks prior to ripening and harvest in slightly cool condition [2]. Conversely dark green peel on harvested fruit usually exists in Smooth Cayenne pineapple. This generally stems from failure in chlorophyll degradation process [3] and β -carotene bio-synthesis [4]. Ethylene, gaseous bio-regulator, had been reported to induce flowering [5], accelerate respiration, abscising, ripening and degeening processes [6]. Application of ethylene on mature green

pineapple fruit may resolve this problem; moreover, harvesting period should be peak. However, timing and concentration applied needs to be concerned [7]. Improper application such as too early can cause abnormal fruit development or induce flowering on following suckers. Paull [8] suggested that ethephon should be sprayed only a week before designate harvest to obtain harvest peak.

Ethephon (2-chloroethylphosphonic acid) can release ethylene when rising up solution pH. This chemical is affordable and easier to utilize practically than ethylene gas. There is a research reported that peel of 'Perola' pineapple turned to yellow by sprayed prior to harvest or quickly dipped after harvest with 500-2000 ppm of ethephon without affecting peel firmness and flesh quality [3]. 'Smooth Cayenne' pineapple in Queensland treated with ethephon showed more evenly degreened peel and superior edible quality to untreated fruit, but shorter shelf life due to peel senescence [9].

'Pattavia' pineapple for fresh market requires $\frac{1}{4}$ to half yellow peel to attract consumers. Therefore, this research aimed to evaluate the influence of ethephon concentration on peel coloration, fruit size and internal qualities in summer harvest.

MATERIALS AND METHODS

Plant Preparation

The experiment was conducted at commercial 'Pattavia' pineapple plantation in Prachub Kirikhan, Thailand (12.3971N, 99.9762E) during warm rainy season (August-October). Uniform plant crops bearing fruit at the twentieth week after flower induction or a week prior to be harvested were used in the experiment. The fruit was fully physiological mature with dark green peel.

Ethephon Application

A commercial ethephon were diluted into 0, 500, 1000 or 1500 ppm a.i. and added with a few drops of surfactant. Fifty milliliters of the solutions were sprayed around the fruit but not on the crown. The fruit was harvested a week later and transported to the laboratory for fruit evaluation in next day.

Fruit Measurement

The sample fruits were evaluated for physical appearances including fruit weight, crown weight, fruit width and length and fruit volume by water replacement. The peel color was visually evaluated by an evaluator based on percentage of yellowish peel surface as 0-100%. Internal qualities were determined by longitudinal cut and evaluation for flesh firmness at the median of the flesh by hand penetrometer. Flesh translucency was visually determined by watery flesh area. Total soluble solids (TSS) and titratable acidity (TA) were examined by hand refractometer and titration with 0.1 M NaOH, respectively. Flesh color was evaluated by color meter at the median of flesh area

Statistical Analysis

The experimental design was completely randomized with 5 replications, 15 fruits in each treatment. Data were subjected to analyze variance and compare means by DMRT.

RESULTS AND DISCUSSION

Peel Coloration and Fruit Appearance

Concentrations of ethephon played a significant role on peel coloration as showed in Table 1. The control fruit (0 ppm ethephon) was mostly green, only 5% of the peel surface degreened. Increasing in ethephon concentration applied resulted in more yellow area. This agreed with 'Perola' pineapple that obtained more yellow peel when applied with higher concentration [3]. At 1000 ppm of ethephon, the coloration developed reaching one-fourth of fruit surface similar to fruit harvest in cool season. Furthermore, up to 1500 ppm the peel develop to 60% yellow which maybe exceeded marketable acceptance due to quick senescence [9]. Application method here, spraying on fruit in the field, is practical and affordable, however dipping fruit in solution after harvest seemingly yielded more evenly yellowing.

The fruit weight, crown weight, fruit size and fruit volume were not significantly different among the treatments (Table 1 and 2). The stage of fruit development at application of ethephon was physiological mature which no or less changes in fruit size but high biochemical changed during the last week of fruit development [10]. Application during fruit enlargement may interrupt cell expansion and bring about immature ripening.

Internal Fruit Qualities

When applied with 0-1000 ppm of ethephon, the flesh firmness in the treatments was similar ranging 2.00-2.14 kg/cm² (Table 3). However, at 1500 ppm of ethephon the firmness obviously decreased. Parallel with flesh firmness, the higher the concentrations used the larger percentage of translucency which developed from basal part. Treated fruit, even lowest concentration as 500 ppm, showed translucency approximately 60-70% while 36% for untreated fruit. Total soluble solids in treated fruit were varied from 13.27 to 14.50%. The titratable acidity between 0.51 and 0.58% indicated that the ethephon did not affect to the fruit acidity. On the other hand, fruit during warm season are naturally low in flesh acidity [7]. The flesh color was considerably changed to be more yellowing (an increase in b-value) and darker (low L-value) (Table 4). This possibly resulted from flesh watery tissue affected by ethephon [11]. Apparently external ethephon could activate peel coloration by chlorophyll degradation, penetrate into the fruit and induce ripening activities.

CONCLUSION

Ethephon applied a week prior to designated commercial harvest can induce peel coloration (degreening) in 'Pattavia' pineapple during warm season. Ethephon spraying at 1,000 ppm is a proper concentration resulting in acquiring ¼ yellow fruit at harvest with improvement of internal fruit qualities.

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Table 1 Percentage of peel coloration, fruit weight and crown weight at harvest in ‘Pattavia’ pineapple fruit applied with various ethephon concentrations at a week prior to harvest.

Ethephon (ppm)	%Peel coloration	Fruit weight (g)	Crown weight (g)
0	5.3 c	721	329
500	9.0 c	820	310
1000	26.0 b	848	349
1500	60.0 a	752	341
F-test	**	ns	ns
cv(%)	88.4	20.3	15.7

Table 2 Fruit width, fruit length and fruit volume at harvest in ‘Pattavia’ pineapple fruit applied with various ethephon concentrations at a week prior to harvest.

Ethephon (ppm)	Fruit width (cm)	Fruit length (cm)	Fruit volume (mL)
0	9.99	10.82	794
500	10.16	11.71	821
1000	10.24	11.5	886
1500	9.99	11.04	730
F-test	ns	ns	ns
cv(%)	4.4	10.0	22.3

*,** Different letters in the same column indicate significant difference, P<0.05 or P<0.01
 ns No difference of means among the treatments

Table 3 Flesh firmness, flesh translucency percentage, total soluble solids (TSS), titratable acidity (TA) and flesh pH in ‘Pattavia’ pineapple fruit applied with various ethephon concentrations at a week prior to harvest.

Ethephon (ppm)	Flesh firmness (kg/cm ²)	Translucency (%)	TSS (%)	TA (% citric acid)	pH
0	2.14 a	36.0 b	13.27 b	0.58	3.83 b
500	2.02 a	70.0 a	14.50 a	0.56	3.91 ab
1000	2.00 a	69.3 a	13.94 ab	0.51	3.98 a
1500	1.71 b	56.7 a	13.75 ab	0.53	3.96 a
F-test	*	**	*	ns	*
cv(%)	13.1	32.1	8.1	21.4	4.0

Table 4 Flesh color determined by L, a, b value in 'Pattavia' pineapple fruit applied with various ethephon concentrations at a week prior to harvest.

Ethephon (ppm)	L	a	b
0	70.51 a	-0.30	20.92 b
500	64.26 b	-0.10	24.69 a
1000	62.57 b	-0.11	24.11 a
1500	62.85 b	-0.33	25.55 a
F-test	**	ns	**
cv(%)	10.5	20.9	14.6

*,** Different letters in the same column indicate significant difference, $P < 0.05$ or $P < 0.01$

ns No difference of means among the treatments

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Paclobutrazol affecting fruit size in ‘Trad Si Thong’ pineapple

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Abstract: Paclobutrazol (PBZ), a growth retardant used in various fruit crop productions, has rarely been reported in the Queen-type pineapple. This research aimed to determine the influences of PBZ on morphological fruit traits in ‘Trad Si Thong’ pineapple (Queen type). The CRD experiment with 3 replications was conducted at Pakchong Research Station, Thailand (14.6805N, 101.4087E, 320m MSL). Nine-month old plants (planted crop) were naturally induced to flowering by cool condition (natural flower induction) prior to treatment with PBZ at 0, 5, 9 or 12 mg/plant into the central cup. The fruits were harvested at fourteen weeks later. The fruit external characteristics were evaluated, and correlations with PBZ concentration were established. It was shown that PBZ at 12g/plant, the fruit’s weight (without crown) decreased at 40% compared to 31% decrease with the crown weight. The fruit’s width slightly reduced from 9.2 to 8.1 cm while the fruit length declined from 14.5 to 12.4 cm. The fruit’s stalk was 43% shorter in the highest PBZ-treated plants compared. Those fruit characteristics were negatively correlated to PBZ concentration. This indicated that PBZ applied from 5 mg/plant up on the pineapple fruit yielded negative influences on the fruit characteristics by reducing in fruit weight, fruit size and fruit stalk. Application at a very low dose of PBZ applied on the fruit should be further investigated.

Keywords: Ananas comosus ‘Queen’, Growth retardant, Paclobutrazol, Fruit characteristics

INTRODUCTION

Pineapple is an important economic tropical fruit crop in Thailand, due to the top fruit export value in lately years. Most of exported items involve processing products as canning or juice which is focus on Smooth Cayenne group including ‘Pattavia’ or ‘Sri Racha’. In contrast, Queen group known as ‘Trad Si Thong’ or ‘Phuket’ is produced in particular locations and used for only fresh consumption in the country. Nowadays ‘Trad Si Thong’ fruit is highly demanded for not only local residents but also hotels and tourists due to its exotic taste and appearance.

Nevertheless ‘Trad Si Thong’, ‘Phuket’ or ‘Phulae’ fruits was obviously smaller in fruit size [1], especially from the ratoon crops but higher price compared with ‘Pattavia’ fruit. This might be indicating a possibility to improve fruit size. Consequently, enhancing fruit volume of ‘Trad Si Thong’ pineapple might bring about increasing yield and grower profits. Plant bio-regulators are a promising option which is involved in plant promoting and plant inhibiting agents.

A number of researches reported that plant growth retardants in Triazole group including paclobutrazol (PBZ) were used to control plant canopy and manipulate flowering [2]. Furthermore, PBZ was an effective agent to increase fruit production of certain fruit crops including durian [3], mango [4], apple [5] and others tree fruit crops [6]. The mode of PBZ action in general plants involved inhibiting of gibberellins bio-synthesis leading to promote photosynthate accumulation and flower initiation [7]. In pineapple there were some reports showed that PBZ played a role in natural flowering inhibition or postpone fruit harvest when applied before natural flowering [8, 9]. This means that PBZ possibly associated with a regulation of ethylene bio-synthesis [10]. The fruit obtained after re-induction of flowering was similar in fruit appearances and internal qualities [11].

The influence of PBZ on pineapple fruit during development is still little known especially for pineapple in Queen group including ‘Trad Si Thong’. Therefore, this research aimed to investigate how this pineapple responds to PBZ during fruit development.

MATERIALS AND METHODS

Plant Preparation

‘Trad Si Thong’ pineapple experimental plot was established at Pakchong Research Station in Thailand (14.6805N, 101.4087E, 320m MSL). The uniform suckers (approximately 500 g) were planted in February, 2009. The regular practices such as irrigation, weeding and fertilization were routinely carried out for nine months of the sucker development. Then the plants at the age of 10-11 months acquired cool season during December, 2009 and January, 2010. This cool environment induced natural flower induction observed from “red bud”, flower initiation at the top of the stump.

Paclobutrazol Treatments

After plants were natural induced during the beginning of december year, 2009, the mature stumps were applied with 0, 5, 9, 12 mg PBZ/plant. The PBZs were prepared as dilution of 50 mL applied into the central stem cup. The inflorescence developed to fruit and grew up through the beginning of summer, 2010. The fruit was harvest in about 3 months after the treatments, and were evaluated for their fruit characteristics.

Data records and Statistical Analysis

At commercial harvest in March, 2010, fruit with half to three fourth yellow were collected for external morphological characteristics as weight of fruit and crown, fruit width and length, and fruit peduncle length. The experiment was conducted in Completely Randomized Design (CRD) with 3 replications, and there were about 20 plants each treatment. The average of treatment parameter were recorded and compared by DMRT. Correlations of paclobutrazol concentration used and individual parameter were established.

RESULTS AND DISCUSSION

The ‘Trad Si Thong’ pineapple fruit obtained from this experiment were varied in fruit weight ranging from 348 to 577 g/fruit (whole fruit weight) shown in Table 1. The control fruit (0 mg PBZ) was the largest and then significantly decreased as an increase in PBZ concentration applied. Percentage of the fruit weight reduction compared with the control was 15, 24 and 40% for 5, 9 and 12 mg PBZ/plant, respectively (Table 1). This correlation of the weight and PBZ concentration was negatively significant ($r = -0.83$, p -value

<0.05). The crown weight was slightly decline from 32 to 20 g (up to 30% reduction) which was less reduction compared to the fruit weight (Table 1). This resulted in a little change in a ratio of crown/fruit weight, which was 0.06-0.07. The correlation was negatively significant ($r = -0.71$, p -value <0.05). This indicated partially that PBZ at concentration from 5 mg/plant up reduces fruit weight.

Table 1 ‘Trad Si Tong’ Pineapple fruit and crown weight at harvest after applied with PBZ

PBZ (mg/plant)	Whole fruit		Fruit without crown		Crown		Crown/fruit
	Weight (g)	Decrease (%)	Weight (g)	Decrease (%)	Weight (g)	Decrease (%)	
0	577 a	-	545 a	-	32 a	-	0.059
5	490 b	15.08	463 b	15.05	27 a	15.63	0.058
9	437 c	24.26	418 b	23.30	19 b	40.63	0.045
12	348 d	39.69	326 c	40.18	22 b	31.25	0.067
F-test	*		*		*		

* Different letters in the same column indicate significant difference, $P < 0.05$

The fruit width declined from 9.2 to 8.1 cm where PBZ concentration increased resulted in 8-12% width reduction (Table 2). The fruit length reduced from 14.5 to 12.4 cm or 14% reduction. Although fruit width and length reduction associated with an increase in PBZ concentration, the ratio of fruit width/ length existed similarly (0.60-0.65) (Table 2). This probably suggested that PBZ played a role in fruit cell expansion and fruit elongation of the whole fruit with similar manner. The negative correlation was found in fruit width and fruit length as $r = -0.78$ (p -value <0.05) and $r = -0.65$ (p -value <0.05), respectively.

Fruit peduncle length was about 17.2 cm in the control (0 mgPBZ/plant) and decreased to 9.8 cm in the 12 mgPBZ/plant treatment with negative correlation of $r = -0.65$ (p -value <0.05) (Table 2). The ratios of peduncle length/fruit length were 1.18, 0.81, 0.85 and 0.79 for 0, 5, 9 and 12 mgPBZ/plant treatments (Table 2). This reduction in the ratio indicated that the reduction in peduncle was more than those in fruit length. In other words, PBZ affected on peduncle length more than on fruit length. This is possibly a benefit to the pineapple fruit which is sometimes damaged from sunburn during fruit development in summer.

Normal fruit size for ‘Trad Si Tong’ is about 1 kg (with crown), 11x17 cm in width x length [1]. The fruit in this experiment were slightly smaller than norm probably due to dry season in January to March during fruit growth. The water stress may leads to low fruit cell water potential together with influence of PBZ that inhibited gibberellins bio-synthesis accounting for reduction of cell expansion [12]. The data from treatment revealed a tendency of changes in fruit weight and diameter.

The results from this research contrasted with other reported possibly due to high concentration of PBZ and plant response. Pineapple flower initiation depends on not only environmental factors but also internal carbohydrate accumulation [13] which was increased

after applied with PBZ in many plants [4, 6, 12]. Gibberellins is a promoting bio-regulator, are necessary to plant cell enlargement including fruit growth [14]. Thus it was possible that the internal gibberellins content maybe was inadequate in this pineapple fruit due to biosynthesis interruption by the PBZ although the stored carbohydrate increased. To minimize this negative effect on fruit, lower concentration of PBZ or earlier application, before flower induction, should be investigated.

Table 2 ‘Trad Si Tong’ Pineapple fruit width, fruit length and peduncle length at harvest after applied with PBZ

PBZ (mg/plant)	Width		Length		Width/ length	Peduncle length (cm)	peduncle/ fruit length
	(cm)	Decrease (%)	(cm)	Decrease (%)			
0	9.20 a	-	14.50 a	-	0.63	17.20 a	1.186
5	8.50 b	7.61	13.90 a	4.14	0.61	11.20 b	0.806
9	8.30 b	9.78	13.90 a	4.14	0.60	11.80 b	0.849
12	8.10 c	11.96	12.40 b	14.48	0.65	9.80 c	0.790
F-test	*		*		*	*	

* Different letters in the same column indicate significant difference, $P < 0.05$

CONCLUSION

The application of PBZ from 5 mg/plant up on ‘Trad Si Tong’ pineapple after natural flower initiation resulted in reduced fruit weight, width, length and peduncle length. Further PBZ applied on the pineapple should be more explored.

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Bioactive Compounds of Thai Medical Plants for Cosmetic Application

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Abstract: Various compounds present in Thai medicinal plants are of special interest due to their potential anti oxidant activity. The anti oxidant activities of three high potential Thai herbal plants, namely *Croton oblongifolius* Roxb., *Gymnopetalum integrifolium* kurz., and *Oxyceros horridus* Lour. were studied. Three solvent serial extractions; Hexane, Dichloromethane and Methanol were used respectively. The anti oxidant capacity of the fruit and plant extracts were determined using a ferric reducing/anti oxidant power assay (FRAP assay) and Total Phenolic Compound test (TPC). The result showed that the methanol extracted of *Croton oblongifolius* Roxb possessed the highest FRAP value and total phenolic value. This research focuses on the effectiveness of antioxidant compounds of the extracts from *Croton oblongifolius* Roxb. as natural ingredients in cosmetic applications.

Keywords: *Croton oblongifolius* Roxb., *Gymnopetalum integrifolium* kurz., *Oxyceros horridus* Lour., Antioxidant activity, Cosmetic applications

INTRODUCTION

Aging is the result of accumulate free radical damage over time. A free radical is any atom or molecule that has a single unpaired electron in an outer shell, which are highly reactive and set off chain reaction known as free radical damage. Antioxidant was helpful in reducing and preventing damage from free radical reactions because of their ability to donate electrons which neutralize the radical without forming another. As a result, the damage to the biological molecule will be slowed hence the appearance of aging will also be delayed.

The classical antioxidant compounds include vitamin C, vitamin E, carotenoids, and phenolic compounds which are common in fruits and vegetables. A large number of researches have studied the beneficial potential of antioxidant compounds from plant extracts to replace synthetic compounds [1-7]. These research works showed that natural products from tropical countries exhibit high content of phenolic compounds. Therefore the aim of this project is to identify and evaluate the bioactive compounds of native Thai plants which have potential to be used as primary natural ingredients and formulate in the form of facial mask.

In this study Plao-yai (*Croton oblongifolius* Roxb.), Kee-ka daeng (*Gymnopetalum integrifolium* kurz.), Kang (*Albizia Odoratissima*), Pepper mint (*Melissae folium*), Cudcult (*Oxyceros horridus* Lour.) and Saba (*Entada rheedii spreng.*) were selected to investigate

their antioxidant properties as their dermatological benefit and cosmetics benefit have not yet been explored and they are abundantly available in Thailand. Plao-yai, Kee-ka daeng and Kang were chosen because of their native qualities which have long been used in the traditional medicine [8]. Peppermint however, was found to be rich in phenolic compounds and antioxidant [9]. The properties of extracts also depend on the extraction solvent and technique used. In this project three extraction solvents are used Hexane, dichloromethane and methanol, with varied concentrations. The antioxidant activity is determined by the Ferric reducing antioxidant power assay (FRAP assay). Along with this, stability inspection of the extracts and volunteer test and feedback will also be conducted to guarantee satisfying results from the consumers.

MATERIALS AND METHODS

Sample Preparation

Plaoyai, KeeKadaeng, Cudcult, Saba, Peppermint and Kang were obtained as dry samples from a local herbal store in Bangkok. They were then cut and grind into small pieces to increase the surface area for the following solvent extraction. The prepared samples were stored in zip lock plastic bags in cabinet away from all sources of light.

Solvent Extraction

Each prepared sample was weighed with digital scale, 50 g each, and separately put into different conical flask. Serial extractions of 3 different solvents were done in the order of Hexane, Dichloromethane and, lastly, Methanol. Three consecutive extractions per one solvent were obtained by adding 3 times of 250 ml of solvent into each prepared conical flask containing the sample. Each time, the flask was left to mix on the shaker for three days before filtering out to be stored within an enclosed container in the refrigerator. After the three of the same extraction solvents were obtained, it will proceed on to the evaporation-condensation method.

Evaporation of Solvent

In order to separate the solvent out of the extracted compounds, evaporation-condensation method was done using EYELA rotary evaporator. The extraction solvent was poured into round-bottom flask. The temperature used for the evaporation of the solvent depends on each solvent's boiling point (Hexane: 50°C, Dichloromethane: 35°C, Methanol: 60°C). After the evaporation process was completed, the evaporated solvent was discarded and the pure extract was washed out from the round-bottom flask using Dimethyl sulfoxide (DMSO) and was poured into a small container. This container was then sealed and wrapped with aluminum foil to keep it away from light and was stored in refrigerator.

Determination of the Content of Total Phenolic Compounds

The content of total phenolic compounds was determined using Folin-Ciocalteu procedure. Each sample (1 mg/mL), 0.2 mL was mixed with 0.5 mL of the Folin-Ciocalteu reagent (diluted 1:10 with deionized water) and 0.8 mL of sodium bicarbonate solution (7.5% w/v). The mixture was allowed to stand at room temperature for 30 min with intermittent shaking. The absorbance of the mixture was measured at 765 nm using a UV-visible spectrophotometer. The content of total phenolic compounds was calculated as mean \pm SD (n=3) and expressed as grams of gallic acid equivalents (GAE)/g of the extract.

FRAP Method

The procedure is modified according to Benzie and Strain. Briefly, FRAP reagent is prepared by mixing acetate buffer 300 mM pH 3.6, TPTZ (2, 4, 6-tripyridyl-s-triazine) 10 mM in 40 mM HCl, and FeCl₃.6H₂O 20 mM in the ratio of 10:1:1 before use. The extracts (100 µl) is mixed with 3 ml of working FRAP reagent and the absorbance is measured by spectrophotometer at 593 nm after incubation at 37°C for 10 min. The 1 mmol/L FeSO₄ was used as the standard solution. The final result was expressed as the concentration of antioxidants having a ferric reducing ability equivalent to that of FeSO₄/g of the extract.

Mask Formulation

This mask formulation was provided by Giffarine Skyline Laboratory, it imparts an immediate fresh feel, followed by a moisturized feel.

- A. Alcohol Denat. (3.00% w/w), Coceth-7 (and) PPG-1-PEG-9 Lauryl Glycol Ether (and) PEG-40 (0.50%), Hydrogenated Castor Oil (Eumulgin HPS, Cognis)(0.50%), Fragrance (parfum) (qs), Preservatives: Methylisothiazolinone (qs), Polyquaternium-39 (0.40%)
- B. Water (aqua) (87.10%), Glycerin (3.00%), Croton oblongifolius Roxb. in MeOH (1.00%)
- C. PEG 7 Glyceryl Cocoate (4.00%)

For Making Mask with 1% Extract

Procedure: Combine A and B separately at Room temperature. Add A into B under stirring. Add C into AB under stirring.

For Making a Controlled Mask without the Extract

Follow the same procedure but omitting the 1% extraction.

Stability Testing

The mask lotion with 1% Plao-yai extract was kept in the refrigerator for ten days, after that it was taken out to re-determine the amount of the phenolic compound. This test is done to observe the stability of the lotion. Also, if the oil and water phases are separated into two layers, it indicates that the lotion is not stable.

Volunteer Testing

The mask was tested on 10 volunteers (2 male and 8 female) at the age group of 25-40 years. Volunteers were asked to apply two small pieces of mask each with different compositions: control mask (A) and mask that contained 1% of Plao-yai root extract (B). The volunteers were not informed which mask is a control or a Plao-yai root cream. Volunteers were asked to apply mask A on one arm and mask B on another arm of the same area every night for 20 minutes before bedtime for a period of 7 days. If any allergies or irritants are observed, the volunteers were advised to stop using the mask immediately.

After a period of 7 days, the volunteers were asked to evaluate and compare the skin texture and skin feel characteristics of the two masks. Volunteers were questioned on the greasiness, tackiness, softening, whitening and firmness of the two masks.

Then five selected volunteers (3 women, 2 men) who show no allergic or irritant to the mask formulation were given two sets of full face mask with the extract and apply them on their faces for 20 minutes before bedtime for two consecutive nights. The final feedback from volunteers were then evaluated.

RESULTS AND DISCUSSION

Extraction of herbal plants in Hexane, Dichloromethane, and Methanol

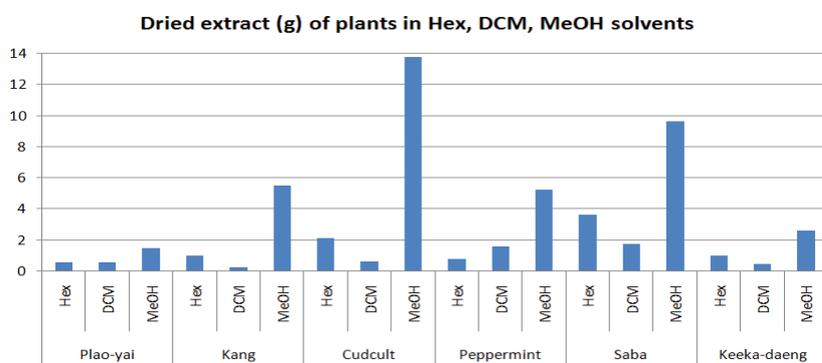


Figure 1 Comparison of amount of pure extracts from Plao-yai, Kang, Cudcult, Peppermint, Saba, Keeka-daeng in Hexane, Dichloromethane, and Methanol solvents

The effect of solvent type influenced the yield of herb extraction.

- *Cudcult* achieved the highest extraction of 13.7 grams in MeOH which accounted for 27.5% of the original dry weight. Its Hex and DCM extracts also yield 4.256% and 1.24% respectively, which gives the total of **33%** extracted amount from its dry weight.
- *Saba* is the most extractable herb by Hex and DCM solvent with the weight of pure extracts of 3.642g and 1.744 g respectively but, second highest extraction in MeOH (9.618g) which accounts for 19.236% of the original dry weight. The total extract amount from Saba's original dry weight for all three solvents is **30%**.
- *Peppermint* obtained 0.772g (1.544% of dry weight), 1.556g (3.112% of dry weight), and 5.228g (10.456% of dry weight) in Hex, DCM, and MeOH respectively. Hence the total extract amount from its original dry weight for all three solvents is **15.1%**.
- *Kang* obtained 1.004g (2.008% of dry weight), 0.223g (0.446% of dry weight), and 5.472g (10.944% of dry weight) in Hex, DCM, and MeOH respectively. Hence the total extract amount from its original dry weight for all three solvents is **13.4%**.
- *Keeka-daeng* obtained 0.991g (1.982% of dry weight), 0.429g (0.858% of dry weight), and 2.595g (5.19% of dry weight) in Hex, DCM, and MeOH respectively. Hence the total extract amount from its original dry weight for all three solvents is **8.03%**.
- *Plaoyai* is the herb could be extracted the least, with the obtained amount of 0.556g (1.112% of dry weight), 0.56g (1.12% of dry weight), and 1.452g (2.904% of dry weight) in Hex, DCM, and MeOH respectively. Hence the total extract amount from its original dry weight for all three solvents is **5.14%**.

Total Phenolic Concentration (TPC) Assay



Figure 2 Samples prepared for the determination of total phenolic content using UV spectrophotometer. *From top to bottom, a.* Hexane solvent extracts at the concentration of 1:25, *b.* Dichloromethane extracts at the concentration of 1:25, *c.* Methanol solvent extracts at the concentration of 1:2000. *From left to right,* Plao-yai (*Croton oblongifolius* Roxb.), Keeka daeng (*Gymnopetalum integrifolium* kurz.), Kang (*Albizzia Odoratissima*), Pepper mint (*Melissae folium*), Cudcult (*Oxyceros horridus* Lour.) and Saba (*Entada rheedii* spreng.)

For hexane solvent; the concentration of phenolic content (TPC) of pure extracts obtained are in the range of 0.0019 g/ml to 0.0169 g/ml with the highest being Saba, and the second highest is peppermint which is 0.0054 g/ml and the lowest amount among six samples is Keekadaeng.

For dichloromethane solvent; the concentration of phenolic content (TPC) of pure extracts obtained are in the range of 0.0023 g/ml to 0.0168 g/ml with the highest being Kang, and the second highest is Cudcult which is 0.0161 g/ml and the lowest amount among six samples is Saba.

For methanol solvent; the concentration of phenolic content (TPC) of pure extracts obtained are in the range of 0.0612 g/ml to 0.9551 g/ml with the highest being Plaoyai, and the second highest is Kang which is 0.6479 g/ml and the lowest amount among six samples is Cudcult.

Plant Solvent	Plao-yai			Kang			Cudcult			Peppermint			Saba			Keeka-daeng		
	Hex	DCM	MeOH	Hex	DCM	MeOH	Hex	DCM	MeOH	Hex	DCM	MeOH	Hex	DCM	MeOH	Hex	DCM	MeOH
dried extract (g)	0.556	0.56	1.452	1.004	0.223	5.472	2.128	0.62	13.747	0.772	1.556	5.228	3.642	1.744	9.618	0.991	0.429	2.595
yield (%)	1.112	1.12	2.904	2.008	0.446	10.944	4.256	1.24	27.494	1.544	3.112	10.456	7.284	3.488	19.236	1.982	0.858	5.19
Concentration in DMSO (g/mL)	0.111	0.1124	0.1449	0.2	0.0446	0.5	0.2	0.125	1.25	0.1539	0.3125	1	0.7143	0.3448	1	0.2	0.0855	0.2381
total phenolic content per 1 gram of extract (g/mL)	0.0048	0.0071	0.9551	0.0041	0.0168	0.6479	0.0023	0.0161	0.0612	0.0054	0.007	0.15	0.0169	0.0023	0.2587	0.0019	0.0125	0.1487

Figure 3 Summary table of dried extract obtained from three evaporations of each solvent, percentage yield, concentration of the extract dissolve in DMSO, and total phenolic content measured by UV visible photometer of six herbal plants; Plao-yai, Kang, Cudcult, Peppermint, Saba, and Keeka-daeng

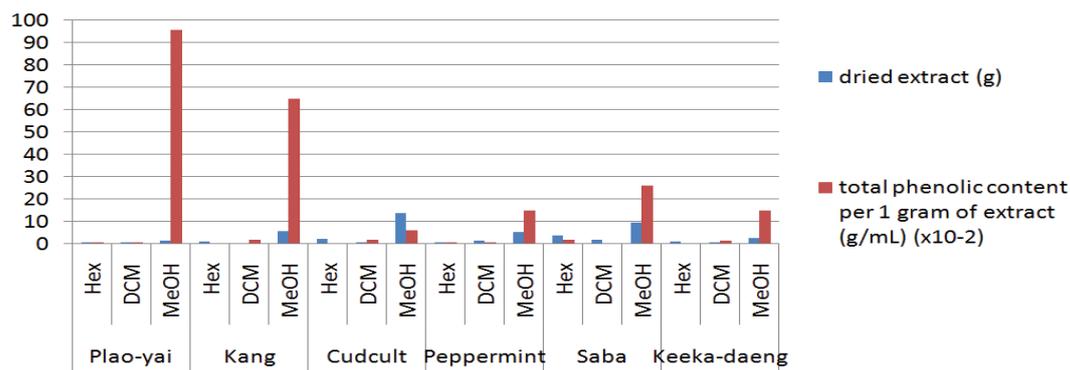


Figure 4 Comparison between the amount of pure extracts (g) and the total phenolic content (TPC) per 1 gram of extract (x10⁻²g/mL)

From Figure 4, there is no relation to the amount of extract and the amount of TPC. For instance, the TPC value for Plao-yai in MeOH is much higher comparing to its extract while for Cudcult, the extract amount is higher than its corresponding TPC value in MeOH solvent.

FRAP (Ferric reducing antioxidant power assay)

	Hex Solvent (FeSO ₄ /g) (x10 ⁻³)	DCM Solvent (FeSO ₄ /g) (x10 ⁻³)	MeOH solvent (FeSO ₄ /g) (x10 ⁻³)
Plao-yai	0.163	0.025	400.7
Cudcult	2.260	16.10	61.16
Peppermint	0.193	0.452	20.85
Saba	6.643	0.226	38.46
Keekadaeng	1.900	12.47	20.22

Figure 5 FRAP results

This was calculated based on 1:5 ratio of the extraction. The results presented indicate that high antioxidant activity is associated with a high phenolics content, a finding reported previously many times (for recent examples see [4,6,10]), Plao-yai in MeOH solvent gives the highest FRAP value of 400.7x10⁻³ FeSO₄/g, more than six times higher than the second highest, Cudcut in MeOH. Plao-yai however, while obtaining the highest FRAP value in MeOH solvent, its extracts in DCM and Hex solvents give the low FRAP value of 0.025x10⁻³ FeSO₄/g and 0.163 x10⁻³ FeSO₄/g respectively, of all samples tested.

Stability Testing

After the lotion was tested for its stability for 20 days, the lotion’s texture and appearance are still the same. The color and smell did not change in the time interval, and the lotion remained homogenous as no separation of oil and aqueous phases was observed. Antioxidant activity method is used to determine the stability of the lotion. At room temperature, the antioxidant activity of the lotion is decreased by approximately 5% after 10 days and after 20 days, the antioxidant activity remained only 90% of the initial amount. However, the users normally keep the lotion (facial mask) in the refrigerator; hence lower storage temperature will slow down the degradation of antioxidant activity and will be able to be kept for a longer period of time. Nevertheless, we can conclude that the lotion formulation

with the addition of Plaoyai extract has a good stability and able to maintain reasonably high antioxidant activity.

Volunteer Testing

After one week of application, the volunteers were asked to evaluate and comment on the characteristics of the mask and the difference observed. The format and results are shown below

Feedback from volunteer		Sample A		Sample B	
Feeling during the application (please tick one most)	Cool	1	10	1	10
	Greasy	1	1	1	1
	No different	1	1	1	1
Scent (please tick one most applicable)	Good	1	10	1	10
	Bad	1	1	1	1
Feeling after Please score (1 is not satisfied, 10 is very)	Smoothness	2	6.5	2	7.5
	Firmness	2	5	2	5
Difference detected after 7 days (please tick one most)	Immediate	2	7	2	6
	Better	1	2	1	2
	Worse	1	1	1	1
	No different	1	8	1	8

¹represents the number of volunteers selecting each quality

²represents the average score of 10 volunteers

Figure 6 Volunteer feedback

All of volunteers report a satisfying cooling feeling during the application of the mask and all reported good scent of both sample A (controlled) and B (with extraction)

The smoothness and softness of the skin after application of sample B was found to be 15% more satisfying than sample A whereas the firmness satisfaction is the same. However the immediate whitening effect of sample B is less than sample A by 14%.

Both of the mask formulations were found to enhance the smoothness of the skin. 80% of the volunteers stated that changes were observed after application of the two creams. While 20% of the volunteers said that both the lotion formulation improves their skin. One out of ten volunteers was found to have skin irritation at the first application of both mask A and B. The person was instructed to immediately remove the formulation and stop applying the formulation on the skin. In this case mask A is the controlled sample and mask B is the sample with 1% extraction.

There are no prominent changes or differences on skin characteristic observed due to short period of time in sample testing. As some of the ingredients might need more time or has to be applied frequently before their effects can be observed. In addition, in the volunteer test, sample A was the control and sample B contained methanol extracted Plao-yai at 1% concentration, due to the dark brown nature color of plao-yai extract, even already diluted, there are still noticeable traces of yellowish color when it was prepared and given out to the volunteers. This could be one of the factors affecting the 'immediate whitening effect' as the color of sample A appeared whiter and clearer. The volunteers' feedbacks when applying the mask on the arm and when applying the mask of the face are the same.

CONCLUSION

The extract of Plao-yai showed the highest antioxidant activity comparing to the results of Kang, Cudcult, Keekadaeng, Peppermint, and Saba. Between the three solvents, methanol could extract the highest amount of antioxidant compounds as the greatest FRAP and phenolic compound determinations values of the samples were from methanol extraction.

Stability testing of the mask lotion has shown that the lotion were still in good condition after 10 days. Ninety percent of the volunteers were not allergic to the mask with 1% Plao-Yai root extract. One of the volunteer was suspected to be allergic to the lotion formulation rather than Plao-yai extract since she was allergic to both samples A and B.

According to the result obtained from the volunteer, the mask improves the smoothness and softness of the skin upon immediate removal. However, longer time is needed to see the long-term result of anti-aging and whitening effect of the extract.

In conclusion, the feedbacks from volunteers show a consistent desirable trend with a high satisfaction and minimal irritation. The lotion improves volunteers' skin texture. For this reason, we can claim that the herb extract used in facial mask lotion is accomplished in satisfying customer's demand and can replace some chemical additives in cosmetics. Moreover, the finding could raise the capability and add value to Thai herbs since they are naturally derived and commonly known for its non-toxicity.

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The Feasibility Study on the Production of Wood Coating from Para Rubber

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Abstract: Wooden decorative products in houses, such as picture frames, wooden vases or any other decorative products are mostly coated with synthetic chemical lacquer. The basic formulations of those lacquer was 55-75% solvents that are volatile organic compounds (VOCs). Normally NC Lacquer contains 72% solvents and polyurethanes contain 58% solvents. These types of solvent base lacquer are not environment friendly. Natural para rubber (Latex) is flexible and can form into film. Feasibility study on the production of wood coating from para rubber is possible. The natural liquid para rubber for this study was para rubber species prim 600. Two formulations were created. The first formula was base coat or sealer ratio 10 : 3 : 3 and second formula was final coat or top coat ratio 2 : 1 both formulations contained zero solvent. The randomized design was used for this testing by doing 4 picture frames sized 43x58 cm with 10 replications and compared with normal lacquer. It was founded these 2 formulations could replace solvent based lacquers when considering the function of picture frames. To use these 2 formulations would automatically increase forest area and this rubber tree forest will carbon dioxide up to 1.7-43 metrikton per rai (1,600 m²) per year, reducing global warming.

Keywords: Latex, Wood Coatings, Production, Solvent

INTRODUCTION

Wooden decorative products are requiring lacquer or paint for help to protect from the life time used. Lacquer or paint also help for making wooden decorative products look beautiful. But those lacquer or paint with normally get from shop or department store even from the local market area in Thailand is mostly content 55-72% solvent which is not environment friendly. Also it can create prolusion and cause harmfully to human health, beside this the solvent base can be flammable can cause fire then also can make carbon dioxide to the air if it burn or fire and cause global warming at the end.

The research purposely is to study for the possibility of using latex from Para rubber tree as a main raw materials base on hypothesis that "latex from Para rubber tree can do film forming". So, by this hypothesis then to produce solvent free lacquer from this Para rubber tree for wooden products without using any solvent for producing or mixing then this product already help environment. The rubber tree is well growth in world tropics area by northern hemisphere at approximately 23°26' (23.5°) N and the tropic of Capricorn in the southern hemisphere at 23°26' (23.5°) S which means the hold Thailand can plant this Para rubber tree because Thailand is locate in the tropics area. The used of latex samples from Para rubber plantation tree of this research come from Surat thani, south Thailand. A part of this research help for the environment by using new solvent free Para rubber lacquer product another part

also help and support to the Para rubber plantation tree farmers to have alternative ways to supply their latex if any investor from business investment who is interested to continue research and development on this Para rubber lacquer.

And this research is based on 22 years experience on wooden finishing and technology myself which is difference experience technology from USA, Sweden, Italy, Taiwan, Japan and Thailand. Currently the technology has been developed far ahead for the environment friendly products but also too expensive with the technology and development. Since Thailand has Para rubber tree plantation and the latex from Para rubber tree itself have ability of film forming, then is worth to add value by create new products and environment friendly, easy and low tech for wooden decorative products such as picture frame, lamp or wood craft.

MATERIALS AND METHODS

The feasibility evaluation on the production of wood coating from Para rubber is to study the possibility and purposely to produce new solvent free Para rubber lacquer to use for wooden decorative product. Accordingly, this research assessment start by literature review, papers and development then do a lot of testing and try to produces Para lacquer in difference formulation. The natural liquid Para rubber for this study is using plantation Para rubber tree species prim 600 from South Thailand. After get formulation then applies by brush on the picture frame the record and analyst to all process and formulation checking quality of all formulations. Finally create 2 formulations. First formula for base coat or sealer mixing ratio 10:3:3 and second formula for final coat or top coat ratio 2:1. The randomized are design for this testing by doing 4 pictures frame size 43 x 58cm and 10 replications test and compare with normal lacquer. The quality test method is base on Europeans DIN EN Standard Quality Initiative method to compare with normal lacquer quality.

Test Method

1. Scratch test Resistance to scratches

Resistance to fine scratches is tested by scratching the surface with Scotch Bright

2. Adhesion test by Grid cut According to DIN EN ISO 2409

The adhesive properties of the varnish film to the substrate and to itself are tested using a single or multiple blade cutters. The blade is used to make a cross-cut on the test specimen offset by 90°. This produces a kind of chessboard pattern. The blades must cut through the varnish film. After cutting, any loose parts are removed from the surface with a brush. An initial inspection is carried out, afterwards, an adhesion test is carried out with a defined adhesive tape. The tape is pressed onto the lattice with force before being pulled off at an even speed (between 0.5 – 1 second).

3. Chemical resistance

According to DIN 68861 Parts 1

In the following of table you will find a list of the chemicals used for measure chemical resistance in accordance with DIN 68861 Part 1.

4. Heat resistance (Cigarette test)

Corresponding to DIN 68861 Parts 6

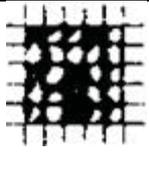
RESULTS AND DISCUSSION

Scratch Test Resistance to Scratches

Resistance to fine scratches is tested by scratching the surface with Scotch Bright, applying normal pressure. Since no test equipment has been defined for this type of test, it can only provide subjective test results and the result found the same as normal quality.

Adhesion Test by Grid Cut According to DIN EN ISO 2409

The surface is rated according to the Table, as follows:

Grid Cut Classification	Description	Appearance of surface in area of grid-cut where flaking has occurred (example is for six parallel cuts)
0	The edges of the cuts are completely smooth; none of the lattice squares is detached.	-
1	Small flakes of coating have detached at the intersections of the cuts. The area affected is not significantly greater than 5% of the cross-cut area.	
2	The coating has flaked along the edges and/or the intersections of the cuts. Area of the cross-cut considerably greater than 5% but not significantly greater than 15% of the total cross-cut area.	
3	The coating has flaked along the edges of the cuts in wide strips partly/completely and/or partial / complete flaking on some of the squares. A cross-cut area considerably greater than 15% but not significantly greater than 35% is affected.	
4	The coating has flaked along the edges of the cuts in wide strips and/or partial/complete flaking on some of the squares. A cross-cut area considerably greater than 35% but not significantly greater than 65% is affected.	
5	Any flaking that cannot be classified under Category 4.	-

According to DIN 68861 Parts 1

In the following table you find a list of the chemicals used to measure chemical resistance in accordance with DIN 68861 Part 1. It also lists the results needed to pass the test.

Our Para rubber lacquer for prefinished picture frame is not table, chair or flooring so the test is request on some chemicals test only under DIN 68861 Part 1. After 7 days. no mark is ok.

Pos.	Chemical	Rating											
		1 A		1 B		1 C		1 D		1 E		1 F	
		Time	Res.	Time	Res.	Time	Res.	Time	Res.	Time	Res.	Time	Res.
1	Acetic acid	7 d											
2	Citric acid	7 d											
3	Sodium carbonate	7 d											
4	Ammonia water	7d											
5	Ethyl alcohol	7 d											
6	White wine, red wine, fortified wine	7 d											
7	Beer	7 d											
8	Carbonated drinks	7 d											
9	Instant coffee	7 d	0	5 d	0	3 d	0	2 d	1	1 d	2	8 h	3
10	Black tea	7 d	0	5 d	0	3 d	0	2 d	1	1 d	2	8 h	3
11	Blackcurrant juice	7 d											
12	Condensed milk	7 d											
13	Water	7 d	0	5 d	0	3 d	0	2 d	1	1 d	2	8 h	3
14	Petrol	7 d											
15	Acetone	7 d											
16	Ethyl-/ butylacetate	7 d											
17	Butter	7 d											
18	Olive oil	7 d											
19	Mustard	7 d											
20	Cooking salt	7 d											
21	Onion	7d											
22	Lipstick	7 d											
23	Disinfection agent	7 d											
24	Black ballpoint pen ink	7 d											
25	Stamping ink	7 d											
26	Cleaning agent	7 d	0	5 d	0	3 d	0	2 d	1	1 d	2	8 h	3
27	Cleaning solution	7 d	0	5 d	0	3 d	0	2 d	1	1 d	2	8 h	3

Rating:

- 0: No visible changes
- 1: Barely visible changes in gloss or colour
- 2: Minor changes in gloss or colour; structure of test surface unchanged
- 3: Strong visible markings; structure of test surface largely undamaged
- 4: Strong visible markings; structure of test surface changed
- 5: Major changes to test surface/destroyed

Heat Resistance (Cigarette Test)

Corresponding to DIN 68861 Parts 6

Cigarettes are used for this test. The first 10mm cigarette is smoked before being placed on the coated surface. The cigarette is removed from the test surface once the cigarette has burned down a further 40mm.

If any changes to the surface arise, either in its colour or other visible changes, the surface will need to be cleaned as thoroughly as possible with a defined cleaning agent.

Rating of the test results from the cigarette test:

6A No change

6B Change in gloss visible to naked eye

6C Gloss and/or colour change

6D Colour change

6E Destroyed

CONCLUSION

The study found these two formulations are replaceable from solvents base lacquer when considering for the function of pictures frame. Even the test result are not so good but to compare with normal lacquer with this solvent free to use on pictures frame which was not much or high requirement for the surface resistant. And to use these two formulations was good enough for the picture frames or some other decorative products with not high requirement for the surface resistant.

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Biomass and Carbon Accounting of Large-leaf Mahogany (*Swietenia macrophylla* King) and Dipterocarp Plantations in Mt. Makiling Forest Reserve, Philippines

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Abstract: The study assessed the potential of tree plantations to sequester atmospheric carbon by measuring the amount of carbon stored in its biomass. Specifically, it involved Large-leaf Mahogany and Dipterocarp plantations located inside the Mt. Makiling Forest Reserve (MFR). The carbon pools investigated included: above-ground biomass (trees, understorey/herbaceous vegetation), ground-biomass (litter and coarse woody debris), and below-ground biomass (roots and soil). Results showed that Mahogany stand has a total biomass of 1,119.61 Mg ha⁻¹ while the Dipterocarp stand has 1,046.76 Mg ha⁻¹. In terms of carbon content in its biomass, Mahogany stand has a slightly lower value of 542.58 Mg C ha⁻¹ than Dipterocarp, 556.13 Mg C ha⁻¹. Its equivalent CO₂ content totaled to 1,989.41 Mg ha⁻¹ and 2,039.12 Mg ha⁻¹ for Large-Leaf Mahogany and Dipterocarp stands, respectively. Estimation of biomass density to carbon accumulation per sink for Mahogany and Dipterocarp stands respectively, showed the following results: above-ground (378.55 Mg C ha⁻¹ and 401.39 Mg C ha⁻¹); ground biomass (32.14 Mg C ha⁻¹ and 15.81 Mg C ha⁻¹); and below-ground biomass (131.89 Mg C ha⁻¹ and 138.93 Mg C ha⁻¹). Both plantations exhibited the same ranking of carbon stored in its carbon pools; aboveground biomass as the highest followed by belowground biomass and last is the ground biomass. The tree component supplied most of the aboveground biomass and has the highest carbon deposits among the carbon pools within the stand followed by soils. Specifically, the actual amount of carbon and CO₂ stored per carbon pool in both plantations were determined to be in the following order: tree biomass > SOC > roots > coarse woody debris (CWD) > ground litter/necromass > understorey/herbaceous vegetation.

Keywords: Tree plantation or stand, Carbon sink/pool, Biomass density, 1 Mg (megagram) = 1 ton

INTRODUCTION

Global warming and climate change are two inseparable issues that are no longer threats but real and on-going process. Scientists posed that although the earth follows a natural cycle of warming and cooling over thousands of years but what happens now is there is an abnormal and drastic occurrence of warming in the earth's surface. The recent IPCC report strongly suggests that there is a discernible human influence on global climate since the industrial period and has led to a net global warming [1]. The rise in global temperatures has been attributed to emission of greenhouse gases, notably carbon dioxide.

Forests play a crucial role in the global carbon cycle. They either serve as carbon sinks by assimilating CO₂ through biomass build up or as a carbon source by releasing it through deforestation, burning or decay [2]. Specifically, tropical forests have significant role

in mitigating carbon emissions. It can sequester significant amounts of carbon (80% of the forests total) through conservation of oldgrowth forests, conservation of biodiversity, good harvesting techniques and through the establishment of forest plantations, as trees in the tropics grow favorably and at a much faster rate than elsewhere. Great attention is directed toward tropical forest management to offset carbon emission due to its cost effectiveness and high potential rate of carbon uptake associated with environmental and social benefits.

Plantation forest in particular is seen as major potential to sequester atmospheric carbon. Though its sequestration potential varies in terms of species, age and silvicultural practices applied which can enhance the growth of trees and increase their biomass [3] and rotation period [4].

To further prove these findings, the study was conducted to determine the potential of tree plantations, specifically Large-leaf Mahogany and Dipterocarp plantations to sequester carbon. Estimation on the amount of carbon from its different sinks was done through direct measurement of tree biomass and its associated vegetation including soil organic carbon.

MATERIALS AND METHODS

Description of the Study Sites and Location

The study sites are located inside the Mt. Makiling Forests Reserve (MFR) which serve as demonstration forest of the College of Forestry and Natural Resources, University of the Philippines Los Baños. The reserve is located 14°08' North and 121°11' East and lies 65 kilometers South of Manila. The study sites are situated within elevation range of 110-199 meters above sea level (masl) with topography characterized by slightly flat to moderately rolling terrain with a clay loam type of soil. The area has tropical monsoon climate specifically belonging to the Climatic Type I under the Corona Classification which is wet from May to December and dry from January to April. It has an annual mean rainfall and temperature of 2,397 mm and 24°C, respectively [5].

The Mahogany plantation was established in 1940 with a total land area of 0.7 hectare. While the Dipterocarp plantation was initially established in 1912 with a total land area of 2.5 hectares planted with mixed dipterocarp species belonging to the following genera: *Parashorea*, *Shorea*, *Dipterocarpus*, *Hopea* and *Anisoptera*.

Biomass Sampling and Computations

The study used the *belt transect* method. Five transects measuring 50m x 10m each were established and replicated systematically adjacent to each other covering almost the entire stand. Each transect has five sampling plots inside. Figure 1 shows the actual lay-out of a transect and sampling plots per C pool with corresponding dimension per plot.

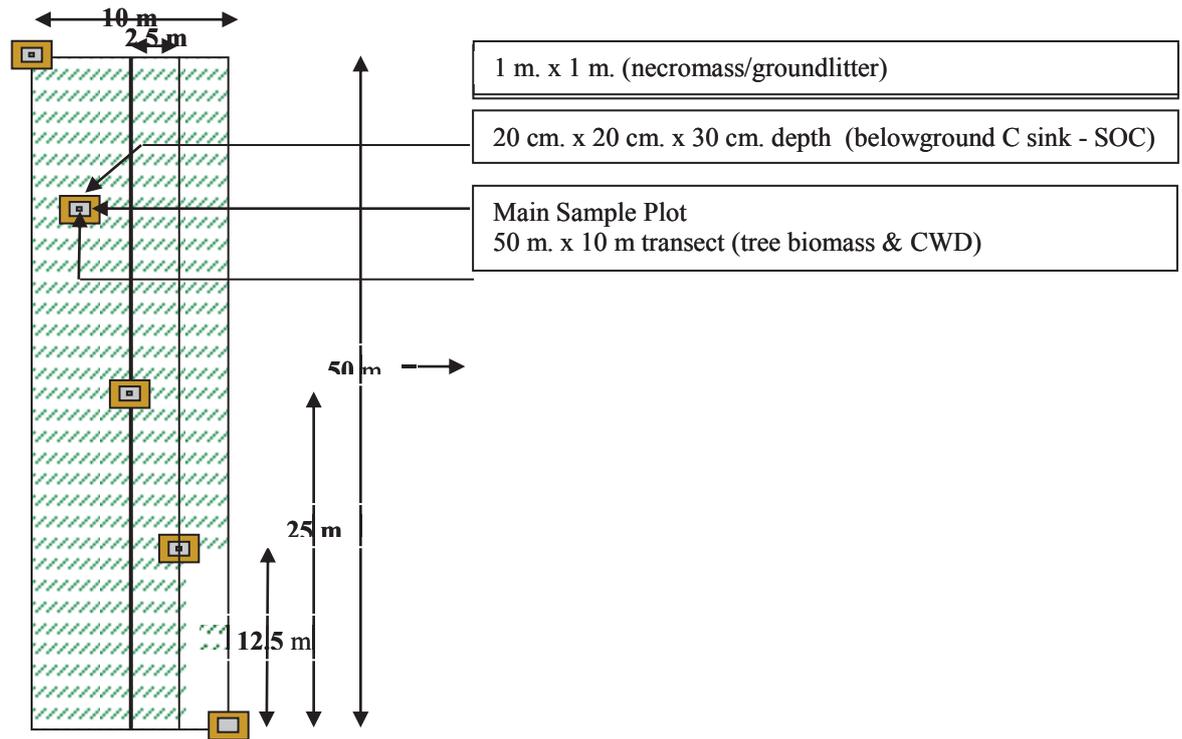


Figure 1 Experimental lay-out and dimension of sampling plots per transect.

Complete enumeration of all trees with $DBH \geq 5$ cm was done inside each transect including standing dead trees and fallen logs for coarse woody debris (CWD) estimation. For live trees, data gathered include DBH, merchantable height, total height and crown diameter while DBH and total height for CWD. The study used purposive sampling to measure biomass density of U/H (including trees with $DBH < 5$ cm and other vegetation) and necromass (ground litter and some woody materials) by determining first the fresh and over dry weight of samples.

Composite samples of soils were collected at varying depths to determine the organic matter content and soil organic carbon value. A separate soil sampling was carried out at randomly selected spots within the stand to measure soil bulk density. From the soil samples gathered, the following data were obtained: a) fresh weight; b) oven dry weight; c) moisture content; d) organic matter content and e) soil bulk density.

Biomass Computation

The tree biomass and coarse woody debris (standing dead tree and fallen logs) were computed using Brown [6] allometric equations for tropical moist forest:

For trees with DBH that ranges from 5–60 cm. - $Y = EXP(-2.134+2.530*LN(DBH))$

For trees with $DBH > 60$ cm. - $Y = 42.69-12.8*DBH+1.242*(DBH)^2$

Where Y = tree biomass (kg) DBH = diameter at breast height (cm)

Biomass per tree was converted to ton or Mg measurement unit: 1 ton = 1 Mg

Root biomass was computed based on tree biomass of individual tree using *Pearson T., S. Walker and S. Brown* [7] formula: $Root\ Biomass = EXP(-1.0587+0.8836*LN(Tree\ Biomass))$

Carbon Density and Carbon Dioxide (CO₂) Content Estimation

Plant biomass was converted to equivalent amount of carbon by multiplying % carbon content per sink. The % carbon values were based from the carbon analysis of wood and roots samples done at the International Rice Research Institute (IRRI) laboratory. The corresponding % C content per pool, are as follows: wood (41.60%), U/H (43.40%), litter (38.40%), and CWD (38.47%).

The soil organic carbon (SOC) was computed by determining first the bulk density and dry weight of soil. It was derived using the formula: $SOC = \text{Weight of soil (Mg)} \times \% SOC$

Carbon content per sink was converted to CO₂ density in Mg ha⁻¹ using the formula below:

$$CO_2 = C \text{ stored in Mg ha}^{-1} \times 44/12$$

Where: CO₂ = 1 molecule of Carbon and 2 molecules of Oxygen; Atomic weight C = 12 O = 16

Weight of CO₂ is C + 2*O = 43.999915 or 44; The ratio of CO₂ to C is 44/12 [8]

Total CO₂ = Total carbon per sink x 44/12.

RESULTS AND DISCUSSION

The Large-leaf Mahogany stand exhibited a total biomass production of 1,119.61 Mg ha⁻¹ while the Dipterocarp stand is 1,046.76 Mg ha⁻¹. The carbon stored in biomass is equivalent to 542.58 Mg ha⁻¹ for Large-leaf Mahogany and 556.13 Mg C ha⁻¹ for Dipterocarp stand. The amount of CO₂ equals to 1,989.41 Mg ha⁻¹ in Large-leaf Mahogany stand and 2,039.12 Mg ha⁻¹ in Dipterocarp plantation (Table 1).

Table 1 Total biomass, C and CO₂ accumulation of Large-leaf Mahogany and Dipterocarp plantations.

CARBON SINKS	Mahogany plantation			Dipterocarp plantation		
	Biomass (Mg ha ⁻¹)	C (Mg ha ⁻¹)	CO ₂ (Mg ha ⁻¹)	Biomass (Mg ha ⁻¹)	C (Mg ha ⁻¹)	CO ₂ (Mg ha ⁻¹)
<u>Above-ground biomass</u>						
Tree biomass	902.20	375.32	1,376.16	881.13	400.03	1,466.79
U/H	7.45	3.23	11.85	3.25	1.36	4.97
Sub-total	909.65	378.55	1,388.01	884.38	401.39	1,471.76
<u>Ground biomass</u>						
Litter/Necromass	39.98	15.35	56.29	18.79	7.03	25.76
CWD	43.64	16.79	61.55	22.18	8.78	32.21
Sub-total	83.62	32.14	117.84	40.97	15.81	57.97
<u>Below-ground biomass</u>						
Roots	126.34	59.26	217.27	121.41	57.79	211.89
Soils		72.63	266.29		81.14	297.50
Sub-total	126.34	131.89	483.56	121.41	138.93	509.39
TOTAL	1,119.61	542.58	1,989.41	1,046.76	556.13	2,039.12

Both plantations exhibited the same trend in carbon accumulation of the three carbon pools investigated. Above-ground sink as the highest contributed mainly by trees, followed

by below-ground sink and the lowest is the ground biomass. Below-ground carbon sink is primarily supplied by its soil component.

The amount of carbon stored in both plantations is relatively higher than the estimate given by Lasco [9] that natural forests in SE Asia typically contain a high C density up to 500 Mg ha⁻¹. However, it falls in the upper range of carbon densities (446-1126 Mg ha⁻¹) of old-growth forests in other parts of the Philippines. The result is midway within the C storage range as reported from Malaysian forests. Malaysian forests have C storage ranging from 190-880 Mg ha⁻¹ or an average of 364 Mg ha⁻¹ combining vegetation and soil. The highest C storage was from swamp forests (880 Mg ha⁻¹) followed by mangrove (450 Mg ha⁻¹) [10]. Meanwhile, the result is way above those in Indonesia and even C storage derived from different forest types in the Philippines. In Indonesia, the highest reported C storage was on an undisturbed forest which is 390 Mg ha⁻¹ [11]. In the Philippines, particularly in Palawan province from the study of Lasco *et al.* [12] the amounts of carbon stored from different forest types, are ranked as follows: old growth forest (349.81 Mg ha⁻¹) > mossy forest (204.25 Mg ha⁻¹) > residual forest (336.4 Mg ha⁻¹) and > mangrove forest (174.9 Mg ha⁻¹).

Consistent with earlier studies conducted, tree biomass is the major sink of carbon with a total C of 375 Mg ha⁻¹ and 400 Mg ha⁻¹ for Large-leaf mahogany and Dipterocarp plantations, respectively. It was reported that trees can store large amounts of carbon in their standing biomass. This is primarily true in those stands with larger trees with dbh ≥ 60cm and whose biomass is greater than 4 tons the carbon content is high. Although they are few in number but they can share more than 40% of the carbon in an old-growth stand [13, 14]

Soils shared the second highest carbon deposits in both stands next to tree biomass which resulted to an average of ave. of 77 Mg C ha⁻¹. Results of this study affirmed other studies conducted and somehow corroborates the claim of Moura-Acosta [15] that soil carbon plus C of necromass is equivalent to 90 tons ha⁻¹ of the total C of a forest ecosystem. Brown *et al.*, [14] reported that variations in the rate of SOC's accumulation are due to the differences in species and environmental factors. Some species produce more litter and roots than others thus producing more organic inputs which eventually influence SOC. Further, they added that soil organic matter could recover under forest plantations at rates similar to or faster than secondary forests. It was noted by Lasco *et al.*, [16] that the amount of SOC increases over time. It can be deduced that as vegetation matures, its soil carbon content also increases. Since the study involved a plantation which is considered mature already, higher amounts of SOC's can be expected.

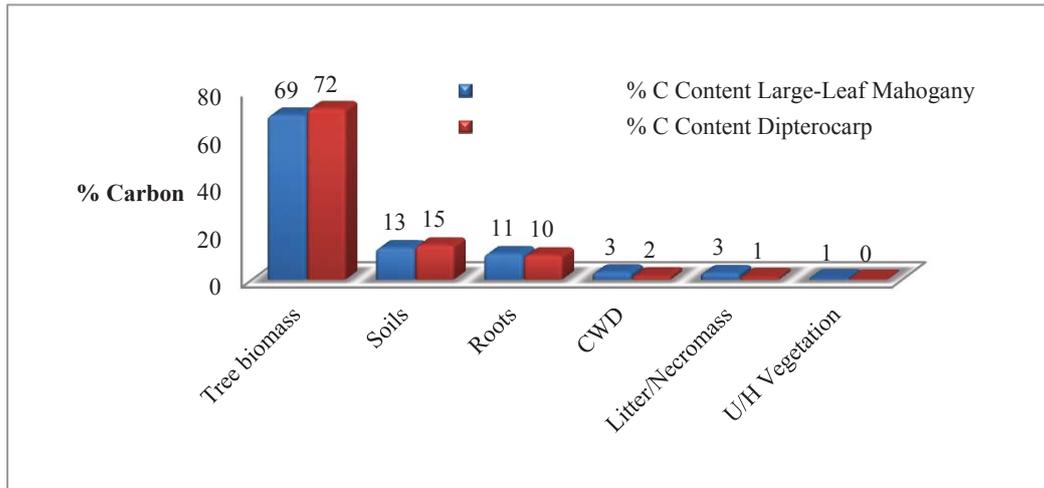


Figure 2 shows the details of percent amount of carbon and CO₂ stored per carbon pool in both plantations determined to be in the following order: tree biomass > SOC > roots > coarse woody debris (CWD) > ground litter/necromass > understory/herbaceous vegetation.

CONCLUSION

Results of the study showed that both Large-leaf Mahogany and Dipterocarp plantations accumulated carbon in its biomass in notably higher rates more than natural forest, secondary forest, some fast growing plantations and agroforestry farms. It can be inferred that the potential of forest plantations to sequester carbon can be maximized by considering species-site compatibility, appropriate silvicultural practices, minimizing anthropogenic disturbances or impacts, and allowing the stand attain optimum physical productivity.

It was also observed that although fast-growing species like Mahogany could accumulate biomass faster than slow-growing species like Dipterocarp, however, the latter can store more carbon in their biomass than the former at the same period of time. Slow-growing species normally have denser wood which allows them to accumulate greater amounts of carbon in their wood biomass. It can be concluded further that the carbon storage capacity of trees is affected by three major factors: species type and wood density, age and physiological and environmental conditions.

Moreover, conservation of mature forest similar to this study could prove to be an effective and more economical way to embark on carbon offset program. Although it has higher mortality rate due to natural attrition, the decrease in biomass is offset by regeneration and recruitment. Further, protection efforts should be actively pursued in plantations within forest reservations to conserve C pools. This is in addition to the attendant benefits derived from forest conservation such as increased biodiversity, enhanced aesthetics and recreation, and better livelihood opportunities to local communities.

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Effect of *Tagetes minuta* and *Chrysanthemum indicum* Flower Extracts on Duckweed Growth

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Abstract: In agriculture, mostly synthetic chemicals are used to manage weeds due to their rapid results. However, the use of chemical herbicides is hazardous to health and the environment. This study was aimed at examining the inhibitory effects of aqueous and methanolic extracts from *Tagetes minuta* and *Chrysanthemum indicum* flowers on plant growth using *Lemna phytotoxicity* assay. Dried flowers of *T. minuta* and *C. indicum* were extracted with methanol and water and tested their exhibited inhibitory effects on duckweed (*Lemna minor*) growth compared with negative control in the tested model. The inhibitory activities of the extracts were determined by testing serial dilutions of each extract and expressed as effective concentration that resulted in 10% (EC₁₀) inhibition of duckweed growth. It was shown that methanolic extracts of *T. minuta* had the highest inhibitory effects with EC₁₀ of 95.58 µg/ml, followed by the aqueous extracts of *T. minuta* with EC₁₀ of 107.59 µg/ml. Extracts of *C. indicum* were shown to have much less inhibitory activity. Methanolic extract of *C. indicum* had EC₁₀ of 227.44 µg/ml, while aqueous extract of *C. indicum* had the least inhibitory effect with EC₁₀=277.68 µg/ml. A phytochemical screening of *T. minuta* and *C. indicum* showed rather similar pattern of chemical compositions in methanolic extracts of both plants and in aqueous extract of *T. minuta*, the major one was phenolic compound, flavonoid glycoside. As expected, aqueous extract of *C. indicum* was shown to contain no other phytochemical except sugars and phenolic group. Further investigation should be carried out since this may lead to the discovery of new effective, safe and applicable bioherbicide.

Keywords: Bioherbicides, *Lemna phytotoxicity* assay, *Tagetes minuta*, *Chrysanthemum indicum*

INTRODUCTION

In agriculture, pesticides are commonly chemical compounds that are used to eliminate or control a variety of agricultural pests that can damage crops and reduce farm productivity, including insects, rodents, fungi and unwanted plants (weeds). By their nature, pesticides are potentially toxic to other organisms, including humans, and need to be used safely and disposed of properly. Furthermore, they also are harmful to environment including loss of biodiversity, residual toxicity in foods, pest resistance, soil and groundwater contamination. Therefore the development of bio-pesticides for eco-friendly sustainable agricultural production and biodegradable is the most promising and feasible [1-3].

The most commonly applied pesticides are insecticides (to kill insects), herbicides (to kill weeds), rodenticides (to kill rodents), and fungicides (to control fungi, mold, and mildew). Some plants are implemented as pesticides with a focus on insects (insecticides) [4]. Weeds is an another important issue as well which they are mostly managed by the synthetic chemicals (herbicides) that kill weeds and other plants that grow where they are not wanted with rapid results. Plants discovery strategies have not been as successful for herbicides as for other pesticides [5]. Inhibition of growth of plants by other plants in their vicinity has been known for a long time. The chemical interaction between plants, which can cause enhancement or inhibition of growth, has been named allelopathy [6]. Chemicals which are responsible for the allelopathic activity of a plant may be exploited as herbicidal compounds. Numerous allelochemicals are involved in the allelopathic activities of the allelopathic plants; such as phenolics, terpenoids, alkaloids, coumarins, tannins, flavonoids, steroids and quinines [7]. There are not much compounds extracted from plants that have been applied in agricultural weed control with promising results, such as cineole, benzoxazinones, quinolinic acid and leptospermones [8]. Plant containing volatile oils as allelochemicals has been described frequently [9-10].

There are several methods for the evaluation of phytotoxicity [11], Lemna phytotoxicity assay or duckweed growth inhibition test, is one of these methods that is recognized as an acceptable, sensitive, simple and inexpensive screening test for phytotoxic effects [11-12]. Duckweeds (*Lemna* spp.) are aquatic plants of the family Lemnaceae, they are floating fast-growing plant, reproduce by vegetatively producing new fronds (single leaf-like structure). These characteristics make it an ideal candidate for toxicity testing [11]. Hence, the duckweed bioassay has become a standard toxicity method for many certification entities and international organizations. Accordingly, the United States Environmental Protection Agency (USEPA) developed guidelines for a plant toxicity test using *Lemna* spp. [13] Moreover, the Organization for Economic Cooperation and Development (OECD) completed a guideline draft for the Lemna test [14]. The growth inhibition is expressed as effective concentration that resulted in 10% (EC₁₀) inhibition of duckweed growth which is appropriate value to evaluate this inhibitory effect [14].

In this research, two flowering aromatic plants, *Tagetes minuta* (TM) or marigold and *Chrysanthemum indicum* (CI) flowers were determined. Both of them are in the family of Compositae. TM have yellow showy flowers, they are commercial flowers using for horticultural purposes and was cut to make floral garland, furthermore they also have insecticidal properties. CI is in the same genus of Pyrethrum (*Chrysanthemum cinerariifolium*), naturally occurring pesticides, pyrethrins which possess insecticidal and insect repellent activity that was used for centuries. CI dried flowers are used for beverage by boiling with water. Dried flowers of TM in the floral garland and marc of CI after water-boiling are discarded as waste. Therefore, this study was aimed at screening the inhibitory effects of aqueous and methanolic extracts from TM and CI flowers on plant growth using Lemna phytotoxicity assay. The study is worthy of further investigation since this could provide potential bioherbicide from waste-materials to value-added products and may lead to the discovery of new effective and applicable bioherbicides.

MATERIALS AND METHODS

Plant Materials and Extraction

Tagetes Minuta (TM) or Marigold

The fresh flowers of *Tagetes minuta* (TM) with fresh appearance, free of bruising were purchased from market in Nakhon Pathom, Thailand. After purchasing, the samples were kept at 4°C until the time of experiment, usually be on the same day of the purchase.

Prior to experiments, the florets were separated by hand and dried under hot air oven at 40°C for 24 hours.

Chrysanthemum indicum (CI)

Dried flowers were purchased from market in Nakhon Pathom, Thailand. After purchasing, the samples were kept at 4°C until the time of experiment. Before extracting, the dried flowers were cut into small pieces.

Plant Extraction

The small dried pieces of TM and CI were serially extracted with methanol and water by digestion for 30 minutes and repeated again 1 time. The combination of 2 lots of filtrate was then concentrated until dry by using a rotary evaporator at reduced temperature and pressure. Each extracts were kept in evaporating dish with cover and stored at 4 °C until time to experiment whether they exhibit inhibitory effects on *Lemna minor* growth.

Lemna Phytotoxicity Assay

Duckweed preculture

Duckweed (*Lemna minor* L.) were collected from ponds in Silpakorn University, Nakhon Pathom (Thailand). Duckweed are assembled in colonies, usually composed of 2-4 fronds. *L.minor* with 3-4 fronds of similar size and shape were selected for exposure in the experiments.

Before experiments, selected *L.minor* were disinfected by immersion in 70% ethanol for 1-2 min and then rinsing with sterile distilled water during 2 min for 3 times.

Procedures

The cultures mediums for *L.minor* are E-medium [12] Every treatment and control group had operated by three replicate. Fifteen fronds of 3-4 fronds of duckweed colonies were selected and added to each container and cultured in a growth cabinet, calibrated at 25 ± °C under continuous light provided by cool white fluorescent lamps. During tests, test solutions were placed in culture dishes with covers. The inhibition activities of extracts was determined by serial dilutions of each extract for 6 concentrations in the range of 1-1000 µg/ml, with 1 set of negative (only culture medium) and positive (Copper sulfate solution) control group for each experiment. Duckweed growth was determined by measuring frond number, the frond number was scored at day 0 and at day 7 after the experiments. All visible fronds were counted. All culture dishes were incubated in the growth cabinet for seven days and the total number of fronds per dish were counted and recorded the number and appearances. The results were interpreted by analyzing the growth regulation in percentage calculated with reference to the negative control. The inhibition percent relative growth rate was selected as the end point for phytotoxicity test. It was calculated using the following formula [14-15]: Relative growth rate (RGR)/day = $[\ln(N_t/N_0)] / \text{no of day}$. Percent

inhibition of growth rate (%GRI) = $(RGRc - RGRt) / RGRc * 100\%$ where: N_t = the number of fronds per replicate at the end day of experiment, N_0 = the number of fronds per replicate at the beginning, $RGRc$ = average relative growth rate of the control group and $RGRt$ = average relative growth rate of the tested group. Concentration (\log_{10}) was plotted against percent inhibition (%GRI) and expressed as effective concentrations that resulted in 10% (EC_{10}) inhibition of duckweed growth which is appropriate value to evaluate this inhibitory effect [14].

RESULTS AND DISCUSSION

Lemna Phytotoxicity Assay

The herbicidal potentials of the extracts derived from the *Tagetes minuta* (TM) and *Chrysanthemum indicum* (CI) were evaluated against *L. minor* growth. The data of average growth rate and % inhibition of growth rate compared with negative control (normal growth in culture medium) were shown in table 1. All extracts had percent inhibition of growth rate increased when concentrations were increased. After plotting graph between log concentration on axis-X and % inhibition of growth rate in axis-Y, effective concentration that inhibit growth by 10% (EC_{10}), 20% (EC_{20}) and 50% (EC_{50}) were calculated. The results obtained indicated that the extracts of TM possess tremendous herbicidal activity, by which methanolic extracts had the greatest inhibitory effects with EC_{10} of 95.58 $\mu\text{g/ml}$ while aqueous extracts had the second most inhibitory effects with EC_{10} of 107.59 $\mu\text{g/ml}$. (EC_{20} and EC_{50} were also showed as present in table 2).

Extracts of CI were shown to have much less inhibition activity on duckweed growth, methanolic extracts had EC_{10} of 227.44 $\mu\text{g/ml}$, while aqueous extracts of CI were shown to have the least inhibitory effect ($EC_{10} = 277.68 \mu\text{g/ml}$). (EC_{20} and EC_{50} were also showed as present in table 3).

Table 1 Average relative growth rate and %Inhibition of growth rate on *L.minor* of various extracts of *Tagetes minuta* (TM) and *Chrysanthemum indicum* (CI)

Plant materials	Extraction	Conc. µg/ml (ppm)	Average growth rate / day	% Inhibition of growth rate
<i>Tagetes minuta</i> (TM)	MeOH	1000	-0.2942 ± 0.1605	227.09
		800	-0.2355 ± 0.1342	201.74
		600	-0.0406 ± 0.0150	117.52
		400	-0.0081 ± 0.0464	103.48
		200	0.0785 ± 0.0055	66.09
		100	0.1597 ± 0.0125	31.01
<i>Tagetes minuta</i> (TM)	Water	1000	-0.0230 ± 0.0336	109.96
		800	0.0040 ± 0.0314	98.27
		600	0.1092 ± 0.0473	52.83
		400	0.1357 ± 0.0291	41.37
		200	0.1594 ± 0.0170	31.13
		100	0.1878 ± 0.0132	18.89
<i>Chrysanthemum indicum</i> (CI)	MeOH	1000	0.1526 ± 0.0218	40.61
		800	0.1601 ± 0.0031	37.72
		600	0.1820 ± 0.0055	29.17
		400	0.1823 ± 0.0255	29.06
		200	0.2476 ± 0.0101	3.67
		100	0.2745 ± 0.0224	-6.82
<i>Chrysanthemum indicum</i> (CI)	Water	1000	0.1818 ± 0.0113	29.26
		800	0.2253 ± 0.0247	12.33
		600	0.2262 ± 0.0146	11.98
		400	0.2233 ± 0.0084	13.13
		200	0.2396 ± 0.0284	6.78
		100	0.2483 ± 0.0051	3.39

Table 2 EC₁₀, EC₂₀ and EC₅₀ of *Tagetes minuta* (TM)

<i>Tagetes minuta</i> (TM)	EC ₁₀ µg/ml (ppm)	EC ₂₀ µg/ml (ppm)	EC ₅₀ µg/ml (ppm)
Methanol extracts	95.58	108.11	156.47
Water extracts	107.59	140.26	310.75

Table 3 EC₁₀, EC₂₀ and EC₅₀ of *Chrysanthemum indicum* (CI)

<i>Chrysanthemum indicum</i> (CI)	EC ₁₀ µg/ml (ppm)	EC ₂₀ µg/ml (ppm)	EC ₅₀ µg/ml (ppm)
Methanol extracts	227.44	357.94	> 1000
Water extracts	277.68	946.23	> 1000

In practice, controlling weeds through allelopathy is one strategy to reduce dependency on chemical herbicides [5-10]. As our results, *Tagetes minuta* (TM) or marigold exhibited promising results on inhibitory effects on duckweed growth in Lemna phytotoxicity assay in both extracts, methanolic and aqueous extracts. Then they showed potential to implement as natural herbicides, that are safe, not hazard to man, animal and environment, for weed control instead of harmful chemical herbicides. In addition, it is worthy if TM or

marigold that are waste after they are made into floral garland were withered and dried, is pick up to make more useful bioherbicides.

It is worthy of further investigation since this could provide potential bioherbicides from waste-materials to value-added products and may lead to the discovery of new effective and applicable bioherbicides.

Phytochemical screening (Data not shown)

A phytochemical screening of TM and CI flowers showed rather similar pattern of chemical compositions in methanolic extracts in both plants and in aqueous extract of TM, the major one is phenolic compound of flavonoid glycoside. Besides, steroidal structures were present only in methanolic extracts from both plants. As expected, aqueous extract of CI was shown to contain no other phytochemical except sugars and phenolic group moiety structure. Alkaloids were not detected in both plants.

CONCLUSION

From the present study, it could therefore be concluded that methanolic extracts of *Tagetes minuta* (TM) or marigold showed the greatest inhibitory effects, following by aqueous extracts of TM. Extracts of *Chrysanthemum indicum* (CI) were shown to have much less inhibition activity especially the aqueous extracts which was exhibited the least inhibitory effect on duckweed growth.

Findings from this study suggest that *Tagetes minuta* (TM) or marigold, that are waste after they are made into floral garland were withered and dried, is the most promising candidates for biological weed control and might be used as potential natural herbicides or as alternative material for the reduction amount of chemical herbicides to be used. It is worthy of further investigation since this could provide potential bioherbicides from waste-materials to value-added products and may lead to the discovery of new effective and applicable bioherbicides.

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Production of Ethylcellulose-Aloe Vera Gel Nanofibers

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Abstract: Electrospinning technique has been recognized as a versatile technique that can be used to manufacture nanofibers from biomaterials. After functionalized by selected bioactive compound, functional nanofibrous scaffolds have shown their great potential in many biomedical applications, such as tissue engineering, wound dressing, enzyme immobilization and drug (gene) delivery. In this research, nanofibrous films were prepared from ethyl cellulose and fresh Aloe vera gel solutions using electrospinning. Rheology of neat ethylcellulose was investigated using a rotational viscometer. The semi-dilute entangled regime was found when the concentration of ethylcellulose was higher than 7% wt. Then, target solutions were electrospun to produce nanofibers and fiber morphology was examined using a scanning electron microscope (SEM). Optimum ethylcellulose concentration for a production of mostly smooth fibers was 11% wt or higher. The higher the solution concentration is, the larger the average fiber diameter. Mixing aloe vera gel in the precursor solution improved smoothness of fibers. Lastly, tensile strength and elongation of electrospun films were also examined. It was revealed that fiber diameter significantly affected the physical property of the produced nanofibrous films.

Keywords: Aloe vera gel, Electrospinning, Scaffold, Wound dressing.

INTRODUCTION

Electrospinning is a technique that is widely used to produce films from ultra-fine fibers with high surface to volume ratio using high voltage. The produced fibers have noticeably different properties compared to conventionally spun fibers (that are produced from the same raw materials) such as very high specific surface area to volume ratio and high film flexibilities [1-2]. Biomaterials were widely used to produce electrospun film that can be used as a scaffold due to their non-toxicity [3]. It was reported that the prepared electrospun films from biomaterials were better than gauze and commercial sponge wound dressing in term of wound healing efficiency, cell migration and cell proliferation [4]. Another advantage of electrospun scaffolds over commercial scaffolds is the softness of electrospun. This is because the average size of fibers in electrospun mat is much smaller than those of fibers in commercial scaffold.

Viscosity of the solution is one of a critical factor in electrospinning [5]. When the precursor solution experiences high electric field between the spinneret and a collector plate, the solution droplet at the spinneret tip will transform into a Taylor cone and a polymer jet will be ejected from the Taylor cone's tip to the collector plate. The polymer jets can possibly break up during electrospinning due to electric repulsive forces inside the solution. In order to prevent the breaking up of polymer jet, polymer chain entanglement inside the solution is

necessary. One indicator that relates to polymer chain entanglement is the solution viscosity. When the polymer concentration is higher than the entangled concentration, one can notice a sharp increase in solution's viscosity [6].

In this study, two biomaterials i.e. ethyl cellulose and aloe vera gel were used to prepare bioactive nanofibrous films using electrospinning technique. The viscosity of the solution was investigated in order to determine suitable concentration for electrospinning. Effects of polymer concentration and process conditions on fiber's morphology were also examined using a scanning electron microscope. Finally, mechanical properties of the nanofibrous films were determined.

MATERIALS AND METHODS

Ethyl cellulose was purchased from Sigma-Aldrich (CAS 9004-57-3, USA). Ethanol was supplied from UV Holding (Thailand). Aloe vera (about 2 years old) was planted in-house. To obtain aloe vera gel, aloe vera leaf was freshly cut and only clear gel was immediately collected, filtered and used as is.

Preparation and Examination of Rheological Property of Polymer Solutions

Ethyl cellulose solutions was prepared by dissolving the polymer in 90% (v/v) aqueous ethanol (EtOH) under vigorous stirring for approximately 2-4 hr at room temperature (about 25-27 °C) to obtain clear solutions (2-14 %wt). To prepare ethyl cellulose-aloe vera gel mixture, aloe vera gel was mixed in an ethyl cellulose solution at a ratio of 1:9 by volume. The mixture was stirred until it became homogeneous. The solutions' viscosities were then measured using a rotational viscometer with a plate to plate measurement system (Thermo HAKKE, RheoStress 1, Germany). All measurements were done in triplicate and mean values and standard deviations were reported.

Electrospinning Experiments

In this research, a modified electrospinning technique so-called "solvent coating" technique developed by Kanjanapongkul [7] was employed in order to prevent clogging during electrospinning. Polymer solution was loaded into a syringe which was locked on a syringe pump (New Era, NE-300, NY). A stainless needle at the end of the syringe served as a spinneret and was electrically connected to a high voltage generator (Gamma High Voltage, ES30P-6W, Ormond Beach, FL) while a collector plate at the opposite side of the syringe was electrically grounded. The distance between the spinneret and the collector plate was 10 cm. The solution and solvent flow rate was set at 20 and 7 $\mu\text{L}/\text{min}$, respectively. The voltage between needle tip and the collector plate was fixed to 16 kV. The collected fiber mats were dried at room temperature and wrap with foil paper prior to further analysis.

Investigation of Fiber's Morphology and Analysis of Film's Mechanical Properties

The morphology of the fibers was examined using a scanning electron microscope (SEM) (Camscan, MS2000, UK). The samples were sputter-coated with gold. The average diameters of the electrospun fibers were determined by the image analysis software Image J (National Institutes of Health, Bethesda, MD). Finally, film's mechanical strength was examined using a universal testing machine ((Instron, 5569, USA) with a 0.5 kN load cell. Each film sample was cut into a rectangular shape (10 mm x 160 mm). The initial gauge separation and the crosshead speed were set to 100 mm and 10 mm/min, respectively.

RESULTS AND DISCUSSION

Effects of Polymer Concentration on Fiber's Morphology

Figure 1a) shows the effect of ethylcellulose concentration on solution's viscosity. Viscosity increased slowly with polymer concentration when the concentration was relatively low. For example, the viscosity increased from 16 to 40 Pa.s when the polymer concentration increased from 5%wt to 7%wt. However, a sharp increase in the solution viscosity was observed when polymer concentration was raised from 7 %wt to 13 %wt. This indicated that the polymer chain entanglement initiated when the polymer concentration was higher than 7%wt. From our results it was estimated that the entangled concentration of ethylcellulose solution was about 7.5 %wt (data not shown). Thus it was expected that the minimum suitable concentration of ethylcellulose solution should be somewhere between 7.5 %wt and 13 %wt.

To determine a suitable concentration of the solution, morphologies of beads and fibers obtained from electrospinning of solutions with different ethylcellulose concentrations were investigated. Figure 1b) to f) show morphologies of beads and fibers produced from different solutions. Electrospinning condition was set as follows: voltage of 16 kV; electrospinning of 10 cm; solution flow rate: 20 μ L/min. Obviously no fiber was formed when the polymer concentration was 5 %wt (Figure 1b). This was due to a lack of polymer chain entanglement in the solution. At a concentration slightly higher than the entangled concentration (9 %wt-Figure 1c), small fibers with large beads were observed. Increasing ethylcellulose concentration to 11 %wt resulted in a mainly fibrous structure (Figure 1d). The average fiber's diameter was about 300 ± 150 nm. A decrease in bead formation was observed when the concentration was raised to 13 %wt (Figure 1e) and the average fiber's diameter was found to be 540 ± 165 nm.

Lastly, the effect of aloe vera gel on the morphology of fibers was also investigated. Figure 1f) shows that mixing of aloe vera gel into a 13 %wt ethylcellulose solution results in less bead formation and smaller fiber (average diameter of 430 ± 160 nm). This could be because the higher hydrophilicity of aloe vera gel as compared to ethylcellulose increased the charge density in the polymer jet. Consequently, electrical forces increased and polymer jet was quickly stretched out.

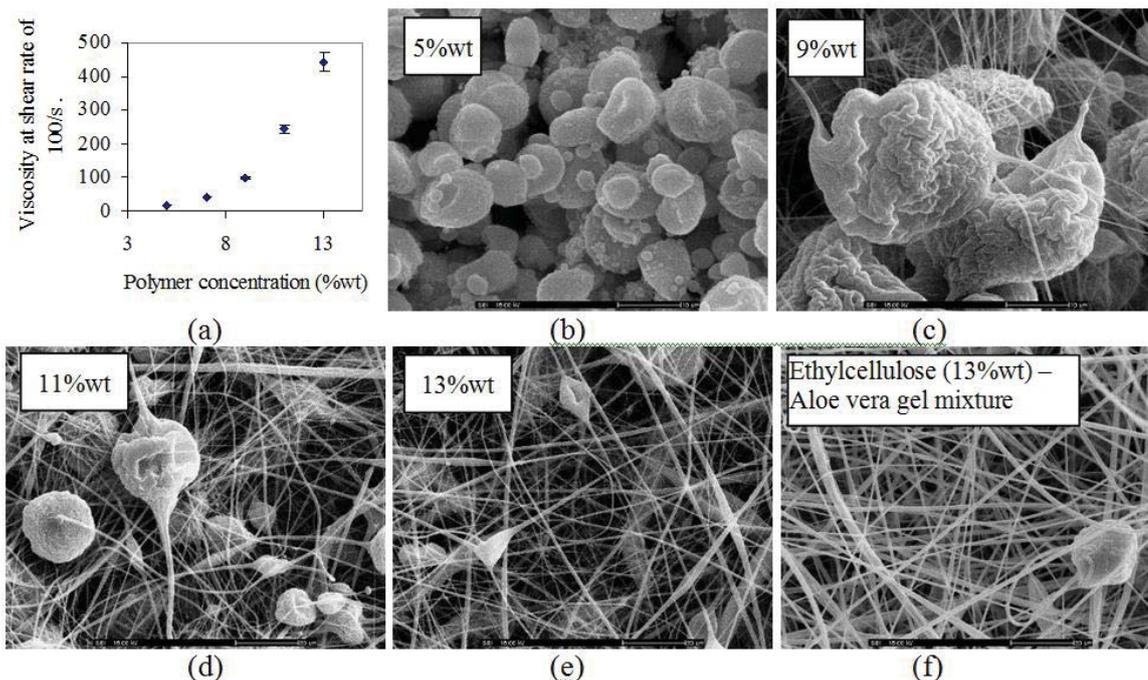


Figure 1 Effects of ethyl cellulose concentration in the solution on solution’s viscosity (a) and morphology of beads and fibers (b to f). Electrospinning condition was: voltage = 16 kV; electrospinning distance = 10 cm; solution flow rate = 20 μ L/min.

Film’s Mechanical Property

Table 1 shows the effect of polymer concentration on fiber’s diameter and mechanical properties of the films. Tensile stress and average fiber’s diameter increased from 1.64 ± 0.39 MPa and 300 ± 150 nm to 2.74 ± 0.36 MPa and 540 ± 165 nm, respectively, when ethylcellulose concentration was raised from 11 to 13 %wt. Our results implied that fiber size strongly affected the mechanical properties of the electrospun file. This agreed well with previous research work by Ali *et al.* [8] who showed the positive relationships between fiber’s diameter and fiber’s tensile stress and elastic modulus. Stylianopoulos *et al.* [9] studied the effect of fiber’s diameter and orientation on tensile properties of electrospun films prepared from polyurethane solutions. They concluded that the tensile properties of electrospun films were sensitive to microstructure of the films.

Table 1. Mechanical properties of electrospun films.

Ethylcellulose concentration (%wt)	Average fiber’s diameter (nm)	Tensile stress (MPa)	Tensile elongation (%)
11	300 ± 150	1.64 ± 0.39	1.00 ± 0.48
13	540 ± 165	2.74 ± 0.36	1.33 ± 0.60

*Data shown in the table is the average value and standard deviation.

CONCLUSION

Electrospun films were successfully prepared from either ethylcellulose solutions or the mixture of ethyl cellulose and fresh aloe vera gel. The critical ethyl cellulose concentration was found to be higher than 7.5 %wt. Under this critical concentration, beads were mainly observed. The suitable concentration ranged from 11 to 13 %wt in order to produce smooth fibers with less bead formation. SEM images shows that mixing aloe vera gel in the precursor solution helped improve smoothness of fibers as well as reduced the average fiber's diameter. A study of tensile strength and elongation of electrospun films showed the dependency of tensile properties on fiber's diameter. In conclusion, the results revealed that it was possible to produce nanofibrous films from ethylcellulose solution that contained aloe vera gel and alter film's tensile properties by varying ethylcellulose concentration in the solution.

ACKNOWLEDGEMENTS

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Cooking of Jasmine Rice by Ohmic Heating

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Abstract: Ohmic processing is an electrical heating method that electrical current passes through food products that serve as a resistive load. The advantages of the process include, uniform temperature profile in foodstuff, high heat generation rate and high-energy efficiency. In this research, cooking of Jasmine rice using ohmic heating was conducted at various electric field strengths. A batch ohmic heating system was designed to heat 300 mL of a mixture of jasmine rice and water with the mixing ratio of 1 : 1.5 (rice : water). The temperature dependence of electrical conductivity of Jasmine rice soup was investigated and could be summarized into one equation, while σ and T are the electrical conductivity and temperature of rice respectively. Then, energy consumption during cooking of rice using ohmic heating was recorded and compared with energy consumed by a tradition rice cooker. It was shown that ohmic heating could save an overall cooking energy in one batch for more than 50% while cooking time was also slightly reduced by 10%.

Keywords: Cooking, Energy efficiency, Ohmic heating, Jasmine Rice

INTRODUCTION

Cooked rice is an important carbohydrate source for Asian people. Beside carbohydrate, rice kernel also composes of about 8% of protein and 25% of amylose [1]. Rice is usually consumed as a whole kernel. Before consumption, it is necessary to cook rice by heating until rice kernel is fully gelatinized in order to improve digestibility and have desired texture, appearance, aromatic and taste [2]. Typical cooking time is about 15-25 minutes [3-4], mainly depends on type, rice to water ratio and heater's power. From consumers' perception, cooking time is one of important factors that affect their satisfaction [2]. Thus some research works have been conducted to decrease cooking time. For example, Pongpetch [5] prepared instant rice drying using a heat pump dryer and found that at drying temperature higher than 40 °C, the heating rate was higher and rehydration capability was better than at low temperature. However, Rewthong *et al.* [6] pointed out that glycemic index (GI), which is an index to show how quickly that the blood sugar level increases after consumption, in the rehydrated instant rice was generally higher than GI in freshly cooked rice. Stickiness and adhesiveness were also lower in a case of rehydrated pretreated-rice. This might affect consumers' perception in term of health and food texture. Therefore it is still necessary to find a new cooking method that is faster but has no adverse effects on the cooked rice's properties.

Ohmic heating is a quick heating method by passing electric current through food stuff. For simple ohmic heating system, food to be heated is put into a food container, which is typically called as an ohmic cell. At both sides of the ohmic cell, there are two conductive plates which serve as electrodes. To heat the food stuff, two electrodes are electrically

connected to a power supply. Once electric current passes from the power supply via electrodes through food stuff, electrical energy rapidly and directly transforms into heat due to resistivity of food itself. Since the magnitude of electric current strongly depends on food's conductivity, electric field and ohmic cell configuration, it is convenience to customize the system to have the desired heating rate that matches to the product's characteristic by simply adjusting aforementioned factors. Ohmic heating system is generally simple, cheap, and clean since no chemical additives is required in the process. More over, food is quickly and uniformly heated [7] with high energy-efficiency [8] if the system is properly designed.

In this research work, the possibility to cook rice using ohmic heating was examined. Electrical conductivities of rice at different temperatures were estimated. Energy consumption and cooking time were determined and compared with a traditional cooking process using a commercial automatic rice cooker.

MATERIALS AND METHODS

Stale Jasmine rice (Royal Umbrella, Thailand) was purchase from a local super market. The sample was kept at room temperature (about 25 to 28 °C) and used in the experiment without further treatment.

Determination of Rice's Electrical Conductivity

Basic set up of ohmic heating experiment was shown in Figure 1. A single-phase variac (Silicon, Thailand) (1) was used as a power source. A PID temperature controller (TAIE, FU48-101000, Taiwan) connected to a 3-wire pt-100 RTD sensor was used to control heating temperature. A rectangular ohmic cell was made from glass (4). Two stainless electrodes were fixed at both sides of the ohmic cell, opposite to each other.

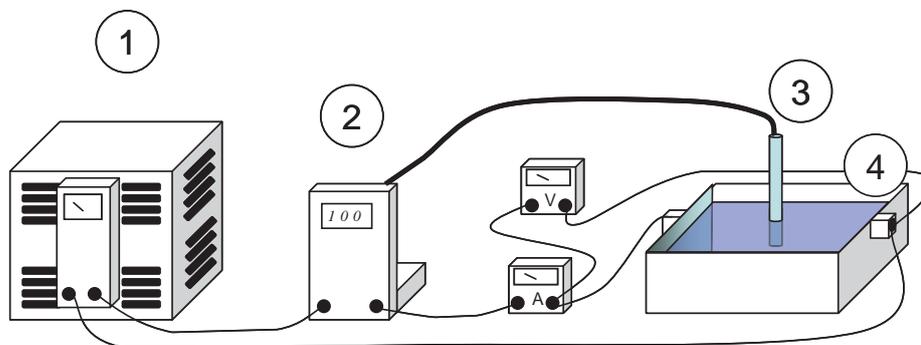


Figure 1 Batch ohmic heating system consists of 1) a power supply (0-250 V), 2) a PID temperature controller equipped with 3) a 3-wire RTD sensor and 4) a rectangular ohmic cell with two stainless electrodes located on the left- and right-hand sides of the cell.

A mixture of rice and 0.008 M aqueous NaCl solution was ohmically cooked at a constant voltage ($V = 200 \text{ V}$). The electric current (I - in A) measured using a digital ammeter was recorded periodically and used to calculate electrical conductivity (σ - in S/m) of the mixture of Jasmine rice and NaCl solution as a function of temperature (T - in °C) as per equation 1:

$$\sigma(T) = \frac{I(T) \cdot L}{V \cdot A} \tag{1}$$

L was the distance between two electrodes (= 0.1 m) and A was an effective area of each electrode (= 0.003 m²). The experiments were conducted in triplicate and the average value was used in the calculation.

Estimation of the Power Consumption

The electric power consumption (W - in kW-hr) over the whole cooking period (t - in s) was determined using equation 2:

$$W = \frac{1}{1000 \times 3600} \int I(t) V dt \tag{2}$$

As aforementioned, a commercial automatic rice cooker with a heater power of 600 W was also used to cook rice in order to compare overall power consumption as well as cooking time.

RESULTS AND DISCUSSION

Electrical Conductivity of Jasmine Rice

Prior to determine the electrical conductivity of Jasmine rice, it was necessary to find the relationship between temperature and electrical conductivity of NaCl solution used in this experiment. This was simply done by ohmically heat NaCl solution alone (i.e. without rice). As expected a positive linear relationship between electrical conductivity of NaCl solution and temperature was obtained (data not shown) as shown in equation 3:

$$\sigma_{0.008MNaCl} = 0.0031T + 0.0503 \tag{3}$$

Similarly, electrical conductivity of a mixture of Jasmine rice and NaCl solution was found to be a linear function with the sample’s temperature as follows:

$$\sigma_{rice-mixture} = 0.0030T + 0.0160 \tag{4}$$

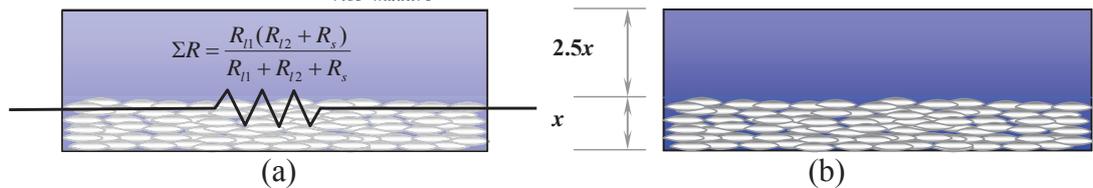


Figure 3 A simplified-physical model used to estimate electrical conductivity of Jasmine rice (a). R_{11} , R_{12} and R_s represent resistances of NaCl solution in the upper portion (with a height of $2.5x$), NaCl solution in the lower portion (with a height of x) and Jasmine rice, respectively (b).

Figure 3 shows a mixed series-parallel model was then applied to extract the information of Jasmine rice’s electrical conductivity. Form a simple relationship between resistance and electrical conductivity, electrical conductivity of Jasmine rice was solved as shown in equation 5:

$$\sigma_{rice} = \frac{(0.00275T - 0.06975)(0.0031T + 0.0503)}{0.00345T + 0.17035} \tag{5},$$

which can be further estimated by equation 6 ($R^2 = 0.998$):

$$\sigma_{rice} = 0.0020T - 0.0560 \quad (6)$$

In this estimation, a change in rice's volume was neglected. Thus there might be a discrepancy between the actual and predicted values at high temperature because the volume expansion of rice kernel. However, equation 6 fitted well for the whole range of working temperature in this research (30-100 °C).

Power Consumption and Cooking Period

Though the power of the commercial rice cooker used in this experiment was about twice of the average power of ohmic heater (600 W and 300 W, respectively), the cooking time required by ohmic heating process was slightly lower (16 min for ohmic heating v.s. 18 min for traditional cooking method).

Figure 4 shows that ohmic heating can reduce overall electric power by more than 50%. The mechanism of heat transfer in a commercial rice cooker started from a heat source located under an aluminum container. Heat is transferred from the heater to the container by conduction, and transferred to the surface of rice kernel and water by both natural convection and conduction. Differently, no heating medium is required in ohmic heating process because the heat source is directly located inside the resistive food when electric current passing through. Moreover, electric field might enhance the diffusivity of water into rice kernel which facilitated gelatinization process during heating. This single step of heat transfer in ohmic heating could be the main reason that ohmic heating process consumed less power compared to conventional method.

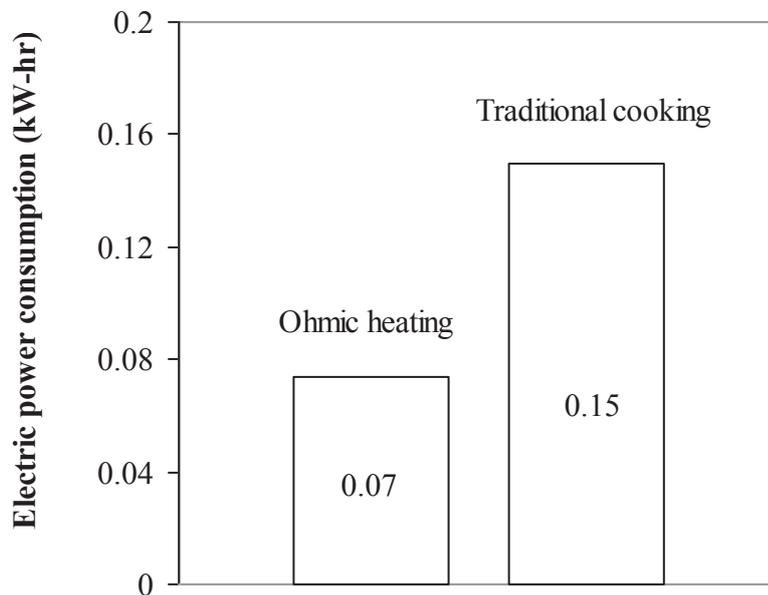


Figure 4 Comparison between electric power consumed by ohmic heating (left) and traditional cooking.

CONCLUSION

Electrical conductivity of Jasmine rice was successfully estimated by using a series-parallel circuit model. The estimation worked well in the working temperature range. The

comparison between electric powers consumed by a conventional rice cooker and an ohmic heater confirmed that ohmic heating was a highly efficient heating method for rice cooking.

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Computer Aided Application for Course Transfer in Uttaradit Rajabhat University

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Abstract: This research aimed to design and develop a computer-aided application for course transfer in Bachelor of Technology Program (Industrial Technology), Faculty of Industrial Technology, Uttaradit Rajabhat University. The method was to find out the terms and conditions of course transfer. These results were also compared with using traditional course transfer and evaluation of the efficiency in real operation. For the research methodology, the system development life cycle (SDLC) was adopted by dividing into 7 steps. An application was designed into two parts: the contents of web page (front page, menu, subjects, course, subjects of course transfer and all related documents) and database schema consisted of 4 tables (Admin, Subject, Course and Subject of Course Transfer). A developed application was run on the web browser through an internet client 39 students from B.Tech. (Industrial Technology) tested the application and evaluation of result was satisfactory.

Keywords: Computer application, Course transfer, System development life cycle

INTRODUCTION

In recent year, the learning and teaching of Bachelor of Technology Program (Industrial Technology), Faculty of Industrial Technology, Uttaradit Rajabhat University is regulated by Office of the Higher Education Commission. The commission has the policy to propose the programs of four years full-time attendance specifically for bachelor's degree courses [1]. Thus, it has impacted Higher Vocational Certificate graduates that continue their traditional degrees for 2 – 2 1/2 years of study. However, the university has admitted them as for transfer program but students' disciplines and their former institutions are different. Therefore, the transferring courses are different and difficult to verify, resulting in a delay planning of the study, and making a difficulty for teachers and officials to advise each student.

Monticha [2] studied the problem about transfer credits for students in the course Bachelor of Arts (political science) including concepts and weaknesses of the transfer system. Yokkaew [3] did a research on a system of transfer credits for Rajabhat Universities which provides information for students and individuals who want to transfer courses that were studied from other institutions and can be excluded from current curriculum. The system will compare the subjects between universities and then generate a number of credits and subjects, as well as, indicate subject group and course structure of the program required for students to enroll. Moreover, the system also indicates the remaining number of credits that must be studied in order to complete the course structure of Rajabhat Institute.

In this paper, we were carried on with the purpose to design and develop a computer aided application for course transfer in Bachelor of Technology Program (Industrial Technology), Faculty of Industrial Technology, Uttaradit Rajabhat University. The

application will search for requirements and methods used for course transfer. Finally, performance of the course transfer system between using and not using a computer program is compared.

MATERIALS AND METHODS

In this research, the sampling populations are 36 students from Bachelor of Technology Program who want to do course transferring program, and 3 computer specialists. We used System Development Life Cycle (SDLC) [4] as an experimenting method of the research. The method can be divided into 7 steps: 1) problem definition, 2) analysis, 3) design, 4) development, 5) testing, 6) Implementation and 7) maintenance. Furthermore, questionnaires have been used as a tool to assess and evaluate the satisfaction of the program.

RESULTS AND DISCUSSION

Analysis of the Original System's Problem

Most of the relevant information contained in documents format which has several editions. The information can be sited on university webpage but is time consuming to search on and does not provide sufficient details. Therefore, students who came from different educational institutions or have different disciplines commented that, there should be a system to guide or test the course transfers which will assist students on their decision making.

Analysis and Structural Design of Computer Program

From the context diagram [5], there are two groups of people who assess the courses transfer database; Users and the Administrator. The information that passes along each process is presented in Data Flow Diagram (DFD) [6] which indicates directions of the data from both senders and receivers. Five functions can to be processed in the program; record subjects' data, record study planning, record transferring subjects, search data and analysis of transferring credits. Four databases are categorized; administrator database, subject database, courses planning database and courses transferring database. The Data Flow Diagram of the program was illustrated in Figure 1.

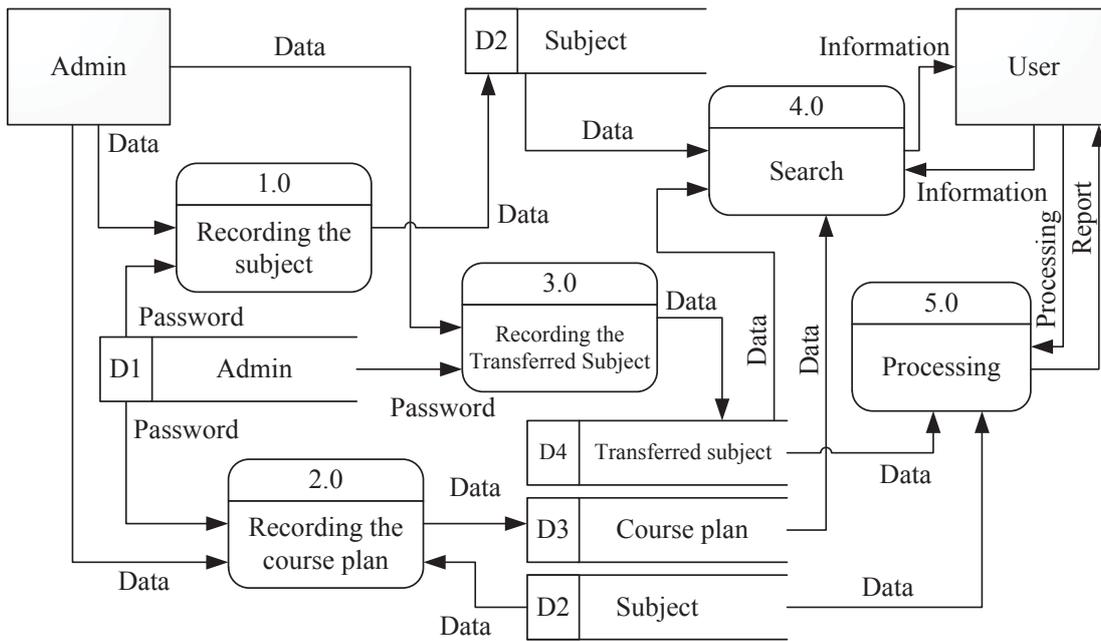


Figure 1 Data Flow Diagram (DFD) of the program

Evaluation of Satisfaction and Process of the Program

There were 86.1 % (31 from 36) of students that return the questionnaire. It can be generally concluded that, there are 16 students which graduated from Uttaradit Technical College (51.6%) and 6 students graduated from Phare Technical College (19.4%). Of all the students, 20 students studied Mechanical program and 7 students studied Manufacturing program. Other results on satisfactions and efficiency of the developed program are concluded in Table 1.

Table 1 Mean (\bar{X}) and Standard Deviation (SD) satisfactions and efficiency of the developed program

Topic	\bar{X}	SD	Levels of opinion
1. Designing web layouts has suitable to use	4.39	0.76	Good
2. Issue contents have suitable to use	3.77	0.72	Good
3. Data validation is easier	3.68	0.75	Good
4. The program meets user needs	4.23	0.76	Good
5. Accuracy and reliability of data	3.81	0.70	Good
6. Reduce the time to searching	4.26	0.68	Good
7. The program can use functionally to course transfer	4.35	0.80	Good
Average	4.07	0.74	Good

The results of evaluation by three computer specialists shown in Table 2.

Table 2 Mean (\bar{X}) and Standard Deviation (SD) evaluation by computer specialists

Topic	\bar{X}	SD	Levels of opinion
1. Input data	4.20	0.46	Good
2. Programming process	3.30	0.17	Fair
3. Report data	4.33	0.46	Good
4. Information content	4.19	0.49	Good
Average	4.01	0.40	Good

CONCLUSION

This research has been achieved the primary purpose which is design and develop a computer aided application for course transfer in Bachelor of Technology Program (Industrial Technology), Faculty of Industrial Technology. The method of the System Development Life Cycle (SDLC) was implemented. An information system of course transfer requirements has been developed and equipped in the computer aided application. The application has been tested to check its compatibility; this was done by comparing the efficiency of manual method against presented application. Students' satisfaction on the application was evaluated using questionnaires. The overall average evaluation is in a good level ($\bar{X}=4.07$, $SD=0.74$). Moreover, evaluation from computer specialist also show that the developed information system of the application can be applied for actual work in a good level ($\bar{X}=4.01$, $SD=0.40$).

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Development of Three Phase Motor Pump Variable Speed Drive for Water Flow Control of Solar Pumping System

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Abstract: This paper proposed a water flow rate control of solar pumping system by using variable speed drive of centrifugal pump coupling with three phase induction motor. The electrical variable speed drive control of centrifugal pump was energized by DC input from solar photovoltaic system and also 220 V 50 Hz single-phase electrical power. The variable speed drive motor control was based on the principle of 3 phase AC motor pump frequency adjustable circuit which developed by IC MC3PHAC for generate PWM control signal to drive an IGBT Intelligent Power Module (IPM) voltage rated 600 V, current rated 30 A. In order to verify proposed technique, the demonstration solar pumping system was built. The system composed of 1 inch piping system, 370 watt (0.5 hp) three phase centrifugal pump, 2 x 300 watt solar module, battery charger and 24 V lead acid battery. In the experimental, two methods of water flow rate control such valve control and motor pump variable speed drive were compared. It was found that energy consumption of motor pump variable speed drive was saving more than valve control proportional to the water flow rate in accordance with the pump similar theory. The variable speed drive solar pumping system can be used for water irrigation and water supply for cultivation to substitute diesel pump and generate electricity for electrical pump in the rural area.

Keywords: Variable Speed drive, Water flow control, Solar pumping

INTRODUCTION

A Water Pumping system with solar energy is one of the most popular photovoltaic applications in Thailand. It is useful for irrigation, agriculture, drainage and sanitary system especially in the rural area which lack of electricity. The electric motor pumps are general divided into two types, DC motor pump and AC motor pump [1-2]. The benefits of DC Solar motor pumping is very simple system. But drawbacks of DC pump are life cycle and maintenance of motor and high price [3]. In contrast AC motor pump has low price, low maintenance and available in the industrial but it need inverter to convert DC voltage to AC voltage for supply the motor, then the cost of AC solar pump may higher after including inverter particularly high power rated of three phase AC motor. Another type of solar pumping system is considered by battery backup or non battery backup [4]. The battery has high cost of investment but it can be storage excess energy from high solar irradiation and retrieves energy to use when radiation in rainy day and also night time low. In case of non-battery backup solar pumping, the pump cannot control flow rate and energy, the water flow rate is depend to the solar irradiation, solar energy will be transfer to the pump without storage [5]. When low solar irradiation, the water flow will decrease and it will affect to the water user, irrigation. In order to solve this problem a battery backup is designed to be buffer

storage and variable speed drive of AC pumping is used to save energy and also save water resource of solar water pumping by water flow rate control. In this paper, an overview of solar water pumping technology is proposed [6-10].

MATERIALS AND METHODS

Solar Water Pumping Technology

The solar water pumping has subsections as shown in Figure 1 such as water piping system, valve, accessories to transfer water resource to water supply, motor pump, battery storage system.

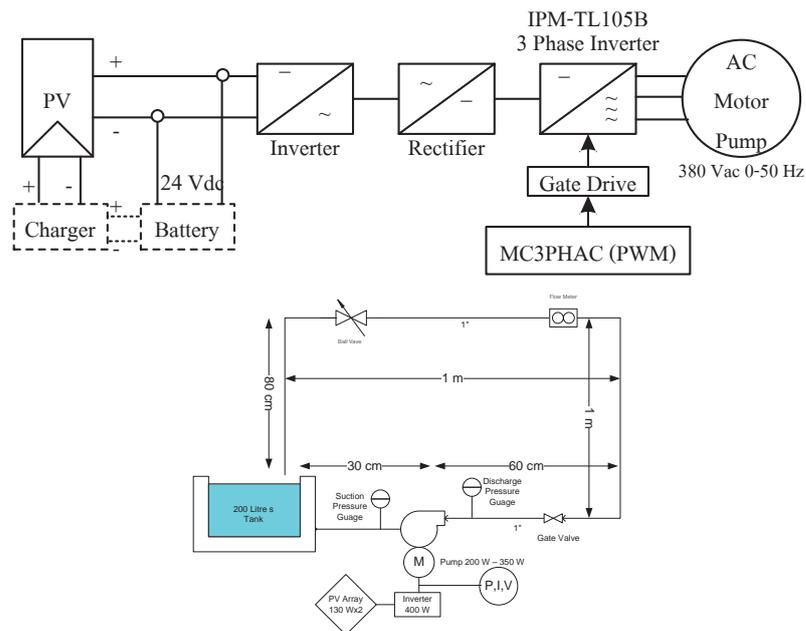


Figure 1 Diagram of 3 phase AC Solar Pumping with Variable Speed Drive

A Design of Solar Pumping System has the method following to the diagram follow as

Stage 1 Find Daily Solar Energy and Peak sun Hour

The average solar irradiation worst (lowest) month in units of kWh/m²/day is need to evaluation solar energy resources. The simple way to get average Solar Irradiation is used solar energy map which developed by Ministry of Energy. By identify latitude, longitude of area, the database or program will inform the average Solar Irradiation. In case of non-identify the location, average solar irradiation of Thailand can be used to evaluation and peak sun hour (PSH) can be calculated in equation (1).

$$\begin{aligned} \text{Peak Sun Hour} &= \text{Daily Solar Insolation (kWh/m}^2\text{/day)}/1000 \text{ W/m}^2 & (1) \\ &= 5.05 \text{ (kWh/m}^2\text{/day)}/1000 \text{ W/m}^2 = 5.05 \text{ hours} \end{aligned}$$

Stage 2 Determine Daily Water Requirement and Daily solar water pumping

In sanitary, irrigation or water drainage system, user should find the daily water requirement in order to know how much water to be pumped. The information about water resource, distance of pumping, deep level, quantity and quality of water. The quantity of water is identified in cubic meters. (1 m³ = 1000 liters). Suppose the water requirement is 25

m^3/day and Peak sun hour 5 hour, then Daily water pumping by solar energy is calculated from equation (2)

$$\text{Daily water pumping} = \text{Daily water requirement } (\text{m}^3/\text{day}) / \text{PSH (h)} = 25/5 = 5 \text{ m}^3/\text{h} \quad (2)$$

Stage 3 Water Piping Sizing

The water piping sizing is determined water velocity and identify the daily water requirement. Normally water velocity has interval in 1-3 m/s, the low velocity has benefit such low friction loss in pipe, no water hammer but it will increase the size of pipe. In contrast when high velocity of water, the pipe is small, save material cost but friction loss is high, risk to occur water hammer which damage equipment. The size of pipe can be calculated by continuity equation (3)

$$Q = AV; A = Q/V = (5 \text{ m}^3/\text{h}) / (1.5 \text{ m/s}) \quad (3)$$

$$D = \sqrt{4A/\pi} = 0.0515 \text{ m then } r = 2.575 \text{ cm (approximately 1 inch)}$$

Stage 4 Piping System Design and Pressure Head Calculation

The water piping system is composed of water pipe, valve, elbow and accessories. The diagram of demonstration system is designed and implemented. The Head of system is calculated in order to know system head. There are three types of pressure such as pressure head, lift head and velocity head from pipe and value.

a) Pressure Head is the head from change of pressure between input and output can be calculated from equation (4). which γ is specific weight in unit $[\text{N}/\text{m}^3]$, ρ is density of liquid in unit $[\text{kg}/\text{m}^3]$ and g is gravity in unit $[\text{kg} \cdot \frac{\text{m}}{\text{s}^2}]$. In this system, there is no different between P_2 and P_1 then pressure head is negligible.

$$H_p = \frac{P_2 - P_1}{\gamma} = \frac{P_2 - P_1}{\rho g} \quad (4)$$

b) Potential Head of is the head to lift liquid in vertical distance

$$H_p = Z_2 - Z_1 = 1 \text{ m.} \quad (5)$$

c) Velocity Head is the energy loss from friction of pipe and accessory. There are two types : Major loss (H_{lf}) and Minor loss (H_{le}) as shown in Equation (6) and Friction is calculated from moody diagram and Reynold number from equation (7)

$$H_v = H_{lf} + H_{le} = f \frac{L}{D} \frac{V^2}{2g} + K \frac{V^2}{2g} \quad (6)$$

H_{le} is friction loss from accessory and valve (m), K is friction loss coefficient depend on type and size of equipment V is velocity of fluid (m/s). The system compose of pipe which has size 1 inch and length 2.7 meter, the fluid velocity is 1.5 m/s Suppose water temperature is 25 degree, PVC pipe has roughness coefficient (ϵ)=0.001 then the relative roughness, Specific volume, the Reynolds number are calculated by equation (7)

$$\epsilon/D = 0.01/2.54 = 0.003, V = 1.007 \times 10^{-6} \text{ m}^2/\text{s}; Re = \frac{VD\rho}{\mu} = \frac{VD}{\nu} = \frac{1.5 \frac{\text{m}}{\text{s}} \times 2.54 \text{ cm}}{1.007 \times 10^{-6} \text{ m}^2/\text{s}} = 36,200 \quad (7)$$

Re is Reynold Number, V is velocity in fluid pipe (m/s), D is Diameter of Pipe (m) ρ is density of fluid (kg/m³), μ absolute viscosity (N.s/m²) and ν = kinetic viscosity (m²/s). If Re number more than 4000 it imply that the water flow is turbulent. Both Re and e/D is used to find friction coefficient from moody diagram which approximately 0.002. The major loss head is calculated from equation (8).

$$H_{lf} = f(L/D) V^2/2g = 0.002 \times (2.7/0.0254)(2.25/2 \times 9.81) = 5 \text{ meter} \quad (8)$$

In minor loss calculation, the system has 2 pieces of tee connection $K = 0.4$, 4 pieces of 90 elbow $K = 0.75$ and 2 pieces of $\frac{1}{2}$ open gate valve $K = 4.5$, then the minor loss is calculated as

$$H_{le} = \sum K \frac{V^2}{2g} = [2 \times 0.045 + 4 \times 0.75 + 2 \times 4.5] \frac{1.5^2}{2 \times 9.81} = 1.44 \text{ meter} \quad (9)$$

Total Head = Pressure Head + Potential Head + Velocity Head

$$= \left(\frac{P_2}{\gamma} - \frac{P_1}{\gamma} \right) + (Z_2 - Z_1) + H_{Loss} = 0 + 1 + 5 + 1.44 = 7.44 \text{ meter} \quad (10)$$

Stage 5 Select type and pump & motor sizing

The centrifugal pump is used for horizontal or onground pumping and submersible pump for vertical or underground pumpig. In order to select pump, there are parameters such flowrate (Q) m³/s, water pressure (P) or system head and $NPSH_r$ and $NPSH_a$. In this study, three phase AC induction motor is selected because it has low cost in same size, available and controllable. When the system gets solar energy in DC electric energy, the inverter is the crucial equipment to convert DC to AC electrical energy. The appropriate output of inverter must have sinusoidal wave otherwise the motor pump insulation and coil may have damage from heating by harmonics content of electrical signal. The motor pump sizing is calculated from equation (11). Where ρ is water density [kg/m³], $g = 9.81 \text{ m/s}^2$, $Q = 0.00138 \text{ m}^3/\text{s}$, H is system head = 7.44 (m) and η = efficieency of pump and motor = 0.85.

$$P_{pump} = \frac{\rho g Q H}{\eta} = \frac{1000 \times 9.81 \times 0.00138 \times 7.44}{0.85 \times 1000} = 118.5 \text{ W} \quad (11)$$

Stage 6 Battery Energy Storage and Battery Charger

Battery Energy Storage increase battery cost compare with non-battery system, but it can store solar energy for using in the rainy day or the night time. The battery for using with solar is deep cycle type which plate of battery is thicker than start and ignition battery. To store and prolong lifetime of battery, the battery charge is used to control charging and discharge of battery. The four conditions of charging process are composed of Bulk Charge, Float Charge, Trickle Charge and Equalize. In discharge mode, the Battery charger used to control energy in battery not lower than Depth of Discharge (D.O.D.) which is opposite to state of charge (S.O.C). An amount battery (Ah) is concerned by using D.O.D. shortage Energy day, voltage of battery as shown in Equation (12)

$$\text{Ah (Battery)} = \text{Wh (Pump)} \times \text{Shortage Energy Day} / (\text{D.O.D} \times V) \quad (12)$$

In this study, the $\frac{1}{2}$ hp (370 W) of pump, duration of pumping 5 hour/day, the shortage energy day is two days, the battery voltage 24 V. Then $\text{Wh (Battery)} = 370 \times 5 \times 1 / 0.5 = 3700 \text{ Wh}$; $\text{Ah (Battery)} = 3700 \text{ Wh} / 12 \text{ V} = 308.33 \text{ Ah}$, Number of Battery = $\text{Ah (Battery)} / \text{Ah (one battery)} = 308.33 / 80 = 3.08$ sets. If the system use battery 12 V 80 Ah,

total of battery is 308/80 Ah which equal to 3.85 or at least 4 sets. Battery can be connected in series to increase voltage to 24 V (2 sets) and parallel (2 sets) then battery charger is selected as 24 V.

Stage 7 Solar Panel Calculations

From the previous stage, the solar energy demand for pumping is calculated by equation. Then numbers of Solar Panels about 130 W are derived by equation (13) and (14).

$$E_{solar} = \frac{\rho g V H}{\eta} = \frac{1000 \times 9.81 \times 25 \times 7.44}{0.77 \times 1000} = 2.36 \text{ MJ} = 0.658 \text{ kWh} \quad (13)$$

$$P_{solar} = \frac{E_{solar}}{PSH} = \frac{658}{5} = 131.6 \text{ W} \quad (14)$$

Variable Speed Drive for AC pumping

The objectives of VSD are to control flow rate and also save energy of pump. The most popular technique for VSD is PWM (Pulse Width Modulated) because of this technique has high efficiency and low loss. The VSD can be operated with manual or automatic by using water flow sensor, pressure sensor and other devices. The commercial VSD has high cost, so the VSD invented from IPM and basic IC controller is proposed in this paper. The VSD is appropriate for fluctuation water flow control upon to solar energy, output flow requirements and other effect. The principle of pump and similarity rule about speed, head and power of pump are shown in equation (15). It means that if speed of motor pump decrease, the power is consumed power decrease in triple times of original speed.

$$\text{Discharge } Q_2 = \left(\frac{N_2}{N_1}\right) \times Q_1; \text{ Head } H_2 = \left(\frac{N_2}{N_1}\right)^2 \times H_1; \text{ Shaft power } L_2 = \left(\frac{N_2}{N_1}\right)^3 \times L_1 \quad (15)$$

which N_1, Q_1, H_1, L_1 is original state before using VSD and N_2, Q_2, H_2, L_2 are state after using VSD.

A water flow control of pumping can be operated via motor speed control such as Volt/Hz, Vector Control, Direct Torque Control and etc. The Volt/Hz technique is the simple method to control flow it is appropriate to control flow and low accuracy of pressure head. The VSD for three phase inductor motor pump flow control based on solar energy is composed of power circuit and control circuit as shown in Figure 2. The converter circuit is used to convert DC battery energy to drive three phase AC induction motor which composed of Step up Inverter 24 Vdc/220 Vac, rectifier circuit to convert 220Vac/300 Vdc and Inverter which can control AC output between 0-380 V and frequency 0-50 Hz. The speed of three phase AC induction control is proportion to the frequency of electrical signal as shown in Equation (16). However speed of motor is less than rotation magnetic field which called slip about 1-3% upon load of motor. Where N_s is rotation magnetic field (RPM), f is frequency of three phase electrical signal to motor, P is pole of motor, N_r is motor rotor speed, s is slip. Where N_r is shaft speed of motor rpm, S is ratio of rotor speed and rotation magnetic field.

$$N_s = \frac{120f}{P}; \quad N_r = N_s(1-s); \quad s = \frac{N_s - N_r}{N_s} \quad (16)$$

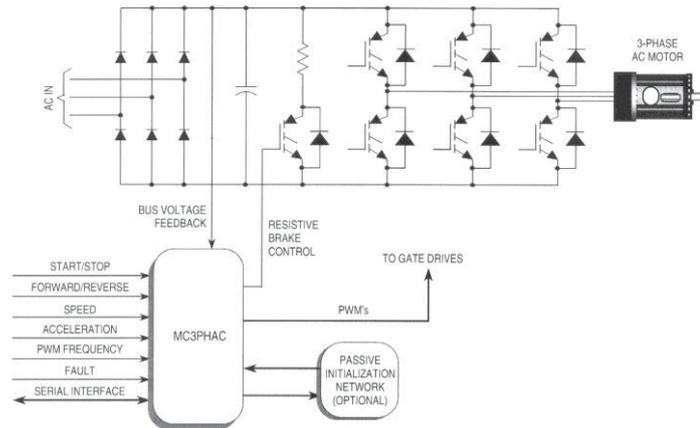


Figure 2 Variable Speed Drive for 3 phase AC motor Control

RESULTS AND DISCUSSION

The solar water pumping system for experimental is setup which composed of PVC piping system in 1 inch., water tank 200 liters, three phase motor pump 370 W which nearest the design rating in commercial type. The solar system are composed of inverter 24 dc/220 Vac 1000 W, battery 12 V 2 x 80 Ah, charger 24 V 30 A and solar panel 300 W. In the experimental, the measurement of water flow rate, AC pump power consumption and solar energy generation are collected and analysis. The two methods of water flow control in (LPM) are studied as valve control and variable speed drive of motor pump. The comparisons of energy consumption of both methods are compared as shown in Figure 3.

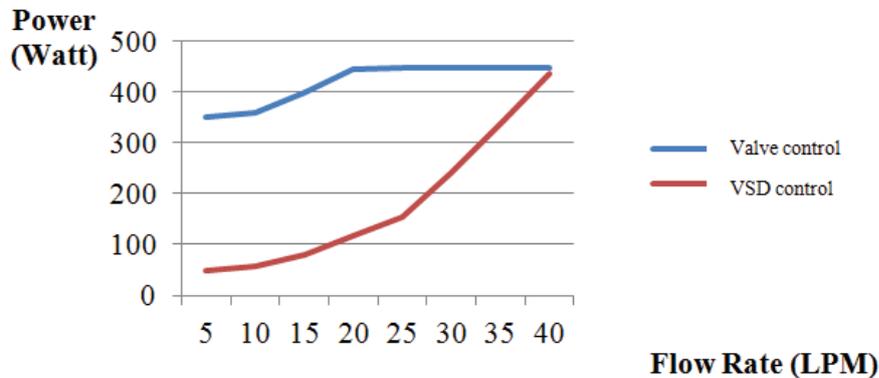


Figure 3 Comparison of water flow control by using valve and VSD

CONCLUSION

In the experimental, two method of water flow rate control such value control and motor pump variable speed drive are compared. The result is found that energy consumption of motor pump variable speed drive is saving more than valve control in the proportional to the water flow rate with according to the pump similar theory. The application of variable speed drive solar pumping system can be used for water irrigation and water supply for cultivation to substitute diesel pump and also electrical pump in the rural area.

ACKNOWLEDGEMENTS

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Drying and smoking Sulfur Process Improving for Water Hyacinth: A Case Study of Communities Ban Sang District, Amphur Muang, Phayao province

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Abstract: The objective of this research was to reduce the time of drying and smoking sulfur processes in Ban Sang District, Phayao Province. The products (dry water hyacinth) from drying machine have to be similar with Ban Sang dry water hyacinth. The control system was automatic system, which can dry and produce sulfur smoke, following Ban Sang requirements. This system uses electronic devices and microcontroller to control temperature and drying time. It was found that the optimal condition drying temperature was at 70-80oC for 4 hours and sulfur smoking at 70oC for 1 hour. The products were dried, with no humidity and similar to the products from Ban Sang process. The weight of dry water hyacinth was 106.67 g, which was close to the dry water hyacinth from Ban Sang process. Time used by the drying and smoking machine was 5 hours compared to Ban Sang process, which took 5 days.

Keywords: Drying, Smoking Sulfur Chamber, Water Hyacinth.

INTRODUCTION

Water Hyacinths can grow very well, as shown in Figure 1. It is available with Thailand environment, so it can overspread in the river. This occurrence lead to water pollutant, problem of irrigation system, fishery, agriculture and water transportation which effect to social and economic system of the country. The community has the idea for water hyacinths changing to products which promote the revenues for housewife audiences and elderly group. The feedback from the user of these products from water hyacinths is very well. Furthermore people in the community (Ban Sang Communities Ban Sang District, Amphur Muang, Phayao province) also present these products to OTOP product. Most of products are the bags and utility things as shown in Figure 2. The researchers are research for the possibility for reduce the production time of water hyacinths treatment. The drying and sulfur smoking process is the process which is improved (time reducing). Generally, water hyacinths have to drying and sulfur smoking before change to products. But, the problem from this process is a lot of time using. If someday has the rain or no sunny, water hyacinth is not dry in time to use. The time of drying and sulfur smoking process is 4-5 days. In addition to, there is the problem of odor from sulfur which use in sulfur smoking process. This odor is interference to nearly neighboring.



Figure 1 water hyacinth which can find in the community

Therefore, the researchers are design and determine the performance of water hyacinths oven. The purpose is “Time reducing of drying or dried in the sun”. This research use the automatic heat control system which can dry water hyacinths as required. The sulfur smoking is uses the electronics devices and microcontroller to control water hyacinth dryer. These can reduce the time, increase the performance and comfort to Ban Sang communities and nearly communities or other province (i.e. Phayao province) which make products weaving from water hyacinths.



Figure 2 Weaving products from water hyacinths.

Objectives of the Research

To design Drying and smoking Sulfur Chamber for Water Hyacinths and technology transferring to Ban Sang communities, Ban Sang district, Amphur Muang, Phayao province. The details are;

1. To study, design, make and test for water hyacinths drying and smoking Sulfur oven.
2. To reduce the drying time, reduce the problem of rain and odor from sulfur.
3. To use as the innovative model which can develops for the communities.

Scope of the Research

1. This research is the designing, making and testing for water hyacinths drying and smoking Sulfur oven.

2. Make and test the water hyacinths drying and smoking Sulfur oven which has the size of 150x110x70 cm.

3. Water hyacinths are bring from the communities and has the size follow to them requires.

4. Drying temperature is in 60-90°C.

MATERIALS AND METHOD

1. Study for problems of drying information and sulfur smoking of Ban sang communities, Ban Sang district, Amphur Muang, Phayao province. And, study for the theory and related research papers.

2. Design and make the water hyacinths drying and smoking Sulfur oven.

2.1 The structure of drying and smoking Sulfur Chamber is follow to;

- The dimension of the cabinet 150 x 110 x 70 cm.

- Inside the cabinet has 3 shelves for

place the materials. The shelves are like net and can remove outside to easy clean and place the materials.

Drying and smoking Sulfur oven are controlled by microcontroller and other devices such as heater, measurer and output display.

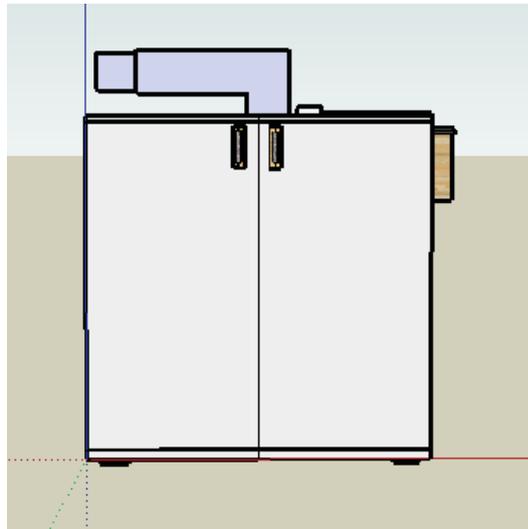


Figure 3 The feature of water hyacinths drying and smoking Sulfur oven

2.2 Smoking sulfur part is connected at the side of the cabinet and let the smoke flow in the cabinet all of drying process. Sulfur smoking temperature is at 100°C. Drawing of drying and smoking Sulfur oven is shown in Figure 4.

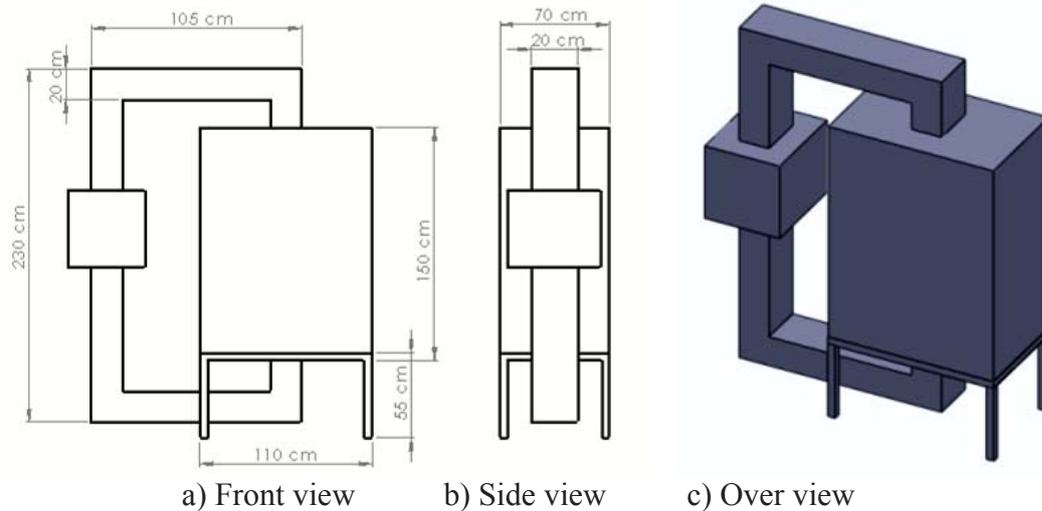


Figure 4 Drawing of drying and smoking Sulfur oven

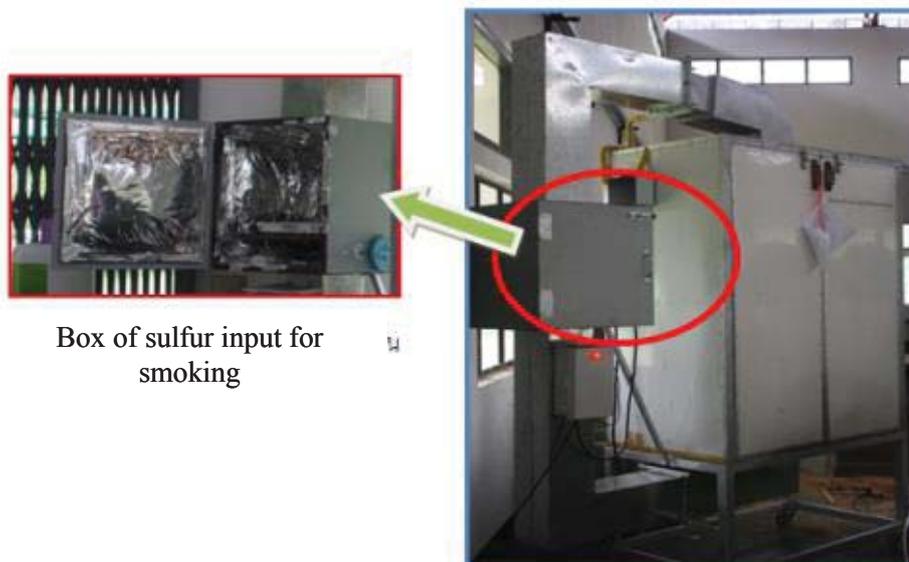


Figure 5 The feature of drying and smoking oven.

3. Install controller set for humidity disposing and sulfur smoking.

4. Experiment and record the drying and sulfur smoking data of water hyacinths from drying and smoking oven. The drying experiments are divided to 2 methods which are; Method 1) Drying at the temperature of 70 -80 °C for 4, 6 and 8 hours. After that, dried water hyacinths are brought to sulfur smoking at 70 °C for 1 hour.

Method 2) Drying and sulfur smoking together at 70-80 °C (moisture drying) and 70 °C (sulfur smoking).

**** Remark :** Moisture drying time with sulfur smoking is select from the best of water hyacinths weight from method 1.

5. Compare the feature and weight of water hyacinths from method 1, method 2 and Ban Sang community’s method.

6. Analysis and conclusion.

7. Preparation of final report.

Table 1 Conclusion problems of drying and smoking from Ban Sang communities

No.	Process	Problem	Correction
1	Drying by sun exposure	Drying in rainy season is use a long time to dry.	Make the oven to dry in rainy season.
2	Sulfur smoking	<ul style="list-style-type: none"> - Smoking in rainy season is operated 2 times. (normally smoking is 1 time) - After sulfur smoking, there are carbons remaining from the process which cannot reuse. Because these carbons has the sulfur odor remain. People have to scrap them in the forest which is effect to the environmental pollution. - During the smoking process, people always cover the pipe by plastic. This plastic prevents the sulfur smoke releasing. Because sulfur smoke is reek. In addition to, more smoke releasing make the color of water hyacinths not real white. 	<ul style="list-style-type: none"> - Make sulfur smoking cabinet to protect the sulfur smoke releasing. - Reduce carbons disposal which has the odor of sulfur remain. - Reduce the smoking time in rainy season.

Study Result of Designing, Making and Testing for Water Hyacinths Drying and Smoking Oven

The designing, making and testing for water hyacinths drying and smoking oven are follow to purpose of people in Ban Sang communities’ require. The researchers are investigation the data of problems of drying and smoking process from Ban Sang communities. The details of drying and smoking process. And, the problems of drying and smoking are shown in Table 1. All of the information from drying and smoking process is analyzed. Then design and make the oven for water hyacinths drying and smoking as shown in Figure 6.

From the investigation result of process and problem of drying and smoking by Ban Sang communities, it found that the using time of water hyacinths drying and smoking take 5 days before weaving. After sulfur smoking, there are carbons remaining and sulfur odor remaining. These carbons cannot reuse. They are brought to scrap in the forest which is effect to the environmental pollution. If it is rainy season, drying and sulfur smoking have to use a long time. So, the researchers are design the drying and sulfur smoking oven for use both drying and smoking together as shown in Figure 6. This oven can reduce the problem of carbon remaining from smoking process and save time in drying process.

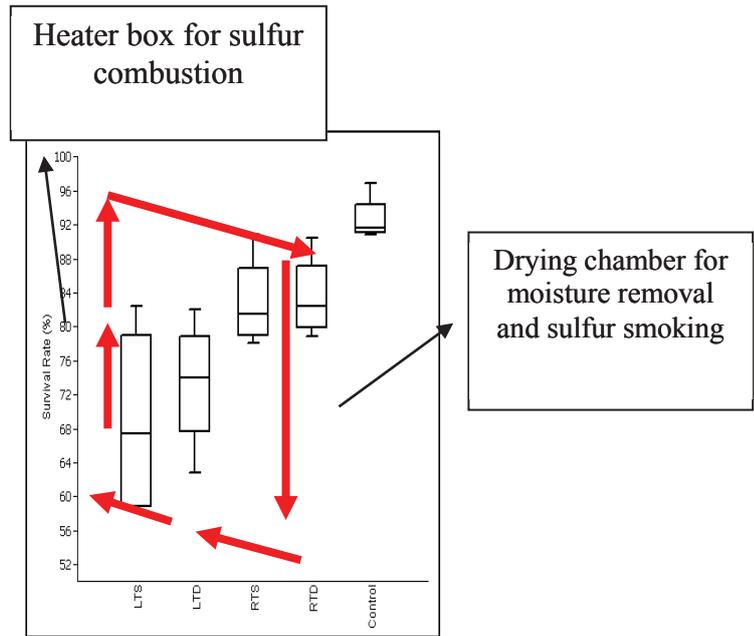


Figure 6 Design of drying and sulfur smoking chamber

The operations of drying and smoking oven are :1)heater is opened for moisture removal, 2) heater for sulfur combustion is opened to combust sulfur into smoke. Sulfur smoke is flow in the oven continuously by exhaust fan. The cycle flow of sulfur smoke is shown by red direction.

Result of Drying Time and Sulfur Odor Reducing of the Process

In the experiment of drying, the researchers have to determine the appropriate temperature for water hyacinths drying at 4, 6 and 8 hours (do not smoking). The temperatures in the experiment are 3 ranges which are 60-70 °C,70-80°C and 80-90 °C. The result of drying is shown in Table 2, 3 and 4.

The researchers design the experiments of drying and sulfur smoking to 2 methods. There are :

Method 1); Drying at 70 -80 °C for 4, 6 and 8 hours. After that, dried water hyacinths bring to sulfur smoking at 70 °C for 1 hour. The result of the experiment is shown in table 6.

Method 2); Drying and sulfur smoking together at 70-80 °C (moisture drying) and 70 °C (sulfur smoking).

The results of method 1 and 2 are compared with method of Ban sang communities’ method by weight and feature of water hyacinths.

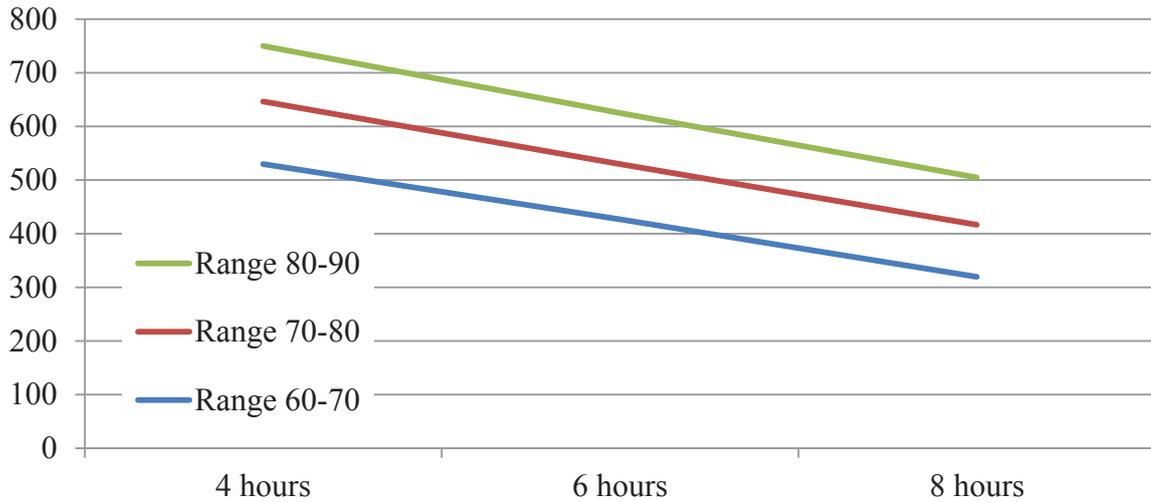


Figure 7 Curve of temperature and weight of water hyacinths drying

CONCLUSION

Study Result of Design, Making and Testing of Drying and Sulfur Smoking Oven.

After the investigation process, the researchers found that there are problems from drying and sulfur smoking process. Process of water hyacinths drying takes approximately 5 days. Sulfur smoking process has carbons remaining and sulfur odor which cannot reuse. These carbons have to scrap in the forest which is effect to the environment. In rainy season, drying and sulfur smoking process takes a long time more than normal condition. Therefore, the researchers are design drying and sulfur smoking oven. Because of, we want to reduce the operation time and disposal problems of carbons remaining. From the experiment, we can reduce the operation time of drying and smoking from 5 days to 5 hours. The products from the process are ready to weave. The optimum condition of this oven is dry for moisture removal for 4 hours and then sulfur smoke for 1 hour.

Study Results of Drying Time and Odor Reduction.

Drying process is moisture removal. Appropriate temperature is at 70 – 80 °C. This temperature, dried water hyacinths no have moisture and not over crispy (as shown in Table 2, 3 and 4). Therefore, this temperature is appropriate for drying and sulfur smoking process. We can conclude the method of drying and sulfur smoking into 2 ways. There are:

2.1 Drying and sulfur smoking follow to method 1. From the result, we found that water hyacinths which dry at 70°C for 4 hours before sulfur smoking at for 1 hour are 106.67 grams. At the condition of 70°C for 6 hours before sulfur smoking at for 1 hour are 93.3 grams. And, at the condition of 70°C for 8 hours before sulfur smoking at for 1 hour are 86.67 grams. The color of dried water hyacinths is white as same as Ban Sang’s dried. So, the best condition of drying is 4 hours before sulfur smoking for 1 hour. Because of this condition give nearly weight of dried water hyacinth with Ban Sang’s (110 grams).

2.2 Drying and sulfur smoking follow to method 2. From the result, we found that water hyacinth which dry at 70-80 °C for 4 hours are 116.67 grams. At the condition of 70-80 °C for 6 hours are 103.33 grams. And, at the condition of 70-80 °C for 8 hours are 96.67 grams. The color of dried water hyacinths at 4, 6 and 8 hours is not white, but it is yellow-white. This color is not the same to Ban Sang’s. Because of, during drying and smoking,

there is water evaporation. Some sulfur smoke is absorbed by vapor of water. So, water hyacinths absorb a few sulfur smokes which lead to color is not white.

Discussion of The Experiment Results

As the results, we found that method 1 (drying at first and then sulfur smoking) is better than method 2 (drying and sulfur smoking together). The best condition of drying is 70 – 80°C for 4 hours and sulfur smoking at 70°C for 1 hour. Drying and sulfur smoking oven can reduce drying time and sulfur smoking. In the previous, people have to dry (sun exposure) for 3-4 days and sulfur smoke for 1 day. But, this oven can reduce the operation time to 5 hours only. There is no odor of sulfur release during the process. Therefore, people can use to treatment water hyacinth before weaving. And, reducing time can lead them produce the product faster.

Table 2 Water hyacinths weight which dry at the temperature of 60-70 °C at 4, 6 and 8 hours.

Time	No.	1	2	3	Average	Remark
4 hours		520 grams	530 grams	540 grams	530.00 grams	has moisture
6 hours		410 grams	440 grams	430 grams	426.67 grams	has moisture
8 hours		320 grams	330 grams	310 grams	320.00 grams	has moisture

(Remark : weight of raw water hyacinths before dry is 1,000 grams)

Table 3 Water hyacinths weight which dry at the temperature of 70-80 °C at 4, 6 and 8 hours.

Time	No.	1	2	3	Average	Remark
4 hours		120 grams	110grams	120grams	116.67grams	no moisture
6 hours		100 grams	110grams	100grams	103.33grams	no moisture
8 hours		100 grams	90 grams	100grams	96.67 grams	no moisture

(Remark : weight of raw water hyacinths before dry is 1,000 grams)

Table 4 Water hyacinths weight which dry at the temperature of 80-90 °C at 4, 6 and 8 hours.

Time	No.	1	2	3	Average	Remark
4 hours		100 grams	110grams	100grams	103.33grams	dry and crispy
6 hours		100 grams	90 grams	95grams	95.00grams	dry and crispy
8 hours		95 grams	90 grams	80grams	88.33grams	dry and crispy

(Remark : weight of raw water hyacinths before dry is 1,000 grams)

From table 3, 4 and 5, we can draw a graph for weight of water hyacinths comparing and drying time. The temperatures are 3 ranges which are 60-70°C, 70-80°C and 80-90°C.

Suggestion

1. The oven should reduce to smaller which is easy to move.
2. The device of oven should make from stainless steel. Because of, zinc can be rusty than stainless when use in a long time. In addition to, lifetime of zinc is shorter than stainless.
3. This research should be approach to the communities.

ACKNOWLEDGEMENTS

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A Review of Refuse Derived Fuel

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Abstract: Nowadays, various technologies for eliminating garbage and producing waste products have been improved. One of the well-known waste products is Refuse Derived Fuel (RDF). It is an alternative fuel replacing other commercial ones such as coal, diesel and fuel oil. The use of RDFs reduces amount of waste that dispersed to the environment. The RDFs are produced as either briquette or pellet for usage in household and industry. Several parameters are concerned in producing the RDFs, and providing acceptable physical and mechanical properties that are advantages for usage and storage. This paper presented the processing technology for RDF production. Details of briquetting or pelletizing technique including the empirical processing model were discussed. Several processing parameters were summed up, i.e. processing temperature and pressure, moisture content, and the ratio of mixture between waste and binder agent. The properties of RDFs for each processing parameters were explained. These properties were chemical composition, calorific value, mechanical strength, bulk density, durability of briquette form, and combustion characteristic. Types of binder agent resulted in the properties of the RDFs were explained. Economic analysis to energy efficiency of each processing parameters was also presented. This review paper was a basis for selecting an appropriate method to produce the RDF.

INTRODUCTION

There is a large amount of solid waste disposing to the environment. Its quantity is increased every year. Several methods of eliminating the waste and recovering energy have been studied. The well-known technique is to produce a high quality fuel called “RDF”. Solid waste disposal, i.e., plastic waste and agriculture waste, are transformed into cubette, briquette, and pellet by densification. Physical and chemical properties of the waste are improved. For example, RDF has high calorific value comparing with other commercial fuels such as coal and natural gas. Moreover, its durability and strength makes advantages over handling, storage, usage, and cost reduction of transportation. The densified RDF is specified by ASTM standard in class 5 or RDF-5.

RDF is ongoing study for quality improvement to meet European (EU) standard [1]. Its qualities depend on processing parameters and fuel composition. These are binding agent, composition materials, densification pressure, processing temperature, moisture content, percent of binding agent, type of equipment, and particle size.

This paper reviews in-depth details of briquetting or pelletizing technique. The empirical processing model is also included. Several processing parameters are summed up. Properties of the RDFs affected by several processing parameters are explained. In addition, it is a basis for selecting the appropriate method to produce RDF from plastic waste and biomass.

DEFINITION AND CLASSIFICATION OF RDF

Definition of RDF

RDF or densified fuel is the dense of plastic and waste such as plastic waste, textile, wood, soil, etc. [2, 4]. ASTM [5] states that RDF is energy recovery sources from shredding municipal solid waste (MSW) which is removed for non-combustible materials (metal glass). The majority components of RDF usually consist of plastics and biodegradable waste. Gendebien et al. [6] defined RDF as the high calorific fraction of derived MSW. The other terms of MSW derived fuel are REcovered Fuel (REF), Packaging Derived Fuel (PDF), Paper and Plastic Fraction (PPF), and Processed Engineered Fuel (PEF).

Classification of RDF

RDF can be classified into 7 categories as shown details in Table 1. As seen in the table, the class of RDF is defined by processing method, form of RDF, material compositions, and mesh size of RDF. It can be found that raw of MSW is classified as RDF-1. Transformed MSW are classified as RDF-2 to RDF-7. RDF-2, RDF-3, and RDF-4 are in square shape which RDF-4 is in powdered form with the size of 0.035 in. or 0.889 mm. Pellet and similar forms of RDF is RDF-5. RDF-6 and RDF-7 are liquid fuel and gaseous, respectively.

Table 1 Categories of RDF by ASTM [5]

Class	Form	Description	Mesh size
RDF-1	Raw (MSW)	MSW fuel as discarded form.	N.A.
RDF-2	Coarse (c-RDF)	Coarse particle size of MSW processed with or without ferrous metal separation such that 95% by weight	6 in. (square shape)
RDF-3	Fluff (f-RDF)	Shredded fuel derived from MSW processed for the removal of metal glass and inorganic materials. The particle size of this shredded material is such that 95% by weight	2 in. (square shape)
RDF-4	Powder (p-RDF)	Combustible waste processed into powdered form	0.035 in. (square shape)
RDF-5	Densified (d – RDF)	Combustible waste densified (compressed) into pellets, slugs, cubettes, briquettes, or similar forms.	N.A.
RDF-6	Liquid	Combustible waste processed into liquid fuel.	N.A.
RDF-7	Gas	Combustible waste processed into gaseous	N.A.

Quality Standard of RDF

RDF can be used as a commercial fuel. Therefore, there is the EU standard for many countries. Table 2 presents the qualify properties of RDF that are designed for European and other countries. It is notice that the standard requires the important properties of RDF which are calorific value, moisture content, remaining ash, and matter contaminate.

Table 2 Quality standard by Australia, Sweden, German and European country.

Property	RDF quality of each country					
	Australia	Sweden	German	European country		
				Class A1	Class A2	Class B
Calorific value (MJ/kg)	≥ 18.0	≥ 16.9	17.5 – 19.5	16.5 – 19.0	16.3 – 19.0	16.0 - 19.0
Moisture (%)	≤ 10	≤ 10	≤ 12	≤ 10	≤ 10	≤ 10
Ash (%)	≤ 0.5	≤ 0.7	≤ 1.5	≤ 0.7	≤ 1.5	≤ 3.5
Chlorine-Cl (%)	≤ 0.02	≤ 0.03	≤ 0.03	≤ 0.02	≤ 0.02	≤ 0.03
Sulfur-S (%)	≤ 0.04	≤ 0.08	≤ 0.08	≤ 0.03	≤ 0.03	≤ 0.04
Lead-Pb (mg/kg)	N.A.	N.A.	≤ 10	≤ 10	≤ 10	≤ 10
Chromium-Cr (mg/kg)	N.A.	N.A.	≤ 8	≤ 10	≤ 10	≤ 10
Copper-Cu (mg/kg)	N.A.	N.A.	≤ 5	≤ 10	≤ 10	≤ 10
Nikel-Ni (mg/kg)	N.A.	N.A.	N.A.	≤ 10	≤ 10	≤ 10
Arsenic-As (mg/kg)	N.A.	N.A.	≤ 0.8	≤ 1	≤ 1	≤ 1
Mercury-Hg (mg/kg)	N.A.	N.A.	≤ 0.05	≤ 0.1	≤ 0.1	≤ 0.1
Cadmium-Cd (mg/kg)	N.A.	N.A.	≤ 0.5	≤ 0.5	≤ 0.5	≤ 0.5
Zinc-Zn (mg/kg)	N.A.	N.A.	≤ 100	≤ 100	≤ 100	≤ 100

Source: ObernbergerIngwald and ThekGerold, The Pellet Handbook, and The production and thermal utilization of biomass pellets 2010.

FUNDEMENTAL OF DENSIFICATON AND COMPACATION MODEL

Basic of compaction or densification of RDF can be divided into three types depending on the processing pressure, that are high pressure compaction, medium pressure compaction with heating device, and low pressure compaction with binder. Strength of compacted RDF is caused by binding mechanism as shown in Figure 1. Material compositions are fixed together with molecular forces, attractive forces between solid particles, and interlocking. Typical compaction process is shown in Figure 2. In the first stage of compression, particles are preheated, and then they rearrange themselves to form closely packed mass. During this stage, energy caused by wall friction between inter-particle and particle is dissipated. At high pressure, particles are forced against each other and deformed to elastic and plastic matters. This lets to increase the each other inter-particle contact.

The relation of densification factors of the selected compaction process can be determined by testing. The parameters, such as pressure, moisture content, and density, can be related by using empirical formulation. The empirical models from previous researches are shown in Table 3.

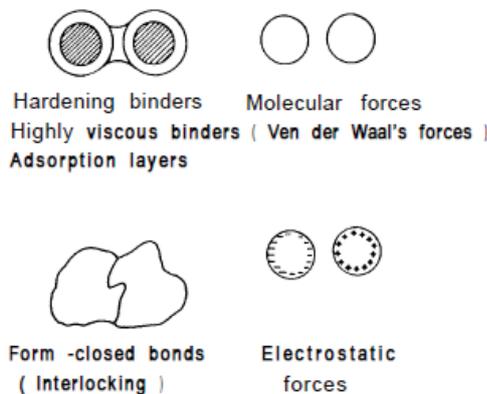


Figure 1 Binding mechanism. [8]

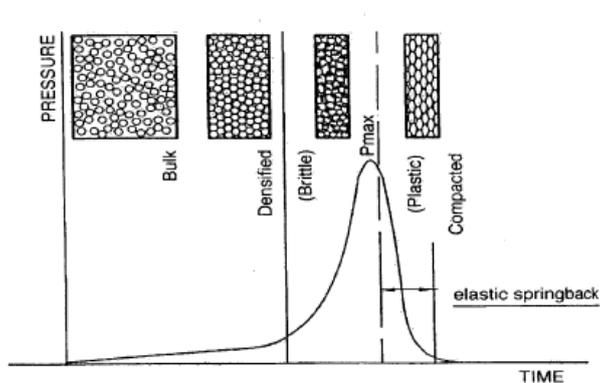


Figure 2 Typical compaction process. [9]

Constitutive model can be used to simulate the compaction process. The model is based on rheological phenomena that explain the behavior of material deformation during compression. Under processing, composition of RDF can change into three phases which are

elastic, plastic and viscous. Typically for compression processes, the constitutive equation shows the relations of stress, strain and temperature. Various model of micro- and macro-structure can be used to construct the relation. Maxwell viscoelastic fluid is the commonly used model that can explain material behavior correctly. Constitutive models from previous researches are summarized in Table 4.

Table 3 Empirical models of compaction processes. [9]

Author	Equation	Relation
Heckel	$\ln \frac{1}{1 - \rho_f} = mP + b$	Pressure and density
Kawakita	$\frac{P}{C} = \frac{1}{ab} + \frac{P}{a}, C = \frac{V_0 - V}{V_0}$	Pressure and volume
Jones	$\ln \rho = m \ln P + b$	Pressure and density

Table 4 Constitutive models of compaction processes. [10]

Author	Equation	Relation
Kaliyan	$\sigma = E\varepsilon + R\varepsilon^n + \eta \frac{d\varepsilon}{dt} + \sigma_f$	Stress, strain, coulomb friction and modulus
Peleg	$s = Ee + Re^n + h \frac{de}{dt} + s_f$	Stress, strain, coulomb friction and modulus
Suched	$\varepsilon^R = \frac{R}{E_R} \left\{ E_\alpha t + E_\rho \left[\frac{\left(1 + \frac{t}{\rho}\right)^{1-m} - 1}{1 - m} \right] \right\}$	Stress, strain, time and modulus

FACTOR AFFECTING TO RDF

Many factors have influenced the RDF quality and properties. The properties of RDF are mechanical strength, calorific value, density, durability of briquette, and characteristic of combustion. The most mentioned factors are as follows:

Type of Binding Agent

Natural binding agent

Natural binding agents found in previous researches are biomass, organic substances and inorganic substances. Biomass binding agent consists of starch, protein, fiber, cellulose and hemicellulose, fat, lignin, and extractives [10]. Organic and inorganic substances are asphalt, sawdust, shell of sunflower seed, cassava starch, tar, clay, gum, molasses, starch solution, paraffin, glue, organic oil waste, limestone, etc. [11, 12]. Strength and durability of RDF can be improved by adding a binding agent. This makes the material particles of the RDF tighten together to form a briquette. RDF with high compressive strength are easily to pile up and transport without damage [13, 14].

Chemical binding agent

Chemical binding agent improves combustion property and durability of RDF. The agents found in previous researches are calcium oxide (CaO), calcium hydroxide (Ca(OH)₂), calcined dolomite (CaO.MgO), and calcium lignosulfonate [15, 16]. It reacts with chlorine to

form ash, e.g. CaCl_2 , MgCl_2 and CaCl_2 [17, 18]. For example, reaction of calcium hydroxide is shown as follows:



Type of Material

Materials that rich of cellulose can improve the durability, combustion property and ash volume [9].

Pressure of Densification

High pressure can increase density and mechanical properties such as scatter index and water resistance [19].

Moisture Content

High moisture content can increase strength and density. Meanwhile, it can decrease calorific value of RDF [20].

Ratio of Material and Binding Agent

The appropriate binding agent is more than 10%. Ratio of material and binding agent effects mechanical strength of RDF [12, 21].

Type of Equipment

Densification equipment can divide into 4 types which are piston press, screw press, roll press and pellet mill. Density and strength of RDF are upon to equipment. The density obtained from piston press, screw press, roll press and pellet mill are $0.9\text{-}1.3 \text{ g/cm}^3$, $1\text{-}1.4 \text{ g/cm}^3$, $0.45\text{-}0.55 \text{ g/cm}^3$ and $1.1\text{-}1.9 \text{ g/cm}^3$, respectively [22, 23].

Particle Size

Small particle size tends to have more density and durability than large size. The reason is that small particle size has higher contacting area than that of the large one [9].

Preheating Temperature

Preheating of feed material can help easier compression. The reason is that it takes fewer loads and makes soften natural binder during compaction process. Appropriate temperature is in range of glass temperature of lignin [10].

CONCLUSION

RDF is an alternative fuel produced from waste. Usage of RDF as fuel is the other way to recover energy and reduce disposal waste. Combustion property of this fuel has been improved that it can be used as a commercial fuel. According to EU standard, their important properties are calorific value, durability, density, and moisture content. Many factors are related to RDF production. These are equipment, production factors such as temperature and pressure, material factors such as moisture and particle size, and material composition such as starch, protein, fat, fiber, lignin and extractives.

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Microencapsulation of Functional Extract from *Saussurea lappa* by Spay Drying using Maltodextrin/Pectin Matrix

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Abstract: Dried plant-extract of *Saussurea lappa* exhibited good antimicrobial and excellent antioxidant properties. However, the plant-extract was sticky and has low-water-soluble materials with a penetrating smell. In this research, the plant-extract encapsulation by spray-drying in a maltodextrin/pectin based matrix was investigated. Physicochemical characteristics and antioxidant properties of the microencapsulation powders were examined and compared with unprocessed extract.

Keywords: *Saussurea lappa*, Spray-drying, Maltodextrin/pectin matrix, Microencapsulation

INTRODUCTION

Saussurea lappa has long been known as traditional herbal medicine in Thailand and Asian countries. Many studies on the extracts of this herbal plant reported in usage for inflammations, rheumatism and asthma [1-3]. The constituents of *S.lappa* have been identified sesquiterpene lactones and sesquiterpenoids [4, 5]. Extracts of *Saussurea lappa* are attractive raw materials for the food and nutraceutical industry. The advantages of using the natural antibacterial agents, when compared to other synthetic chemicals, and they are cheaper, non-toxic to human and easily found in local herbal plants [7]. Our previous works reported the successful use of extracts as antibacterial agents in biopolymer film [6]. However, the poor solubility and unpleasant taste/smell are main difficulties for industrial usage [8]. In addition, oxidation and degradation/releasing of its constituents may occur to reduce the content of antioxidants, phenolic and bioactive compounds during the storage period [9].

Spray-drying is a microencapsulation technique appropriate for sensitive components [10]. The selection of encapsulant agents was depend on their good solubility, interfacial functionality and low viscosity at high solid content [11]. In this present study, maltodextrins and pectin have been used as a carrier for encapsulation. Maltodextrins are soluble modified starch derivatives currently used in process of food and drug for bioactive compounds, plant extracts, vitamins and additives [12, 13]. Pectin is a heterogeneous polysaccharide of structural component in the cell wall used as natural dietary fibre in food applications [14]. The combination of maltodextrins and pectin matrix loaded with the *S. lappa* extracts was investigated. Physicochemical characteristics of the microencapsulation powders were determined and compared to unprocessed extract.

MATERIALS AND METHODS

Chemicals

Maltodextrins (DE dextran equivalents 20, Amycol No.1) was supplied by Nichiden Kagaku Co. Ltd (Japan). Pectin was supplied by Sigma Aldrich (Milan, Italy).

Plant Material Preparation

Rhizomes of *Saussurea lappa* were purchased from Thai traditional herb shop located in Bangkok, Thailand. The rhizomes were washed by distilled water, dried at 50 °C for 24 h and ground into fine powder. The extracts were obtained by homogenizing the dried powder in ethanol keeping the fraction to solvent ratio of 1:10. Extraction was carried out on an orbital shaker for 24 h at room temperatures. The extracts were filtered through Whatman filter paper IV and the supernatant was evaporated in a rotary evaporator. The weight of solid remains after evaporation completed was recorded to calculate a yield of extraction. The extract was stored at 4 °C before use.

Spray-Dried Powder Preparation

The extract (3 g) was suspended in 100 ml warm water by magnetic stirring. The carrier composed of the mixture of 10% w/w maltodextrin and 1% pectin was then added to the extract solution with constant stirring at room temperature for 15 min. The suspension was spray dried with a Buchi mini spray dryer B-190 apparatus (Buchi, Switzerland) under the following conditions: inlet temperature, 120 °C; outlet temperature, 70 °C; air flow rate of 10.7 kg/h; feeding rate of the suspension, 7.5 ml/min. The final extract content of the solid was 3% w/w ratio and final liquid feed concentration was 14% w/v.

Scanning Electron Microscopy

Scanning electron microscope (SEM) (JSM-6301F, Jeol Ltd., Tokyo, Japan) was used to study the morphological images of the spray-dried powders. Powder particles were attached to the SEM stubs of 1" diameter using a two-sided adhesive tape. The samples were then sputter coated with gold and examined at 3500× magnifications. An acceleration potential of 10 kV was used during micrograph.

Moisture Content

The moisture content of the samples was measured by hot air oven at 105°C for 16 h.

Water Solubility

The water solubility of spray dried powders was determined according to Singh and Singh [15]. The powder (0.1 g) was suspended in 10 ml water by magnetic stirring at room temperature for 30 min. The samples were centrifuged for 15 min at 3,000 g. and 2-ml aliquot of the supernatant was transferred to a previously weighed Petri dish. The solids concentration was determined by the oven drying at 110 °C for overnight.

Release Capacity

The powder samples (250 mg) were suspended in 1000 ml distilled water by magnetic stirring at 25 °C. The amount of the extracts dissolved was determined as percentage of total phenolic content.

Stability

Physicochemical stability was performed according to the ICH guide lines [16]. The powder samples were kept in a stability chamber at 40 °C and 75% Relative Humidity (RH %). The total phenolic content in the powder was determined by the method of Singleton and Rossi [17].

RESULTS AND DISCUSSION

Saussurea lappa has rich in organic acids and phenolic compounds. These compounds exhibit good antioxidant properties. The percentage of extract yield was 10.44 and total phenolic compounds in the ethanol extract was 99.43 ± 1.04 mg/g dried extract. As the melting point of active phenolic compounds in *S. lappa* are in a range of temperatures between 130 °C and 250 °C [18], the microencapsulation technique was used to produce stable microencapsulated powders. The combination of maltodextrin and pectin were selected to provide a good physical protection to the *S. lappa* extract. Maltodextrins serves as a matrix forming material, whereas pectin acts as coating agent.

Characteristics of Spray-Dried Powders

In the present work, the 10% maltodextrin was used in order to avoid cake formation and agglomerations of powder and make good semipermeable layer of internal compounds during drying process [19, 20]. The 1 % pectin was selected to produce well-formed and completely coated microparticles [21]. Characteristics of the *S. lappa* extract-MP powders were shown in Table 1. The actual total phenolic content in the powders was 16.72 mg/g powder. The low concentration of phenolic compounds was caused by major loss of volatile active compounds during spray drying. Moisture content was 4.29 %. The powder sample was showed high water solubility.

Table 1 Characteristics of the *S. lappa* extract-MP powders

	Value
Total phenolic content (mg/g powder)	6.72 ± 0.32
Moisture content (%)	4.29 ± 0.05
Water solubility (%)	99.5

Release of the Extract

When the powder samples were test, spray-dried powders provided the high dissolution rate of the *S. lappa* extracts in water. About 99.5% of the extract was dissolved from the powders in 10 min (Table 2). The interaction between the microparticles and water was enhanced by the large total surface of amorphous powders to water, hydrophilic nature of pectin high water solubility property of maltodextrins [22, 23].

Table 2. Release of the *S. lappa* extracts from the Spray dried powders

Time (h)	% Release of phenolic content
0	0
2	71.4
5	87.2
7	93.8
10	99.5
20	100
30	100

Stability

As the extracts from *S. lappa* was rich in phenolic compounds easily interact with oxygen and moisture in the environment for process of oxidation and degradation, the stability property of the powder was examined. About 90.9 % of phenolic content were remained in the powders, whereas the loss of phenolic content in the unprocessed extract was 13.75% after 60 day of storage (Table 3).

Table 3 Total phenolic content of the unprocessed extract and the extract-MP powders

Total phenolic content	Unprocessed	spray-dried powders
D=0 day	6.72 ± 0.32 (mg/g powder)	99.43 (mg/g extract)
D=60 day	6.11 ± 0.12 (mg/g powder)	86.25 (mg/g extract)

SEM Image Analysis

Spray-dried powders prepared from maltodextrin and pectin were observed for granular structure using SEM (Figure 1.) The SEM micrograph of the *S. lappa* extract-MP powders showed spherical in shape of microparticles and with extensive dented surface. They had granules size ranging from <3 to 8 µm. Formation of extensive dented surfaces of particles may be caused by the shrinkage of starch granules in drying processes.

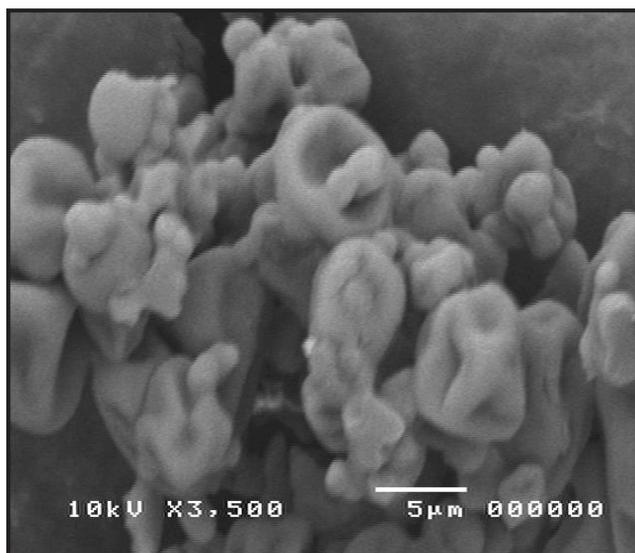


Figure 1 SME (3500×) of spray-dried powders of the *S. lappa* extract in maltodextrin/pectin

CONCLUSION

The results of this present study indicate that maltodextrin/pectin matrix has ability to carry the phenolic compound-rich extracts of *Saussurea lappa* by spray-drying process. The Spray dried powders are suitable to preserve the active agent of the *S. lappa* extract for storage. The powders are rapidly soluble to release the active compounds in the short duration time. The poor solubility and unpleasant taste/smell of the plant extract are improved. However, the low content of total phenolic content was observed in the powder product. Optimization of process parameter will be considered in future studies.

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Production of Acetone-Butanol-Ethanol from Cassava Rhizome Hydrolysate by *Clostridium acetobutylicum* 824

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Abstract: The aim of this work was to demonstrate the feasibility of using cassava rhizome hydrolysate as a carbon source for acetone, butanol and ethanol (ABE) fermentation by *Clostridium acetobutylicum* 824 in batch culture. The effects of reducing sugar concentrations on the solvent production were investigated in the range of 40~80 g/L as well as the effects of different pH : pH 4.5-6.5. It was shown that *C. acetobutylicum* 824 provided solvent production efficiently from cassava rhizome hydrolysate, comparable to that from glucose used. The batch experiment with uncontrolled pH of cassava rhizome hydrolysate resulted in 11.65 g/L of total solvents as compared with 14.76 g/L of total solvents when glucose was used. Within the range of reducing sugar concentration investigated, the highest total solvents production (14.81 g/L) was obtained at 60 g/L initial reducing sugar concentration. It was also found that the highest solvent production (15.92 g/L) was obtained with a controlled pH 5.2.

Keywords: *Clostridium acetobutylicum* 824, Cassava rhizome hydrolysate, Acetone Butanol and Ethanol (ABE), Batch culture

INTRODUCTION

Depletion of fossil fuels and the related environmental issues are driving the need for the alternative energy. Many researches have been intensified towards production of alternative fuels by fermentation in accordance with the increase of gasoline price and the decrease of fuel reservation in foreign countries. Acetone-butanol-ethanol (ABE) fermentation has been proposed as one of the most promising ways of transforming the unused natural biomass to the more valuable chemical compounds [1]. In the past, molasses and grain are the two major substrates that have long been industrially utilized so far [2]. While Cassava (*Manihotesculenta*) is the main carbohydrate source for human consumption [3], Thailand is now the one of the most prominent exporters of that cassava starch [4]. Unfortunately, the cassava wastes such as the stem and rhizome parts are always kept aside on the field. However, Cassava rhizome, containing high content of cellulose, can be hydrolyzed to simple sugars. Therefore, this property explicitly allows this kind of waste as the most suitable feedstock for fermentation. Butanol is an industrial solvent that can be generated using renewable resources as starting material by various microorganisms including *Clostridium acetobutylicum* [5]. It is known with cost of the ABE fermentative process can raise the end product price by up to 40%, thus the selection of a convenient procedure together with the minimization of the cost of the cultivation medium preparation is of key importance. *Cl.*

Acetobutylicum was found in many studies that it usually uses a great variety of sugars [6]. However, there is no study on butanol production from Cassava rhizome. Therefore, objectives of this study were to investigate *C. acetobutylicum* ATCC 824 for its potential to convert sugar content in Cassava rhizome to ABE in terms of concentration of total solvent production, butanol yield and solvent yield using batch fermentation. In order to maximize the utilization of Cassava rhizome, this present work has been conducted using the enzymatic hydrolysis for reducing sugar production. Moreover, the effect of reducing sugar concentration and pH on growth and ABE production by *C. acetobutylicum* ATCC 824 was also examined.

MATERIALS AND METHODS

Microorganisms and Culture Maintenance

C. acetobutylicum ATCC 824 was routinely maintained by growth on Reinforced Clostridia Media at 35°C for 5 days followed by storage at 4°C. The inoculum was heat shocked for 10 min at 80 °C, followed by cooling in ice. The heat shocked spores were then inoculated into 10 mL tryptone glucose–yeast extract (TGY) medium and incubated anaerobically for 12–14 h at 35 °C. Cells were grown anaerobically before they were transferred into cassava rhizome hydrolysate medium. Inoculum was conducted in a 500 ml anaerobic flask containing 100 ml medium on a reciprocal shaker at 10 cycles per minute.

Pretreatment and Hydrolysis of Cassava Rhizome

Cassava rhizome was oven-dried and cut to 50 mesh size by using Wiley Mill. The plant powder was treated with 4% (w/v) NaOH solution at 100 °C for 30 min. After filtration, the residue was washed by tap water until the solution remains at pH 7. Then, the sample was dried and cut to 80 mesh size by pulverizer. After that, the treated cassava rhizome in 0.05M citrate buffer containing enzymes was placed in 1L Erlenmeyer flask. The enzyme sources were NOVO Cellulast 200L, a commercial preparation of cellulase from *Trichoderma reesei* and cellobiase from *Aspergillus niger*, NOVOZYME 188. Filter paper activity unit of cellulase to cellobiose unit was 20:20 (or 30:30) per gram of treated Cassava rhizome. The hydrolysis was carried out in incubator at 50 °C and pH 4.8 for 48 h. Cassava rhizome concentration was 16% (w/v) for producing reducing sugar content of around 72.8 g/l. After hydrolysis, the solid residue was separated by filtration through a thin layer cloth. The pH of hydrolysate was adjusted to pH 7.0 with 0.1 N NaOH. The reducing sugar present in the hydrolysate was analyzed.

Fermentation

Cassava rhizome hydrolysate was used throughout these studies. One liter of medium was supplemented with K₂HPO₄ (0.5 g), KH₂PO₄ (0.5 g), MgSO₄·7H₂O (0.2 g), FeSO₄·7H₂O (0.01 g), MnSO₄·3H₂O (0.01 g), NaCl (0.01 g) and yeast extract (6 g). The pH was adjusted to 8.0 prior to sterilization. Prior to inoculation, nitrogen was bubbled through media for 10 min. All experiments were carried out with the following parameters: temperature = 35 °C, initial reducing sugar concentration = 40-80 g/l and initial pH = 4.5, 5.5, 6.5 and uncontrolled pH.

The Fermentation studies were carried out in 4L laboratory fermenter (Mituwa, KMJ 2-3, Japan) containing reducing sugar content in hydrolysate. The medium and fermenter were autoclaved separately, combined while hot, then stripped of oxygen by sparging with nitrogen until cool. The fermenter was inoculated with 200 ml. of an 48 h old flask culture of

the same medium. The temperature examined was 30°C. In the controlling pH fermentation, the pH was 4.5, 5.5 and 6.5. During pH-controlled experiments, the pH was automatically controlled by adding of 2 M NH₄OH. In uncontrolled pH fermentation, the initial pH was 6.5. In each experiment, agitation was maintained at approximately 50 rpm.

Analytical Methods

The reducing sugar content was analyzed by the 3, 5-dinitrosalicylic acid (DNS) method [7]. Glucose was assayed by Glucose Analyzer (YSI model 27). The cellulose content was measured by a modified TAPPI method [8]. Lignin was measured by Klason-lignin technique [9]. The total carbohydrate was determined by the phenol-sulphuric acid method [10]. The hemicellulose fraction was taken as the difference between total carbohydrates and cellulose fractions. Filter paper activity and cellobiase activity were determined according to Mandels et al. (1976) [11]. One unit (U) of enzyme activity was defined as the amount of enzyme that liberated one micromole of substrate per minute under the assay conditions. Solvent and acids were analyzed by gas chromatography (Shimadzu model GC 7 AG). Cell concentration was estimated by optical density using a predetermined correlation between optical density at 540 nm wavelength and cell dry weight. ABE yield or butanol yield was calculated as g of ABE or butanol produced per g of sugar utilized and is expressed in g/g.

RESULTS AND DISCUSSION

Chemical Composition of Cassava Materials

The composition of the Cassava rhizome used in this study was presented in Table 1. In comparison with the cellulose content in cassava materials, it revealed that the higher cellulose content was obtained in treated material which related to the lower hemicellulose and lignin content when compared to control material.

Effect of Initial Reducing Sugar Concentration

The batch fermentations were carried out to evaluate the ability of *C. acetobutylicum* ATCC 824 to ferment sugars present in the Cassava rhizome hydrolysate at different concentration (40 g/l, 60 g/l and 80 g/l). The fermentation condition was performed at 30°C and uncontrolled pH. The result was shown in Table 2. It can be seen that *C. acetobutylicum* ATCC 824 produced maximum ABE concentration at initial sugar concentration of 60 g/l. The culture produced 10.76 g/l ABE of which acetone, butanol, and ethanol were 3.9857, 6.5674 and 0.2064 g/L, respectively. At lower sugar concentration, the culture provided 7.9043 g/l ABE during the 30 h fermentation. The percentage of sugar utilization was 38.4. At higher sugar concentration (80 g/l), the culture produced lower solvent yields. The percentage of sugar utilization was 49.2. The residual sugar at the end of fermentation was 30.8 g/l.

Table 1 Comparison of main components of cassava rhizome(% w/w)

Treatment	Cellulose (%)	Hemicellulose (%)	Lignin (%)
Control	81.67±0.02	12.53±0.13	5.80±0.34
4% (w/v) NaOH, 100 °C , 30 min	97.02±0.17	1.16±0.08	1.82±0.06

Values represent the mean of triplicate experiment ± SD between samples.

Table 2 Solvent production and sugar utilization for the Acetone-Butanol-Ethanol fermentation in Cassava rhizome hydrolysate media containing different initial concentrations of reducing sugar.

	Reducing sugar		
	40 g/L	60 g/L	80 g/L
Fermentation time (h) ^a	65	65	65
Acetone (g l ⁻¹)	2.167	3.9857	1.958
Butanol (g l ⁻¹)	5.549	6.5674	4.236
Ethanol (g l ⁻¹)	0.1883	0.2064	0.942
Total solvent (g l ⁻¹)	7.9043	10.76	7.136
Acetate (g l ⁻¹)	0.6413	0.316	0.493
Butyrate (g l ⁻¹)	0.8938	0.977	0.827
Sugar utilized (g l ⁻¹)	38.4	54.2	49.2
Butanol yield ^b	0.1445	0.1212	0.0861
Solvent yield ^b	0.2058	0.1985	0.1450

^aFermentation time at which the highest butanol concentration was recorded and all other values were determined

^bYield was determined by dividing grams of butanol or total solvent produced by grams of glucose utilized

Effect of pH

Controlling pH affected solvent production of Cassava rhizome hydrolysate by *C. acetobutylicum* ATCC 824. The result was presented in Table 3. The ABE production at pH 4.5, 5.5, 6.5 and uncontrolled pH was 10.952, 11.53, 10.83 and 10.76 g/l, respectively. The fermentations that were uncontrolled pH produced lower total solvent yield and solvent production per gram of reducing sugar used.

At typical batch fermentation at initial pH = 5.5, solvents were produced and previously formed acids were partly reassimilated. Solvent production was associated with growth, while organic acids slowly increased during growth and reached a maximum at the stationary phase. Solvent concentrations of 11.53 g/l were obtained from 55.8 g/l reducing sugar of Cassavarhizome hydrolysate after 65 hr. Residual sugar declined during growth and reached zero 72 hr later. The acid productivity was grater in fermentation at pH 4.5 and 6.5 than fermentation at pH 5.5. However, the butanol formation was decreased. The batch experiment at pH 5.5 and 60 g/l glucose resulted in 12.43 g/L of total solvents. The results showed that *Cl. acetobutylicum* 824 provided solvent production efficiently from cassava rhizome hydrolysate, comparable to when glucose was used.

Table 3 Solvent production and sugar utilization for the Acetone-Butanol-Ethanol fermentation in Cassava rhizome hydrolysate media at different pH

	4.5	pH 5.5	6.5	uncontrolled	D-glucose 5.5
Fermentation time (h) ^a	65	65	65	65	65
Acetone (g l ⁻¹)	3.390	3.1857	3.018	3.3857	3.912
Butanol (g l ⁻¹)	6.579	8.1379	6.466	5.8674	7.579
Ethanol (g l ⁻¹)	0.983	0.2064	1.356	1.5064	0.939
Total solvent (g l ⁻¹)	10.952	11.53	10.84	10.76	12.43
Acetate (g l ⁻¹)	0.6714	0.659	0.742	0.814	0.437
Butyrate (g l ⁻¹)	0.8439	0.834	0.904	0.977	1.019
Sugar utilized (g l ⁻¹)	51.9	55.8	56.8	54.2	58.1
Butanol yield ^b	0.1267	0.1458	0.1138	0.1083	0.17
Solvent yield ^b	0.2110	0.2066	0.1908	0.1985	0.201

^aFermentation time at which the highest butanol concentration was recorded and all other values were determined

^bYield was determined by dividing grams of butanol or total solvent produced by grams of glucose utilized

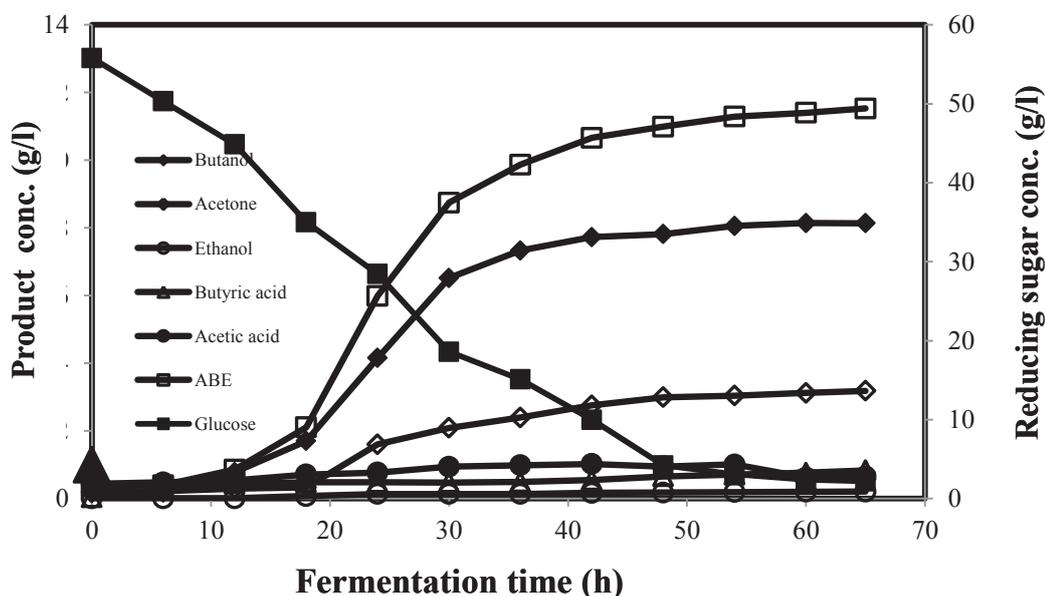


Figure 1 Time course of acid and solvent production of *C. acetobutylicum* ATCC 824 on Cassava rhizome hydrolysate (60 g/l) at 35 °C and pH 5.5

Time course of ABE production and sugar utilization

Figure 1 shows the time course of ABE production and cell growth of *C. acetobutylicum* ATCC 824 on Cassava rhizome hydrolysate at pH 5.5 and 60 g/l reducing sugar. ABE production starts from day 1 and continues till 65 h of fermentation. As evident from the figure, maximal ABE production is achieved in the late stationary phase. Maximal ABE production was achieved in 65 h of fermentation, and the total sugars were almost

completely consumed with approximately 3.67% remaining in the fermentation broth. However, this strain was provided low biomass (data not shown).

CONCLUSION

The results of this study was demonstrated that *C. acetobutylicum* ATCC 824 appeared to utilize all sugars resulting in Cassava rhizome hydrolysate. Butanol and ABE has been produced with the concentration of 8.1379 and 11.53 g/l respectively at 35 °C from Cassava rhizome hydrolysate medium composed of 60% total sugars by fermenter cultivation. Even though it was quite obvious that low cells density in the batch fermentations in the 4 L fermenter resulted in unsatisfactorily moderate solvent production, increasing the initial cell concentration together with increasing the nitrogen concentration might be adopt to rectify such issues.

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Effect of Odor-adsorbing Fillers on Mechanical Properties of Natural Rubber Vulcanizates

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Abstract: Perlite, carbon black and clay were used as odor-adsorbing fillers and mixed with highly odorous STR20. Filler content was varied at 0, 10 and 20 phr. The ability to reduce odor by sensory method and mechanical properties, such as tensile strength, hardness, rebound resilience and abrasion resistance, were investigated. It was shown that addition of perlite and carbon black could reduce odor. The odor reduction efficiency increased with an increase in filler content. Carbon black showed better reinforced effect than at of perlite and clay. The addition of carbon black showed an increase in tensile strength and abrasion resistance, while rebound resilience decreased. The addition of perlite and clay showed an increase in rebound resilience and slightly increase in hardness and insignificant change in tensile strength. Perlite was found to be comparable to clay with respect to mechanical properties and was potentially used as cheap and odor-adsorbing filler.

Keywords: Natural rubber, Perlite, Carbon black, Odor reduction, Mechanical properties

INTRODUCTION

Although natural rubber (NR) is known to exhibit outstanding properties, such as high elasticity and resilience, obnoxious odor or offensive odor emitted from natural rubber products and from natural rubber raw material during drying, storage, mastification, and curing has been recognized as an unsolved problem for natural rubber industry and consumers. [1-4] Many researchers confirmed that low molecular weight volatile fatty acids were the major cause of obnoxious odor. They explained that incomplete degradation during storage and thermal degradation during the processing of non rubber components, such as carbohydrates, proteins, and lipids, were responsible for generating the obnoxious odor. [2-4].

V. P. Hoven *et al.* [2] introduced odor-reducing substances such as chitosan, zeolite13x and activated carbon black to adsorb physically and/or chemically an offensive odor from natural rubber vulcanizates. They confirmed that the reduction of low molecular weight volatile fatty acid, such as an acetic acid, in the presence of chitosan and zeolite13x, was observed by using gas chromatography and gas chromatography/mass spectrometry. They also reported that activated carbon black with highly porous structure and large surface area tended to be a good odor-reducing agent from an olfactometry test. However, those odor-reducing materials were expensive and unpopular in rubber processing.

Perlite is a glassy volcanic rock and able to expand and increasing porosity upon heating. The main composition of perlite is silica. Expanded perlite is cheap and used mostly

in the construction industry, in agriculture and may be used as heavy metals adsorbant for environmental protection [5, 6]. In order to reduce air pollution due to the processing of rubber, the elimination of the unpleasant smell from natural rubber were studied by using perlite as an odor-adsorbing filler. STR 20 was chosen as a representative of highly odorous natural rubber. The effect of perlite content on mechanical properties of cured rubber, such as tensile properties, hardness, abrasion resistance and rebound resilience, was evaluated. Comparative mechanical properties of natural rubber vulcanizates filled with perlite and other commercial fillers, such as clay and carbon black were also investigated. Sensory method was used to measure qualitatively the efficiency of odor reduction.

MATERIALS AND METHODS

Materials

All mixing ingredients were used as received. NR (STR 20), elemental sulphur (S₈), stearic acid, zinc oxide, accelerators and antioxidants were purchased from Lucky Four Co. Ltd. (Thailand). Two types of antioxidants were *N*-(1,3-dimethylbutyl)-*N'*-phenyl-*p*-phenylenediamine (6PPD) and poly (2,2,4-trimethyl-1,2-dihydroquinoline (TMQ). Accelerators are 2-mercaptobenzothiazole (MBT) and tetramethylthiuram disulphide (TMTD) (97% purity). Three fillers used were fired perlite, china clay (hydrated aluminium silicate) and carbon black N330. Clay and carbon black were purchased from Lucky Four Co. Ltd. and fired perlite with high porosity was received from Klongyang Co. Ltd., Lopburi (Thailand). The composition are shown in Table 1)

Table 1 Composition of perlite analyzed by using X-ray diffractometer

Oxide Compound	Weight (%)
SiO ₂	72.59
Al ₂ O ₃	14.09
Fe ₂ O ₃	1.59
K ₂ O	3.30
TiO ₂	0.31
MnO ₂	0.05
CaO	1.08
MgO	0.41
NaO	5.37
Loss on ignition	1.21

Particle size of all fillers was determined by using particle analyzer laser with 2 min. of ultrasonic (Mastersizer S). The Brunauer-Emmett-Teller (BET) surface area of the fillers was evaluated with a nitrogen adsorption instrument (Quantachrome Autosorb-1) according to ISO 9277 [7]. The results are shown in Table 2.

Preparation of Rubber Compounds and Vulcanizates

All rubber compounds were prepared via a conventional vulcanization system according to the formula depicted in Table 3. The six compound formulations are designated as control (no filler), P10, P20, clay and CB. The mixing was carried out in a two-roll mill (model YFTR-8). The mixing sequence is listed in Table 4. The rubber compounds were later compression-moulded at 150°C using a hydraulic hot press (OOMN semi-automatic

moulding press model HPC-100(D), according to their respective cure time (t_{90}) from rheographs.

Table 2 Physical properties of various types of fillers

Filler type	Particle size (μm)	Specific surface area (m^2/g)
Perlite	38.02	3.49
Clay	6.08	5.35
Carbon black N330	5.05	76-80 [8]

Table 3 Formulations of rubber compounds

Ingredient	Amount (phr)				
	Control	P10	P20	Clay	CB
NR (STR20)	100	100	100	100	100
Sulphur	3.5	3.5	3.5	3.5	3.5
Stearic acid	1	1	1	1	1
ZnO	5	5	5	5	5
TMTD	0.8	0.8	0.8	0.8	0.8
MBT	0.5	0.5	0.5	0.5	0.5
6PPD	1	1	1	1	1
TMQ	1	1	1	1	1
Perlite	-	10	20	-	-
Clay	-	-	-	20	-
Carbon black	-	-	-	-	20

Table 4 Mixing sequence of ingredients in a two-roll mill

Minute of addition	Operation
0	Loading of NR
1	Masticaiton of NR
2	Addition of 6PPD
3	Addition of ZnO, Stearic acid, TMQ, TMTD, MBT and filler
17	Addition of sulphur
20	Discharging

Note: For control blend without filler addition, total mixing time was 15 min.

Cure Characteristics

The cure characteristics of the different rubber compounds were determined using a moving die rheometer (model UR-2010) which was operated at 150°C with 3° arc for 30 min., following ISO 6502 [9]. Minimum torque (ML), maximum torque (MH), scorch time (ts) and cure time (t_{90}) were evaluated from the cure curves. The cure time was determined from the time at which the rheometer torque increases to 90% of the total torque change on the cure curve. The evaluation of cure characteristics was repeated three times and an average values was used in data analysis.

Sensory method Ten grams of vulcanized rubber with and without odor-reducing fillers was filled in test tubes. Seventy five persons having ages in the range of 18-20 years evaluated each samples from scale 1-5 ranging from low to high odor intensity. Every person had to smell the odor of coffee beans prior to each evaluation to erase the previous experience the former odor evaluation and odor confusion. Data was statistically analyzed for significance difference by using DUNCAN method with 95% confidence [10, 11].

Mechanical Properties

The tensile properties were measured using an Instron universal testing machine (model 5565) with a crosshead speed of 500 mm/min., and 500 N load cell. The type I specimens, according to ISO 37, were stamp-cut from rubber vulcanized sheets of about 2 mm thick [12]. To achieve uniform tension distribution over the cross section, the specimens were symmetrically placed at the grips of the testing machine. The tensile strength was obtained from stress at break. The elongation at break was also determined.

The hardness of the cured samples was measured using a Shore A durometer (model 716) in accordance with ASTM D2240-05 [13]. It was evaluated at three different positions on the specimens (about 6-mm thick) and the median value was given.

The rebound resilience was evaluated by a rebound tester (model Rebound Check-Pendolo Schob) according to DIN 53512. The cylindrically shaped specimens of 13-mm thickness were prepared. Rebound resilience was calculated as follows: Percentage of resilience = $(1 - \cos\alpha) \times 100$ where α is the maximum rebound angle [14].

An abrasion test was performed according to DIN 53516 [15] using an abrasion tester (Hampden APH-40). The cylindrically shaped specimens of 6-mm thickness were prepared. The abrasion resistance of was given as volume loss when a specimen was abraded for an abrasion distance of 40 m with emery paper (60 grit) at a constant force of 10 N.

RESULTS AND DISCUSSION

Cure Characteristics

The cure characteristics of all NR compound are shown in Table 5. Generally, the torque difference is an indicator of crosslink density of the vulcanizates [16]. It can be observed that the addition of fillers, except clay, increased the torque difference and decreased the scorch time and cure time. Similar results were found in addition of defatted rice bran in NR vulcanizates [17] and addition of rice husk in natural rubber [18]. In the previous study active surface of commercial silica can absorb activator causing the reduction in cure time [18, 19]. Conversely, active surface of silica in perlite might be low. In the case of carbon black, a neutral or slightly alkali pH with low oxygen content might be attributed to the accelerating effect on the cure behavior of rubber [16]. At similar loading level of 20 phr, the CB-filled compound showed the highest torque difference. This could be due to the highest reinforcement efficiency of the highest crosslink density [16].

The Odor-Reduction Efficiency from Sensory Test

The odor of a product is detected when its volatiles enter the nasal passage and are perceived by the olfactory system. In general, only 5-10 well-trained persons are required for the test. Due to the lack of well-trained persons for testing the odor quality, the tests were adapted from the guidelines for sensory analysis [10]. At least 70 persons participated in the test to assure statistically reliable data [11]. Each person determined each samples from scale

1-5 ranging from low to high odor intensity. The method of reducing obnoxious odor from natural rubber is in fact to change the bad odor to be more pleasant by masking and/or reducing the odor intensity to a more acceptable level. An odor adsorbent retains odor molecules on its surface [2]. The higher the odor scale, the lower the odor-reducing efficiency. As can be seen from figure 1, the addition of perlite caused the reduction of offensive smell. The higher perlite content, the higher the odor reducing efficiency. At similar loading level of 20 phr, the perlite seemed to be the most effective adsorbent when compared with other commercial fillers such as carbon black and clay.

Table 5 Cure characteristics of various types of fillers in NR compounds.

Rubber compound	Torque difference, MH-ML (dN.m)	Scorch time, t_{s2} (min.)	Cure time, t_{90} (min.)
Control	15.90	1.15	2.47
P10	17.71	1.17	2.38
P20	22.64	1.12	2.29
Clay	19.53	1.29	3.12
CB	24.83	0.55	2.21

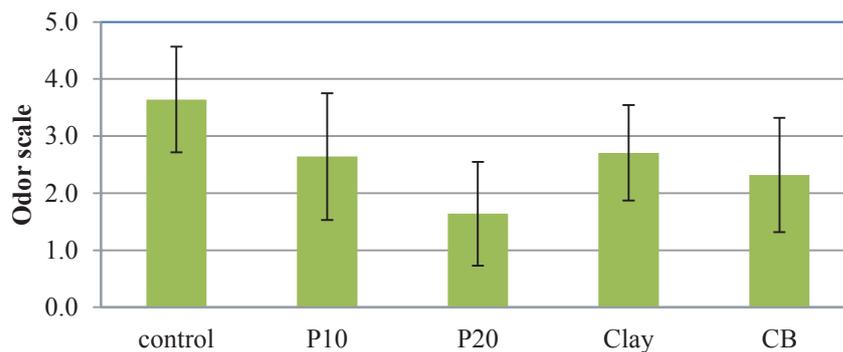


Figure 1 Odor scale of various types of fillers in NR vulcanizates

Mechanical Properties

Tensile Properties

The tensile properties of various NR vulcanizates are expressed in Table 6. The addition of perlite and clay showed an insignificant change in tensile strength and elongation at break. The ability of the fillers to support stress transferred from the rubber matrix could be responsible for an increase in the tensile strength of all filled vulcanizates [20]. At a similar filler loading, carbon black, commercially used as reinforcement filler, exhibited the highest tensile strength, which corresponds to its smallest size and highest surface area, as shown in Table 2. Sae-Oui *et al.* [19] reported that the surface area is the major factor controlling the tensile strength.

Hardness and Rebound Resilience

Figure 2 illustrates the Shore A hardness of the cured rubber. As can be seen, high perlite content caused a slightly increase in hardness. With similar filler loading, carbon black showed the highest hardness values, followed by clay and perlite. The hardness values are corresponded to the torque difference values (Table 5), which indicates that the slightly

increase in hardness of the filled vulcanizates was due to an increase in the cross-link density [17]. Figure 3 illustrates the resilience of the vulcanizates relating to the elasticity of the rubber chain. It can be observed that the rebound resilience decreased with the addition of filler [17].

Table 6 Tensile properties of various types of fillers in NR vulcanizates

Rubber vulcanizates	Tensile properties	
	Tensile strength (MPa)	Elongation at break (%)
Control	2.5±0.4	208±12
P10	3.2±1.1	241±27
P20	2.8±0.7	196± 26
Clay	3.6±0.1	213±9
CB	9.9±0.2	244±15

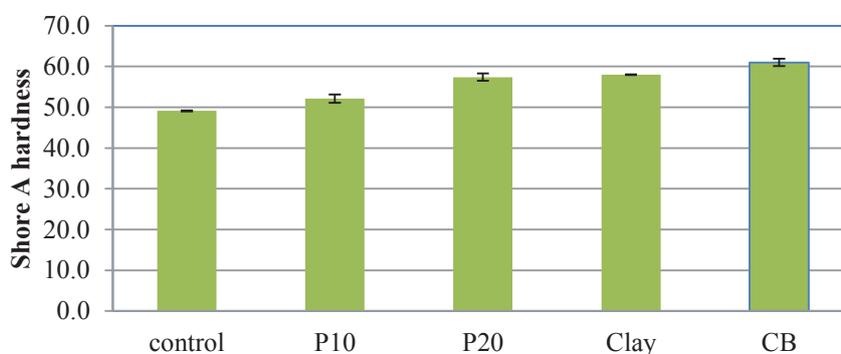


Figure 2 Hardness of various types of fillers in NR vulcanizates

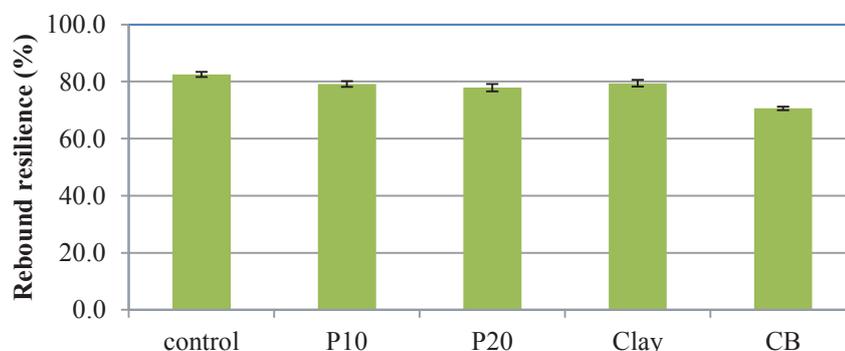


Figure 3 Rebound resilience of various types of fillers in NR vulcanizates

Abrasion

The abrasion resistance of a solid body represents its ability to withstand the progressive removal of material from its surface as a result of the mechanical action of rubbing and scraping or of an erosive action [20]. Figure 4 displays the abrasion resistance of the NR vulcanizates; a higher volume loss indicates a lower abrasion resistance. It can be observed that abrasion resistance tended to decrease with the addition of perlite. This could be attributed to low rubber-filler interaction. Carbon black-filled vulcanizates gave the highest abrasion resistance. This could be due to its highest hardness and cross-link density [17].

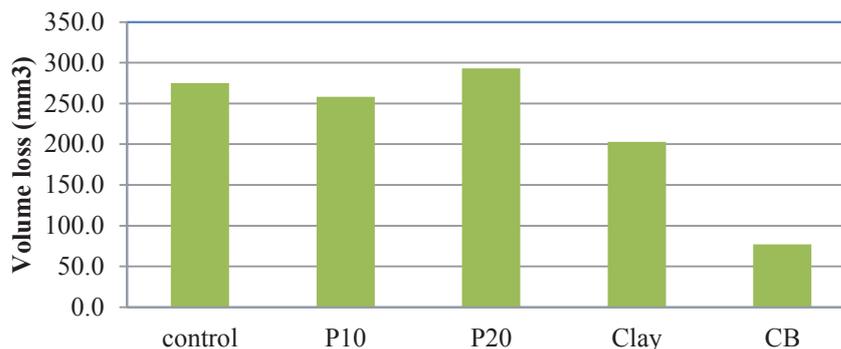


Figure 4 Volume loss (mm³) of various types of fillers in NR vulcanizates

CONCLUSION

Perlite and carbon black seems to be effective adsorbent fillers. The addition of perlite and clay showed an increase in rebound resilience and slightly increase in hardness and insignificant change in tensile strength. Perlite was found to be comparable to clay with respect to mechanical properties. Carbon black exhibited reinforced effect better than those of perlite and clay. The addition of carbon black caused an increase in tensile strength and abrasion resistance, while rebound resilience decreased.

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Phytotoxic Effects of Kaffir Lime Peels (*Citrus hystrix* DC) Extracts

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Abstract: To evaluate the inhibitory effects of selected herbs on plant growth, the peel of *Citrus hystrix* DC was extracted with methanol, 80% methanol and water, and tested by lemna phytotoxicity assay, seed germination bioassay and seedling length bioassay. Acute toxicity of *C. hystrix* was also determined using brine shrimp test as well as its molluscicidal activity on golden apple snails model. It was shown that the methanol and 80% methanol extracts of *C. hystrix* DC had inhibitory effects on duckweed growth. The percent inhibition of both extracts on growth rate increased depending on the concentration of extract whereas the water extract had no inhibitory activity. The methanol extract showed the inhibitory effects with EC₁₀ of 111.69 µg/ml. In seed germination bioassay and seedling length bioassay, it was shown that all extracts of *C. hystrix* DC had no inhibitory effect on germination of lettuce seeds and the seedling length. Acute toxicity study of *C. hystrix* DC as herbicide was also investigated. At 24 hours, more snails were poisoned from 80% methanol extract than water extract. Concentrations of the extracts toxic to snails were inversely related to the age of snails. Phytochemical screening of all extracts showed the same positive results as flavonoids. Steroidal structures were present in test plants. The alkaloids were detected only in the alcoholic extracts (methanol and 80% methanol) but they were not found in the aqueous extracts. The study is worthy of further investigation since this could provide potential bioherbicide and may lead to the discovery of new effective and applicable bioherbicide.

Keyword: *Citrus hystrix* DC, Lemna, Phytotoxicity, Seed germination bioassay, Seedling length bioassay

INTRODUCTION

Citrus hystrix DC or commonly known as Kaffir lime is a common edible herb species of family Rutaceae that can be found everywhere within South East Asia. It has folkloric reputation to be used in flu, fever, hypertension, abdominal pains and diarrhea in infant. The fruits are used as pickle as well as in cooking. The fruits juice is rubbed onto the skin to soften or mixed with bath water to control body odor. The fruits are also used in shampoo as an insecticide for washing the head as a hair shampoo. In addition to be used in cosmetic products, the fruits have been reported to have anti-inflammatory and anti-fertility effects [1]. In Thailand, Kaffir lime have more agriculture production and widely use in agriculture and manufacturer. Recently, a number of studies have proposed that some fruit or vegetable byproducts could be a source of natural antioxidants in order to valorize these wastes [2].

Because of increasing agricultural and industrial productions, they have become a major stress factor in the environment. Among these pesticides, herbicides are chemicals commonly used to control weeds in agricultural activities. These synthetic pesticides including pest resistance and negative impact on natural enemies in addition to environmental and health related concerns. These problems have resulted in the renewed interest in the development and use of botanical pesticides, which could be an appropriate and non-hazardous alternative to the currently used synthetic agrochemicals. As the natural products, they are generally effective, biodegradable and thus pose less threat to the environment [3].

There are several methods for the evaluation of phytotoxicity during composting. The most widely toxicity bioassay that has received much attention recently is the duckweed growth inhibition test. Hence, the duckweed bioassay has become a standard toxicity method for many certification entities and international organizations. Accordingly, the United States Environmental Protection Agency (USEPA) developed guidelines for a plant toxicity test using *Lemna* spp. [4-5]. Moreover, the Organization for Economic Cooperation and Development (OECD) completed a guideline draft for the Lemna test [6]. The bioassay with lettuce seeds as static and of acute toxicity, where the phytotoxic effects of a pure compound or a complex mixture in the germination of seeds and in the development of the seedlings was evaluated during the first few days of growth. The method is inexpensive, quick, and reproducible [7]. Molluscidal activity on golden apple snails model was evaluated [8] and brine shrimp lethality bioassay technique [9] was applied for the determination of cytotoxicity of the fruit extractives. To find some new natural sources of pesticides from botanical origin, the present study is to evaluate the inhibitory effects of *Citrus hystrix* DC on plant growth.

MATERIALS AND METHODS

Plant material and Extraction

Peels of Citrus fruit, kaffir lime (*Citrus hystrix* DC) with fresh appearance, free of rotting and bruising or any other signs of deterioration were purchased from market in Nakorn Pathom, Thailand. After purchasing the samples were kept at 4°C until the time of experiment, which was on the same day of the purchase.

Prior to experiments, fruit samples were washed with tap water and gently rubbed by a sponge. Peels of kaffir limes were taken off from the fruits. The peels were shade dried and then pulverized into fine powder. The powdered plant materials were extracted with methanol, 80% methanol and water. The extract was then concentrated by using a rotary evaporator. The percent yield of the extracts was calculated.

Lemna Phytotoxicity Assay

Every treatment group had three replicate containers. Fifteen fronds were added to each container and cultured under the same light at that in pre-cultureing. Fronds of duckweed (*Lemna minor* L.) were collected from ponds in Silpakorn University, Nakhon Pathom (Thailand). *L. minor* fronds of similar size and shape were selected for exposure. Before experiments, *L. minor* were disinfected by immersion in 70% ethanol for 2 min and then rinsing with distilled water during 2 min for 3 times. The stock cultures mediums are E-media. All aquaria were maintained in a growth cabinet, calibrated at $25 \pm 2^\circ\text{C}$ under continuous light provided by cool white fluorescent lamps. There were 5 test concentrations, one control group for each test. Duckweed growth was determined measuring frond number,

the frond number was scored at the start to the experiments and 7 days after. All visible fronds were counted. The results were interpreted by analyzing the growth regulation in percentage calculated with reference to the negative control. The inhibition percent relative growth rate was selected as the endpoint for phytotoxicity test. It was calculated using the following formula. Relative growth rate (RGR)/day = $[\text{Ln}(N_t/N_0)]/\text{no of day}$. Percent inhibition of growth rate (%GRI) = $(\text{RGR}_c - \text{RGR}_t) / \text{RGR}_c \times 100\%$ where: N_t = the average number of fronds per replicate in one treatment group, N_0 = the number of fronds per replicate at beginning, RGR_c = average relative growth rate of the control group and RGR_t = average relative the growth rate of the experimentation group. Concentration (\log_{10}) was plotted against percent inhibition to determine the EC_{10} values.

Seed Germination Bioassay and Seedling Length Bioassay

Seeds of lettuce (*Lactuca saliva*) which have been recommended by the US Environment Protection Agency, the US Food and Drug Administration and the Organization for Economic Cooperation and Development [6]. Seeds were purchased from a local seed market. The seeds were sterilized in 10% Na hypochlorite solution for 20 minutes to prevent fungal growth, washed with distilled water for several changes. The tests were conducted using 100x15 mm disposable petri dishes and Whatman#1 filter paper. Ten seeds, undamaged and plump seeds with almost identical size were employed and placed uniformly on the surface of the filter paper at the bottom of each dish, which contain 5 ml deionized water. All dishes were incubated at $25 \pm 2^\circ\text{C}$ in the dark for 120 hours. The dishes were covered during incubation. Seed germination and seedling length were measured and calculated. Root length was defined as the length from the tip of the root to the radical. The following parameters were analyzed: (1) Seed Germination (SG), corresponding to the percentage of germinated seeds after the experiment; (2) Root Elongation (RE), calculated by the equation $\text{RE} = (C - M)/C$, where M is the average elongation per treatment and C is the average elongation of the control. Thus, when $\text{RE} = 0$, there is no toxicity; if $\text{RE} < 0$ the sample is toxic; and if $\text{RE} > 0$ elongation is stimulated

The Acute Toxicity on Golden Apple Snails and Brine Shrimp Test. [8-9]

Toxicity test of the peel extracts against golden apple snails (*Pomacea canaliculata*) and brine-shrimp (*Artemia salina*) were evaluated under controlled laboratory conditions.

Statistics

Mean values and standard deviation (S.D.) were calculated from the result. One way analysis of variance (ANOVA) was applied for comparison of the mean value. P value < 0.05 was regarded as significant.

RESULTS

Lemna Phytotoxicity Assay

The herbicidal potentials of the extracts derived from the *C. hystrix* DC were evaluated against *L. minor*. The results obtained indicated that most of the tested extracts possess tremendous herbicidal activity (except water extracted). The 80% methanol and methanol extraction of *C. hystrix* DC had growth inhibition effect and percent inhibition increased when concentration increased, water extraction at low concentration had slightly growth inhibition but could not show the relationship (Table 1). The 80% methanol and methanol extraction of *C. hystrix* DC had growth inhibition effect. The methanol and 80%

methanol extracts of *C. hystrix* DC were also shown to inhibit duckweed growth with EC₁₀ of 111.69 µg/ml and 147.39 µg/ml, respectively (Figure 1, Table 2).

Table 1 Relative growth rate, RGR and % inhibition of growth rate (% GR inhibition) on *L. minor* of extractions of *C. hystrix* DC

Extractions	Conc. (ppm)	RGR/ day	% GR inhibition
MeOH	800	0.0269 ± 0.03	89.84
	600	0.1108 ± 0.01	58.18
	400	0.1739 ± 0.00	34.37
	200	0.1891 ± 0.02	28.60
	100	0.2316 ± 0.01	12.58
80% MeOH	800	0.1128 ± 0.02	57.43
	600	0.1783 ± 0.01	32.71
	400	0.1846 ± 0.02	30.32
	200	0.2279 ± 0.01	13.98
	100	0.2524 ± 0.07	4.73
Water	800	0.2362 ± 0.03	10.85
	600	0.2434 ± 0.0336	8.12
	400	0.2522 ± 0.0034	4.80
	200	0.2186 ± 0.0183	17.48
	100	0.2258 ± 0.0256	14.76

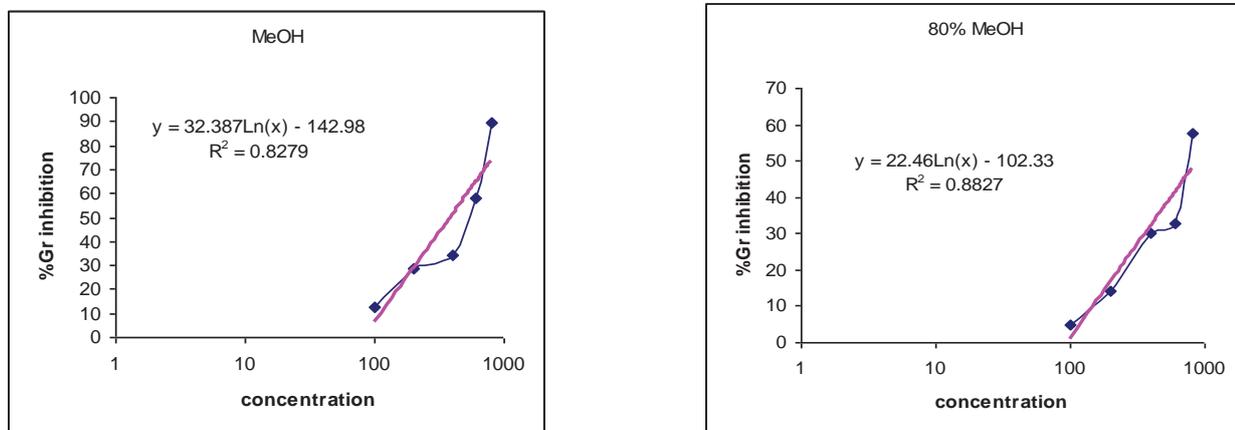


Figure 1 The relationship of *C. hystrix* DC extraction of and the inhibition percentage of duckweed relative growth rate (a) Methanol extraction and (b) 80% Methanol extraction

Table 2 EC₁₀ of extractions of *C. hystrix*

Extractions	EC ₁₀ (ppm)
MeOH	111.69
80 % MeOH	147.39

Seed Germination Bioassay and Seedling Length Bioassay

In seed germination bioassay and seedling length bioassay showed that all extracts of *C. hystrix* DC had no inhibitory effects on germination of lettuce seeds and the seedling

length bioassay. The seed germination bioassay could be relatively low sensitive to many toxic substances, because many chemicals may not be absorbed by seeds and the embryonic plants draws its nutritional requirements internally from seed stored materials and is effectively isolated from the environment [10].

The Acute Toxicity on Golden Apple Snails and Brine Shrimp Test.

The acute toxicity study of *C. hystrix* DC as herbicide in golden apple snail was also investigated. At 24 hours, more snails were poisoned from 80% methanol extracts than water extracts. Toxic concentrations of extracts to snails were inversely related to the age of snails. The molluscicidal bioassay results demonstrated that *C. hystrix* DC had molluscicidal activity with LC₅₀ of 18.24 ppm in 2 weeks old and with LC₅₀ of 164.91 ppm in 4 weeks old. It suggested that *C. hystrix* DC could be an effective plant-derived molluscicide. The exact mode of action of most molluscicidal is not completely understood, but some of compounds might affect some vital enzyme activities in different body tissues and lead to the death of snails.

DISCUSSION AND CONCLUSION

The results showed that the methanol and 80% methanol extracts of *C. hystrix* DC had inhibitory effects on duckweed growth. The percent inhibition of both methanolic extracts on growth rate increased depending on concentration of extractions whereas the water extraction had no inhibitory effect. The methanol extract of *C. hystrix* DC showed the strongest inhibitory effects with EC₁₀ of 111.69 µg/ml. From phytochemical screening of all extracts showed the same positive results on phenolic compounds of flavonoids. Steroidal structures were present in most of both of the test plants. The alkaloids were present only in the alcoholic extracts (methanol and 80% methanol) but they were not found in the aqueous extracts of *C. hystrix* DC (data not shown). The phytotoxic properties of olive mill wastes are mainly associated with their high concentration of phenols (catechol, hydroxytyrosol, tyrosol, oleuropein) that are known to inhibit plant and bacterial growth [11]. It seems that phenolic compounds have bioherbicide activity. The methanol extract of the fruits of *C. hystrix* DC demonstrated various degrees of bioactivities when subjected to antimicrobial, antioxidant and cytotoxicity screening. The bioactivities exhibited by the extractives of *C. hystrix* DC fruits supports the traditional uses of this plant in different diseases as well as its popular uses in foods and cosmetics. The citrus peels and seeds are very rich in phenolic compounds, such as phenolic acids and flavonoids. Since a Citrus fruit is peeled, peels and seeds are not used. It is necessary to estimate these by-products as natural antioxidants in foods [1, 12-13]. Moreover, while flavonoids are abundant elsewhere in the plant kingdom, there are several compounds (e.g. flavanones, flavanone glycosides and polymethoxylated flavones) unique to citrus, which are relatively rare in other plants [2]. As the use of chemical increases throughout the world, agricultural weed control alternatives to the present man-made herbicide-dominated programs are now begin given wide consideration. Controlling weeds through allelopathy is one strategy to reduce dependency on man-made herbicides [14]. The peel of *C. junos* fruit was found to possess potent allelopathic activity and a methanol extract of the peel inhibited the growth of several weed species [14]. It has been shown that certain plant residues and extracts may function as weed-suppressive agents. It is possible that Citrus spp. Waste could be important as a weed-suppressive residue or mulch in a field setting. After juice is extracted from the fruit, the fruit pulp is mostly dumped as waste at large expense. The manipulation of food processing waste is now becoming a very serious

environment issue. It seemed, therefore, worthwhile seeking how to make use of the waste of citrus fruits [11, 14]. From the present study, it could therefore be concluded that *C. hystrix* DC shows strong phytotoxicity and possesses weed-suppressing ability. Hence, these could be one useful natural plant products for developing bioherbicides. The study is worthy of further investigation since this could provide potential bioherbicide and may lead to the discovery of new effective and applicable bioherbicide.

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Upland Rice-based Organic Agriculture Project in Baao and Nabua, Camarines Sur, Philippines

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Abstract: This project aimed to develop mechanisms that formulate, advocate and implement organic agriculture and livelihood activities in uplands to fast-track transformation of exploitative and extractive land use system into more permanent, carrying capacity enhancing livelihood system. Additionally, it aimed to optimize utilization and value of upland areas by using them for organic agriculture to provide food and livelihood opportunities in the community. The project sites were the rolling and mountainous areas of Barangays Antipolo and Caranday in Baao and Duran and San Vicente Gorong-gorong, Nabua, Camarines Sur, Philippines. Participatory Resource Appraisal was used to gather data for the Situational Analysis which characterized the production system of the sites. Thirty one farmers participated which were organized into an association. Capability development activities were conducted in Baao and Nabua: Training on Organic Fertilizer Production and Training on Organic Upland Rice Production. The farmers prepared individual Farm Plans. Agricultural inputs, like vegetable seeds, upland rice seed, molasses and vermicast for organic fertilizer production and knapsack sprayer were provided. The project had three components: Organic Vegetable Production where 3.25 hectares of land were grown with various vegetables where farmers gained \$2,040.89 income; Organic Upland Rice Production where 16.75 hectares of land were planted with various rice varieties achieving about \$4,517.14 income; Organic Fertilizer Production which produced concoctions and vermicompost used as natural fertilizers in their farms. To promote upland organic farming and showcase farmers' produce, farmers' filed day was conducted. To access relevant services and ensure sustainability of the project, linkages were fostered with Department of Agriculture, Philippine Rice Research Institute, Agricultural Training Institute, academe and Local Government Units. The project was able to identify good practices and establish mechanisms which show the sustainability of upland organic farming as a source of livelihood and as a way of good life.

Keywords: Upland organic agriculture, Upland rice, Sustainable agriculture

INTRODUCTION

Upland rice is defined as rice cultivated in flat and sloping lands that are not bounded, basically grown in well drained soils, prepared and seeded under dry conditions, and depends on rainfall for moisture. In addition, it is considered a subsistence crop in Asia specifically in the Philippines and often planted in small land holdings (average of less than 0.5 hectare) by resource poor farmers. At present, some upland rice cultivars are becoming extinct and sources of seeds of this crop are very limited and scarce. Upland rice have lower (1-2 tons/ha) yields than that of the irrigated rice (3-4 tons/ha). Reports, however, revealed that some

traditional upland rice strains have out-performed some modern rice varieties in terms of grain production and drought tolerance.

Over the years, upland rice area in the region gradually decreased due primarily to change in crop preference of upland farmers for other cereals such as corn and legumes. The past years had manifested the cruel unpredictable weather condition in the Bicol region where significant losses in the agricultural sector were recorded. Rice was among the most affected commodity. Flooding damaged the ricelands thus decreasing rice production in the river basin municipalities in the provinces of Camarines Sur (which includes Baa and Nabua) and Albay.

The above situationer on upland rice translates to additional volume of shortage and reduction in rice self-sufficiency in the region. The resultant effects are decrease in livelihood opportunities and increase in net rice importation. The impacts of this situation is complex and will ultimately redound to further deterioration of the upland ecosystem as farmers will look for alternative livelihood sources which are destructive in nature i.e. kaingin, charcoal-making, firewood/fuelwood production, and the likes.

Foregoing considered, the rice productivity growth in the Bicol region will now be limited to crop intensification in the lowland and upland rice expansion and diversification through adoption of appropriate farming systems technologies that will strike a balance between economy and environment. Increased rice productivity and corollary agricultural commodities produced in the upland areas can augment production shortfalls in the flood-prone lowland irrigated and rainfed areas specifically during wet season cropping.

As food security becomes critical, efforts to arrest the impending order becomes urgent and mandatory for survival. The challenge has now shifted to the uplands as the new 'production frontier'. Seemingly, upland rice production is an essential component of the agricultural sector in the region. Although production yields are generally low, yet it has the potential to improve through the development of improved varieties and cultural management practices to suit the soil, climatic, and social conditions. These improvements can be achieved through research and extension, sound national policies and programs, and institutional and governance reforms.

The optimal utilization of upland development zones and the enhancement of productivity of existing farms in the region are major strategies that would address food security and sustainability. The adoption of organic agriculture is a proven approach for increasing productivity and income and for significantly contributing to food security in the countryside.

This project was envisioned to maximize the utilization of the uplands adopting the organic agriculture approach to address food security and sustainability. It established a model community on upland rice-based organic agriculture which can be replicated in other areas of the region. Pursuant to Section 13 of the Organic Agriculture Act of 2010, this project initiated the use of organic fertilizers from agricultural, industrial and household wastes. This project likewise encouraged public-private partnerships through shared responsibilities in community development, land management, biodiversity and resource conservation. Furthermore, the project contributed to the empowerment of resource poor farmers and upland communities toward the attainment of a stronger local agricultural economy.

Generally, the project aimed to develop a mechanism that will formulate, advocate and implement organic agriculture and livelihood activities in the uplands in order to fast track the transformation of exploitative and extractive land use system into a more permanent, carrying capacity enhancing and sustainable livelihood system. In addition, it aims to optimize the utilization and value of the upland areas by using them for organic agriculture to provide food and livelihood opportunities in the community.

Specifically, the project aimed to:

1. Introduce and/or enhance organic-based farming systems and characterize the socio-economic profile of upland rice farming systems in two upland communities in the municipalities of Baa0 and Nabua, Camarines Sur;
2. Determine the specific location adaptabilities and yield performance of released or improved and indigenous upland rice varieties in the project area and identify good practices and develop technologies that can be replicated or adopted by upland rice farmers; and
3. Provide production and technical support and assist the upland communities in developing/establishing enterprises and markets for their organic products as source of income.

MATERIALS AND METHODS

Development Planning Framework

The general development planning framework of this project was the basis for the operationalization of strategic development efforts anchored on the following:

1. An appreciation that the “vicious cycle of poverty” would be broken through these livelihood projects in the uplands ensuring a sustainable income opportunity founded on the available resources and technology;
2. The target focus of the project were the farm families in the upland barangays in Baa0 and Nabua, Camarines Sur that depend entirely and make use of the available resources in these areas;
3. Development of appropriate mechanisms that would generate relevant productivity enhancing technologies addressing location-specific conditions and technology needs of the locality in order that the ecological strengths of the area shall be maximized and the risk minimized;
4. Development of appropriate but urgent strategies and measures to stabilize the productivity and sustainability of the local resources in the community / locality considering that these target areas are impoverished; and

Cognizant of the above cited development planning concept/framework, the following basic strategies were employed, viz:

1. Conduct of a Participatory Rural Appraisal (PRA) on the existing bio-physical, technical, socio-economic, and institutional support systems to include not only the opportunities and potentials, but also its problems and constraints as well;
2. Development of location-specific technologies based on natural processes which would increase the level of productivity and profitability of the upland communities / barangays;
3. Development and strengthening of the upland rice-based sub-sector that would utilize existing and appropriate technologies for long-term employment contracts for the labor sector;

4. Mobilization of resources and stakeholders via a strong and relevant advocacy programs focusing on sustainable development and ensuring the commitment and concrete action of key stakeholders and decision makers in providing sound policy, financial, and logistical support for the identified livelihood projects; and
6. Strengthening of institutional linkages and organization of stakeholders to avail of good markets and ensure profitability.

RESULTS AND DISCUSSION

Situational Analysis

The project team conducted a Participatory Rural Appraisal on August 27 to September 2, 2011 in barangays Antipolo and Caranday in Baao and barangays Duran and San Vicente Gorong-gorong in Nabua, Camarines Sur. The team utilized PRA tools such as house to house interviews and focus group discussions to gather relevant data which were used in the situational analysis. The team also surveyed the areas concerned and gathered crucial technical data like slope, elevation and temperature.

A total of thirty one (31) farmers, selected based on a set of criteria, participated in the project. These farmers allotted a total of 21 hectares as demonstration sites. Eighty percent or 16.8 hectares were planted with upland rice while 4.2 hectares were devoted to organic vegetable.

To ensure sustainability of the project and coordinated efforts, the farmers were organized and elected its own set of officers. They meet regularly to discuss concerns regarding their farms..

Capability Development

Capability development activities were conducted to enhance appreciation and improve the knowledge of the farmers relative to organic agriculture technology particularly on upland agriculture. The trainings conducted were on: organic fertilizer production and organic upland rice production.

On-farm Project Components

The project had three major components: organic vegetable production, organic fertilizer production and organic upland rice production.

Organic Vegetable Production

The farmer-beneficiaries in the project sites engaged in vegetable production in December 2011 until May 2012. With a combined area of 2.85 hectares, they planted the following vegetables: tomato, cabbage, bottle gourd (upo), bitter melon (ampalaya), watermelon, bell pepper, eggplant, hot pepper, cucumber and squash. The seeds were given free to the farmers. Moreover, the farmers used natural farming technology in cultivating these vegetables. They also used natural farming inputs and vermicompost in fertilizing the crops.

The vegetables produced by Baao farmers totaled to 4,062.5 kgs which amounted to US\$1,422.51 in sales. On the other hand, farmers of Nabua produced a total of 1,864.5 kgs of assorted vegetables which gave US\$652.24 in sales. The vegetables were easily sold in the local market.

Table 1 Summary of Vegetable Production and Sales Generated in Baao and Nabua Farms from December 2011 to May 2012.

CROPS	BAAO			NABUA		
	Area (sq.m.)	PRODUCTION (kgs)	SALES (US \$)	Area (sq.m.)	PRODUCTION (kgs)	SALES (US \$)
Cabbage	340	15.00	10.98	200	10	4.88
Tomato	1,341	321.00	196.59	1,000	110	196.59
Bitter Gourd	1,515	123.50	87.93	1,750	95	82.93
Hot Pepper	1,840	135.50	92.07	600	50	48.78
Eggplant	2,660	1,097.00	534.87	2,400	140	62.20
Watermelon	206	17.00	8.29	250	10	4.88
Pechay	95	11.50	4.97	95	11.5	4.98
Squash		580.00	131.56		208	48.29
Cucumber	1,725	323.00	86.59	1,250	135	63.41
Bottle Gourd	3,125	1,439.00	268.66	2,500	55	13.41
String beans*	-	-	-	1,000	40	14.63
Ginger*	-	-	-	5,000	1,000	128.05
Total	12,487	4,062.5	1,422.51	16,045	1,864.50	673.02

(* farmers' own seeds)

Organic Upland Rice Production

About 16.75 hectares (18%) of the project area were planted upland rice. The different upland varieties used were NSIC RC 192 (13.3 hectares), Dinorado (3.05 ha), NSIC 9 (0.1 ha), NSIC 11 (0.1 ha), palawan (0.1 ha) and Inipot-ipot (0.1 ha). Table 2 shows the volume of production of each variety and sales generated.

Table 2 Upland Rice Production from May-October 2012 in Baao and Nabua, Camarines Sur.

Variety	Area Planted	Production (kgs)	Average Production/ha (kg/ha)	Sales (US \$)	No. of farmers
NSIC 192	11.75 ha	6,045.00	1,149.37	4,423.17	22 farmers
Dinorado	2.75 ha	185.00	133.33	180.49	15 farmers
NSIC II	100 m2	12.00		8.78	1 farmer
NSIC 9	100 m2	11.00		8.05	1 farmer
Inipot-ipot	100 m2	6.00		5.85	1 farmer
Pinalawan	100 m2	1.00		0.98	1 farmer
TOTAL	7.25	6,260.00		4,627.32	

The farmer-cooperators of Baao and Nabua, Camarines Sur produced a total of 6,260 kgs of upland rice which amounted to a total sale of US\$ 4,627.32.

The low production is expected because of the shift from conventional rice production to organic upland rice production. Another challenge that was faced by farmers was the

erratic weather conditions like a three week dry spell that was followed by heavy rains. Such weather conditions caused stunting of some of the crops and poor yield.

The upland rice seeds planted by the farmers were given by the Philippine Rice Research Institute (PhilRice). Since it is difficult to acquire upland rice varieties, Phil Rice decided to buy all the seeds that were produced by the farmers.

Organic Fertilizer Production

The farmers were taught how to produce the organic fertilizers which they used in their vegetable and rice production. Each of the beneficiaries was provided with molasses as basic ingredient in the production of natural farming inputs like indigenous microorganisms (IMO), fermented plant juice (FPJ), fermented fruit juice (FFJ), fish amino acid (FAA) and oriental herbal nutrient (OHN). These natural products were utilized in the farmers’ respective organic vegetable and upland organic rice farms. Table 3 summarizes the organic fertilizers produced by the farmers. Each of the beneficiaries also came up with a compost pit to recycle household and crop residues which was also used as organic fertilizer in their farms.

Table 3 Summary of Production of Organic Fertilizer for Baao and Nabua

CONCOCTIONS	Rate of Production	BAAO	NABUA	TOTAL	No. of farmers
Fermented Plant Juice (FPJ)	1-2liters/mo-farmer	156 liters (13 farmers)	144 liters (12 farmers)	300 liters	25 farmers
Fermented Fruit Juice (FFJ)	1liter/mo-farmer	88 liters (11 farmers)	72 liters (9 farmers)	160 liters	20 farmers
Indigenous Micro Organisms (IMO)	1 liter/mo-farmer	88 liters (11 farmers)	72 liters (9 farmers)	160 liters	20 farmers
Oriental Herbal Nutrient (OHN)	1 liter/mo-farmer	64 liters (8 farmers)	56 liters (7 farmers)	120 liters	15 farmers
Compost	½ sack /mo-farmer	48 sacks (12farmers)	32 sacks (8 farmers)	80 sacks	20 farmers

Moreover, vermicompost facilities were established in Baao (2 facilities) and Nabua (2 facilities) so that the farmers will be able to produce the fertilizer. The farmers were able to produce about 2,750 kg of vermicompost.

The vermicompost and liquid organic fertilizers produced by the farmers were all utilized by the farmers to fertilize their farms. These resulted in considerable reduction of farm costs and certainly improved the soil condition of their farms.

Institutional linkages

The project management collaborated with government agencies such as the Department of Agriculture (DA), Philippine Rice Research Institute, Agricultural Training Institute and the Local Government Units. These institutions provided support such as the provision of agricultural inputs and trainings.

CONCLUSION

An analysis of the upland areas of Baao and Nabua shows that establishment of organic upland rice is feasible. Barangays Caranday and Antipolo in Baao, however, gave better yield results because of its topographies which has deep soil suitable and appropriate

for upland rice production. Upland rice production will be more profitable if farmers will utilize organic fertilizer. There is a substantial amount of organic materials in the area which can be used in the production of organic fertilizer. The project was able to identify good farming practices which will help the farmers increase their income and at the same time sustain productivity through the use of appropriate soil conservation strategies and utilize organic farming practices. Among these are the following: planting along contour lines for soil conservation, enhanced multiple cropping practices such as planting vegetable and other crops with rice, household-production of organic fertilizers (FPJ, OHN, FFJ, IMO, NAMO juice, kakawate extracts, vermin tea and composts), use of indigenous practices for pest and disease management (use of vermi tea as control for rice bug, use of oriental herbal nutrient (OHN), hot pepper mixed with water), utilization of household produced organic fertilizers in the application/fertilization in vegetable and rice production (IMO for basal application, FPJ during vegetative stage, FFJ during flowering) and recycling of agricultural residues and household wastes in the production of organic fertilizers.

Moreover, the interventions made by the project was able to demonstrate that cultivation of upland rice and vegetables is a feasible enterprise. The use of natural farming technology and the use of natural farm inputs and vermicompost in fertilizing the farms reduced the cost of production and improved the soil condition of the farms. The vermicomposting production facility established at the community enabled the farmers to produce vermicast. The other organic fertilizers produced, such as FPJ, OHN, FFJ, IMO, and compost, inputs serve the needs of the farmers, and likewise, can be a viable source of income.

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Postmortem Changes of Anchovy (*Stolephorus heterolobus*) under Refrigerated Storage

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Abstract: Postmortem changes in anchovy (*Stolephorus heterolobus*) muscle during 10 days of iced and 4°C storage were studied using changes of ATP degradation products, K-value, TVB-N, TMA-N, total smell intensity and microbiological analysis. During the 10-day ice and 4°C storage, K-value, TVB-N, TMA-N contents increased with increasing storage time. Nucleotide degradation was found to be more rapid in anchovy stored in 4°C than in ice storage. Changes in the total smell intensity score for both storage conditions as storage time increased. TVC did not exceed 7 log CFU/g, which was considered the limit of acceptability after 8 days of 4°C and storage on ice. When fish was rejected in term of sensory assessment the TVB-N value was high for iced and 4°C storage. This result introduces the use of ice storage as a preliminary treatment for anchovy during industrial processing.

Keywords: Postmortem, Anchovy, Refrigerated, Storage

INTRODUCTION

Anchovy (*Stolephorus heterolobus*) is one of the most important fish in Thailand because it has higher essential fatty acids compared to other fish species. It also has a high amount of protein. Yearly harvesting of anchovy in Thailand has increased from 57,800 t in 1987 to 138,600 t in 2010. In Thailand, most anchovy that is captured includes raw materials that produce boiled and dried products. Most of the quality issues found in boiled and dried anchovy products are directly related to the initial quality of the fresh raw materials, which declines continuously due to postmortem changes during preliminary refrigerated storage and that occurs before the drying process. Since fresh anchovy are not processed within a short time, they are always kept at low temperatures during storage, thereby delaying the drying process results in the deterioration of the final anchovy product.

Once the fish dies, several postmortem changes take place. These changes are due to the breakdown of the cellular structure and biochemistry as well as to the growth of microorganisms that are naturally associated with the fish because of contamination during handling [1]. Within these changes that directly and strongly affect its quality and shelf-life. There are the protein degradation, ATP degradation, drop of pH, undesirable compounds production as trimethylamine nitrogen (TMA-N) and total volatile base-nitrogen (TVB-N), which are produced through bacterial action [2]. Microbiological, biochemical and sensory methods are used in order to evaluate the freshness and quality of the fish during handling and storage, with appearance, odor, taste and texture representing the main attributes of freshness [3]. Given the fact that the results of these analyses do not always correlate well, it

is important to use all three methods when the purpose is to adequately define the freshness of a particular species of fish [4].

The anchovy fish is, in Thailand, an important and highly appreciated fishing resource. Unfortunately, there is an inconclusive and scant amount of data that is available on quality changes for keeping them in low temperature storage before processing. The aim of this study is to investigate quality changes for anchovy in Thailand by investigating the practical application of 2 different chilling methods in terms of sensory, microbiological (TVC) and chemical (K-value, pH, TVB-N and TMA-N) changes. Such information is necessary in order to secure a proper amount of handling and processing after their capture.

MATERIALS AND METHODS

Fish Samples

Fresh anchovy (*Stolephorus heterolobus*), approximately 4.5–5 cm in length, is normally caught off the Andaman coast. When the boat reaches port, the fish are transported by truck within 6 hrs to the Prince of Songkla University, Surat Thani Campus. The fish are immediately washed with tap water and randomly divided into 70.0 kg groups. The first lot (I) was surrounded by flake ice at a 2:1 fish to ice ratio and then placed into polystyrene boxes with holes for draining. They were then stored in a refrigerated room at 4 °C. The second lot (WI) was placed in polystyrene boxes without flaked ice and stored in a refrigerated room at 4 °C. A sample of randomly chosen 2.5 kg anchovies was taken from the boxes immediately after being acquired and analyzed daily for 10 days of refrigerated storage.

Determination of K-Value

Determinations of nucleotides and related compounds were carried out by a reverse phase high performance liquid chromatography procedure [5]. The identification of nucleotides, nucleosides, and bases was made by comparing their retention times with those of commercially obtained standards and by the adding or spiking of standards. The K value was calculated as a percentage rate of HxR and Hx to the sum of ATP and degradation products as follows [6]: $\%K = [(HxR + Hx) / (ATP + ADP + AMP + IMP + HxR + Hx)] \times 100$.

Determination of Trimethylamine Nitrogen (TMA-N) and Total Volatile Base Nitrogen (TVB-N)

TMA-N and TVB-N were measured in accordance with a method of [7] using Conway's micro-diffusion method.

Determination of pH

pH was measured in accordance with method [8].

Microbiological Analysis

Total Viable Plate Count (TVC) was performed by the pour plate method using plate count agar according to method [9].

Sensory Evaluation

A sensory evaluation was performed according to [10] with some modifications by using 11 trained panelists who had extensive experience in the evaluation of fish muscle.

Statistical Analysis

The data was subjected to an analysis of variance (ANOVA) and mean comparisons were carried out using Duncan's multiple range test (DMRT). The data values were expressed as a mean \pm SD (n=3) for each specific storage time.

RESULTS AND DISCUSSION

The K value is calculated from the ATP concentration and its products of degradation. It is used to measure how fast these compounds degrade. It shows the relationship, expressed in percentage, between the sum of the HxR concentrations and Hx between the sum of the ATP concentrations and related catabolite compounds. This index is broadly used to evaluate the freshness in fish and presents a very good correlation with its storage time [1, 11]. Reference [6] describes fishing products with K values lower than 20% as very fresh, 50% as moderately fresh, and 70% or higher as not fresh. In this study, the effect of freshness changes of anchovies during different chilled storage times was assessed. The first group was surrounded by flake ice at a 2:1(w/w) fish to ice ratio and the second group was refrigerated with a blast of cold air at 4 °C. A sample of anchovies was chosen randomly every day for analysis during 10 days of refrigerated storage. The analysis of a K value of change of fresh anchovies showed that K's value was initially 2.56 ± 0.20 . This value is similar to that given in a previous report where the initial value of K in Atlantic herring (*Clupea harengus*) immediately after capture was lower than 10% [12]. The freshness of the anchovies decreased sharply during 10 days of refrigerated storage and was determined by the K value increasing continuously shown in Fig.1. In this study, the K-value can clearly be seen as rapidly increasing during refrigerated storage by a blast of air as compared to it slowly increasing with ice storage ($p < 0.05$). At the end of the 10 day storage period, the K-value of anchovy muscle during refrigerated storage with ice and with air blasting was 91.33 ± 2.52 and 99.1 ± 2.88 respectively and are shown in Fig. 1.

TMA-N is often used as an index in assessing the shelf-life and the quality of fish products because it rapidly accumulates in the muscle under refrigerated conditions [2]. The pungent odor of spoiled fish has often been related to TMA tissue levels. Also, with the number of spoiling organisms present in many fish species, the rejection limit is usually 5 to 10 mg TMA-N/100g muscle [13]. In this study, change in the TMA-N content of anchovy muscle during this refrigerated storage period is shown in Fig. 2. In fresh anchovies, the TMA-N content of the sample was 0.35 ± 0.06 mg/100 g. TMA-N content increased in both refrigerated storage conditions during day 3 of its refrigerated storage ($p \leq 0.05$). The TMA-N content of an anchovy muscle during refrigerated storage was ascertained by air blasting it 4 °C higher than with ice on day 6 ($p \leq 0.05$). At the end of refrigerated storage, the mean TMA-N content in anchovy muscle under refrigerated storage with ice and by air blast at 4 °C during 10 days were 31.11 ± 1.42 and 48.87 ± 2.12 mg/100g for the sample, respectively. A similar behavior was observed by [14] for Horse mackerel (*Trachurus mediterraneus*) stored at 4°C with average values of 2 and 48 mg of TMA-N/100 g for days 0 and 20, respectively. Whilst, Rodriguez *et al.* (2006) reported for Farmed Turbot (*Psetta maxima*) stored with ice average values of 4 and 18 mg of TMA-N/100g for days 0 and 40, respectively.

TVB-N is a term that includes the measurement of trimethylamine, dimethylamine, ammonia and other compounds associated with seafood spoilage and increases as spoilage progresses. For several fish species, TVB-N values increased curvilinearly or linearly over time and at a level of 30mg. Muscle TVB-N/100g have been considered the upper limit above which some fishing products are considered spoiled and unfit for human consumption [15]. In this study, change in the TVB-N content in anchovy muscle during this refrigerated storage period is shown in Fig. 3. In fresh anchovies, the TVB-N content of the sample was

3.45±0.22 mg/100g. TVB-N content increased in both refrigerated storage conditions since the early days ($p \leq 0.05$). The air blasted anchovy muscle had a TVB-N content of 4 °C higher than the ice did on the 7th day of refrigerated storage ($p \leq 0.05$). At the end of the 10 day storage period, the mean TVB-N content in the anchovy muscle under ice and through air blasting at 4 °C were 86.45±4.81 and 102.33±5.39 mg/100g, respectively. A similar behavior was also observed by [16] for Wild White Grouper (*Epinephelus aeneus*) stored on ice with average values of 15.4 and 47.9 mg of TVB-N/100g, for days 0 and 22, respectively. Whilst, [17] reported for Tilapia (*O. niloticus*) stored on ice averaged values of 6.5 and 61.34 mg of TVB-N/100g for days 0 and 29, respectively.

Variations amongst the initial values of pH may be due to species type, season, diet, level of activity or stress during the catch and type of muscle. The glycogenolysis that occurs after death in fish causes a reduction in pH. Although the pH value may vary depending on the species, a lower post-slaughter pH limit of 6.2 has been established for species in a state of rest prior to sacrifice [18]. During later postmortem stages, there is a pH increase due to the decomposition of amino compounds caused primarily by microbial activity [19, 20]. The rate of this pH change depends mainly on the storage temperature, with pH values above 7.1 being indicative of decomposition [21]. In this study, changes in pH level in anchovy muscle during refrigerated storage on ice and by air blast at 4 °C are shown in Fig. 4. In fresh anchovies, the pH level of the sample was 5.99±0.12. This value is similar to 5.9 ± 0.5 reported by [22] for Chilean jack mackerel (*Trachurus murphyi*) stored on ice. Nevertheless, it is was also shown that it is lower than 7.1 as reported by [23] for Atlantic salmon (*Salmo salar* L.). Afterwards, the pH level decreased for both refrigerated storage conditions during the first 2 days of storage where ($p \leq 0.05$) and increased in both refrigerated storage conditions from days 3 to 10 of refrigerated storage. At the end of the storage period, the pH level of anchovy muscle during refrigerated storage with ice and by air blast at 4 °C over 10 days were 7.44±0.23 and 7.52±0.24, respectively. Similar pH values were found for other fish species during their storage on ice by [24] and [21].

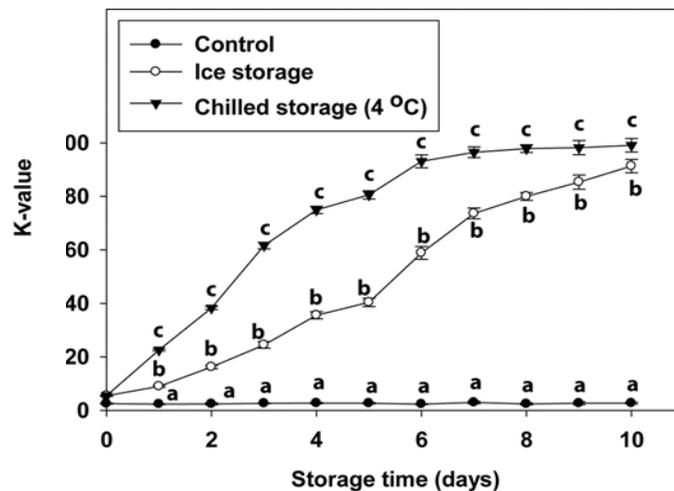


Figure 1 Changes in K-value (%) in anchovy muscle during their refrigerated storage with ice (○), air blast (▼) and fresh anchovies (●) over a 10 day period. Values are mean ± SD (n=3). Different letters within the same storage conditions indicate significant differences ($p \leq 0.05$)

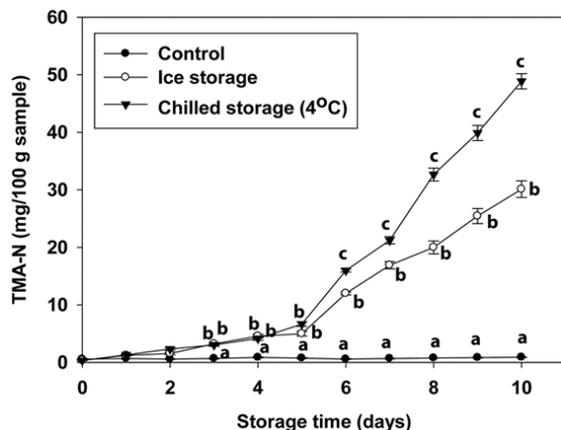


Figure 2 Changes in TMA-N content in anchovy muscle during refrigerated storage with ice (○), air blast (▼) and fresh anchovies (●) over a 10 day period. Values are mean ± SD (n=3). Different letters within the same storage conditions indicate significant differences (p ≤ 0.05)

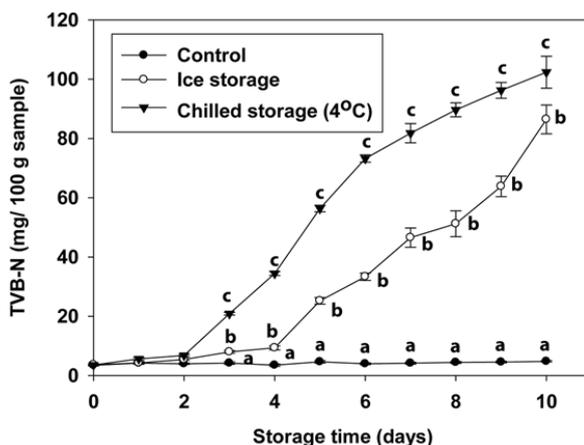


Figure 3 Changes in TVB-N content in anchovy muscle during refrigerated storage with ice (○), air blast (▼) and fresh anchovies (●) over a 10 day period. Values are mean ± SD (n=3). Different letters within the same storage conditions indicate significant differences (p ≤ 0.05)

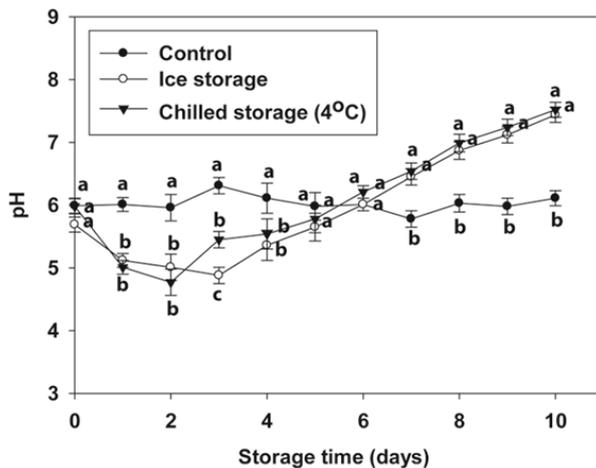


Figure 4 Changes in pH level in anchovy muscle during refrigerated storage with ice (○), air blast (▼) and fresh anchovies (●) over a 10 day period. Values have a mean of ± SD (n=3). Different letters within the same storage conditions indicate significant differences (p ≤ 0.05)

Changes in the Total Viable Plate Count (TVC) for anchovy muscle during refrigerated storage on ice and by air blast at 4 °C are shown in Fig. 5. In fresh anchovies, the TVC of the sample was 1.22±0.11 with a log of CFU/g. The TVC increased for both refrigerated storage conditions during the first days of storage ($p \leq 0.05$). The [9] has established a microbiological acceptability limit of 7 log CFU/g for fresh water and marine species and is fit for human consumption. At the end of the refrigerated storage with ice and by air blast at 4 °C during 10 days, the TVC was 5.87±0.41 and 7.54±0.47 log CFU/g, respectively.

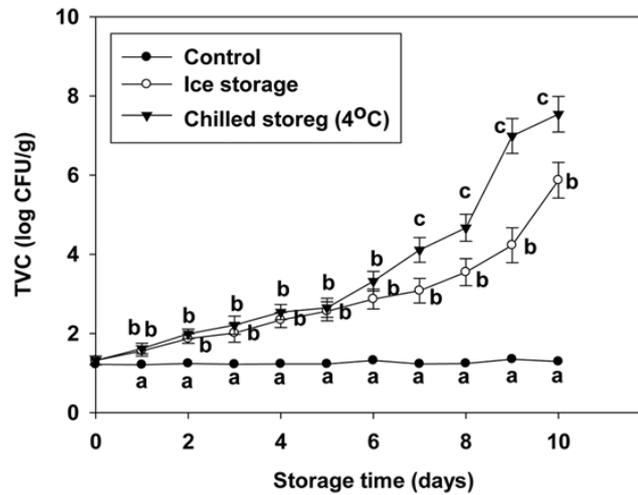


Figure 5 Changes in TVC in anchovy muscle during refrigerated storage with ice (○), air blast (▼) and fresh anchovies (●) over a 10 day period. Values have a mean of ± SD (n=3). Different letters within the same storage conditions indicate significant differences ($p \leq 0.05$).

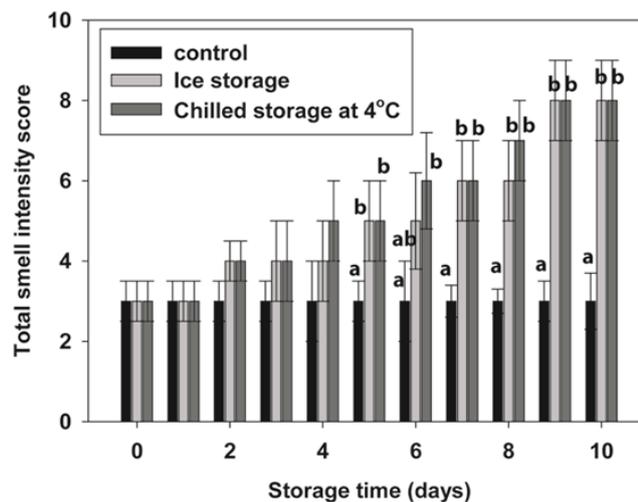


Figure 6 Sensory evaluations of anchovy muscle during refrigerated storage with ice, air blast and fresh anchovies over a 10 day period. Values are mean ± SD (n=3). Different letters within the same storage conditions indicate significant differences ($p \leq 0.05$).

Observed changes in the anchovy muscle during their storage on ice and by air blasting at 4 °C were conducted by 11 trained panelists who had an extensive amount of experience with such observations. Using a 10 point scale where 1 = acceptable and 10 = unacceptable, the external odor of the anchovy at 4 °C under both storage conditions were determined to be unacceptable by day 9.

CONCLUSION

The postmortem behavior of the anchovy muscle indicated that both endogenous and microbial processes could be controlled with appropriate post-capture handling practices. The results of sensory, chemical and microbiological analyses described here show that the refrigerated storage of anchovy with ice allows for more quality control of the product and enhances the shelf-life of fish for up to 9 days. Such information is necessary for proper post-capture handling and processing. Findings of suitable applications could generate higher profitable margins for the producer and serve to improve the development of this kind of fishery.

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Design Features Determining Occupant Perception and Behavior towards Living Comfort and Energy Consumption

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Abstract: Differences in building design features are among the keys influencing the thermal performance of a building and improving thermal comfort in residential spaces. With good orientation for local climatic condition, the need for mechanical cooling could be reduced. This study thus aimed to investigate the designing factors affecting the comfortable indoor climate and finally improving building energy efficiency. Three main building features under investigation included building shape and configuration, orientation and room location. Using the campus dormitories at Maharakham University as the case study, the research examined the interior and exterior microclimate of the dorm rooms. Students' activities within the residing dorms were also investigated to analyze the correlation between the physical conditions of building and energy consumption behavior of residents. The study conducted an inventory survey within 10 dormitory buildings and classified them into 2 categories regarding to the shapes and configurations-1) L-shape building without air conditioning rooms and 2) Rectangular-shape building with and without air conditioning rooms. The study monitored indoor and outdoor temperatures of 10 rooms in each one of the representative L-shape and rectangular-shape buildings by installing data loggers for seven consecutive days. Questionnaire survey was also conducted to collect information and energy consumption behavior from 385 dorm residents. The study compared interior temperatures in responding to the outside temperatures of rooms located on the ground floor and top floor of both L-shape and rectangular-shape buildings were compared. The temperatures in rooms with different orientations were also compared. It was revealed that students living on the northeastern side of the building consumed relatively higher energy. The results retrieved from a study could contribute to the better understanding on the indoor climate in relation to the design features of campus dormitories and could help to achieve more comfortable indoor climate and more energy efficient buildings.

Keywords: Building design, Thermal comfort, Energy consumption behavior

INTRODUCTION

In the hot and humid countries as Thailand, architecture design features are among the most important factors affecting thermal performance of building. The impact of solar load and heat gain on human health and working productivity can be minimized by appropriate urban and building design (Givoni, 2000a). The appropriate design also is significant to the reduction of energy consumption for building cooling purpose. Better understanding on new materials and building products on the indoor climate could help to achieve more comfortable indoor climate (Givoni, 2000a) and more energy efficient buildings.

Background

Effects of Design Features on Thermal Performance of a Building

The thermal performance of a building, in particular its solar load and heat gain, is significantly influenced by the architectural design features. Givoni (2000a) summarized that five major elements determining a building thermal performance includes:

- 1) The layout (Shape) of the building's plan
- 2) The color of the building's envelope
- 3) Orientation of main rooms and windows
- 4) Window size and shading
- 5) Thermal properties of the building materials

Building orientation (orientation of walls) and thermal properties of the building materials are the two key architectural features attribute to the thermal performance of a building. Thailand is located at approximately 10 degrees north of equator, where solar radiation mostly strikes the south wall throughout the day, east and west wall during morning and afternoon. The northern wall receives relatively less radiation comparing to the rest of enclosure.

Appropriate material selection for building envelope thus becomes a solution, where solar radiation load on a wall can be controlled by means of materials utilization and their color (Givoni, 2000a). The role of materials on climatic control aims to minimize solar heat gain toward the interior of shelter during the daytime, while maximize the rate of cooling during the evening and night time. It was suggested that low mass buildings with medium thermal resistance of envelope are considered appropriate for the hot and humid climate (Givoni, 2000a). In this light, in order to minimize operating energy of building in Thailand, the Eastern and Southern facing walls should be insulated by low mass materials such as lightweight concrete blocks that have low thermal conductivity. On the other hand, the walls facing Western and Northern direction can be used to passively reduce heat from indoor through materials and evaporative effect.

Due to the fact that fossil fuel supply is shrinking, and the global warming issue is worsening, passive cooling has become more an urgent issue, especially among developing and low-income countries, where most of them located in the tropical region. Cooling buildings passively can be achieved through the use of various natural heat sinks i.e. ambient air, the upper atmosphere, and the under-surface soil (Givoni, 2000b). In the hot and humid region, the orientation of building should aim to avoid sun light year round and to encourage cross ventilation by introducing cooling breezes (McGee, 2010).

In order to apply the passive cooling techniques more effectively, one needs to understand the local micro climate of the particular region. Jittawikul et al (2004) suggested the utilization of climatic maps for passive cooling methods utilization in Thailand, which applicability of a given cooling system strongly depends on the building type and the local microclimate. Some systems can only be applied to specific types of buildings or only under the specific climatic conditions (Givoni, 2000b).

Thermal Comfort

Thermal comfort in built environment is among the important issues for architects. The term “Thermal Comfort” was defined by the International Standard ISO 7730 as being “that condition of mind which expresses satisfaction with thermal environment” (Ampofo *et al.*, 2004 referred to ISO, 1994). By this definition, the thermal comfort is, therefore, a subjective issue and difficult to convert into physical parameters. People’s thermal comfort depends on their both physiological and psychological states, as well as the sensation of their skin. At the extreme, severe thermal environment can cause heat stress, heat stroke or hypothermia (Ampofo *et al.*, 2004; Rizzo *et al.*, 2004).

The evaluation of thermal comfort in the built environment is usually conducted by psychometric chart. The chart shows the effective temperature which is a line showing equal comfort over a range of relative humidity and dry bulb temperature readings (Ampofo *et al.*, 2004 referred to Parker, 1972). The thermal comfort conditions could be designed using natural or mechanical systems. There are also numerous passive systems applicable in hot and humid climates include (see more in Givoni, 2000b): natural ventilation, nocturnal ventilative cooling, radiate cooling, indirect evaporative cooling, utilizing cooled soil as a cooling source.

In order to apply the passive cooling techniques more effectively, one needs to understand the local micro climate of the particular region. Jittawikul *et al.*, (2004) suggested the utilization of climatic maps for passive cooling methods utilization in Thailand, which applicability of a given cooling system strongly depends on the building type and the local microclimate. Some systems can only be applied to specific types of buildings or only under the specific climatic conditions (Givoni, 2000b).

In this study, building orientation is the main focus. With good orientation for local climatic condition, the need for mechanical cooling could be reduced. This study aims to investigate the designing factors affecting the comfortable indoor climate and finally improving building energy efficiency.

METHODOLOGY

Three main building features under investigation includes building shape and configuration, orientation, and room location. Using the campus dormitories at Mahasarakham University as the case study, the research examined the interior and exterior microclimate of the dorm rooms. Students’ activities within the residing dorms were also investigated to analyze the correlation between the physical conditions of building and energy consumption behavior of residents.

The research comprises of two major tasks for data collection. Firstly, the study conducted an inventory survey within 10 dormitory buildings and classified them into 2 categories regarding to the shapes and configurations—1) L-shape building without air conditioning rooms and 2) Rectangular-shape building with and without air conditioning rooms (Figure 1 and 2). The study monitored indoor and outdoor temperatures of 10 rooms in each one of the representative L-shape and rectangular-shape buildings by installing data loggers for 7 consecutive days. The second task was conducted by using questionnaire survey to collect information and energy consumption behavior from 385 dorm residents.

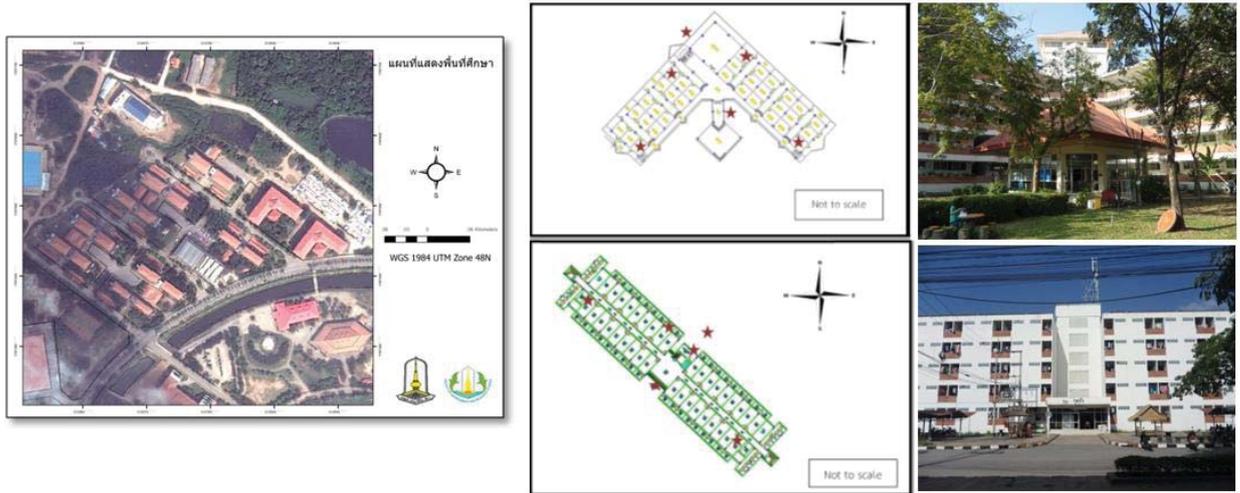


Figure 1 Location and plans of Mahasarakham University dormitories



Figure 2 Interior conditions of dorm rooms

RESULT AND DISCUSSION

Interior Thermal Responses

The study compared interior temperatures in responding to the outside temperatures of rooms located on the ground floor and top floor of both L-shape and rectangular-shape buildings. The temperatures in rooms with different orientations were also compared. The results showed that interior average temperatures of rooms in L-shape building (26.3°C) were relatively lower than the rectangular shape (30.4°C), because the configuration of L-shape building could provide more shading to the room and little direct sunlight exposure. Figure 3 shows the interior thermal responses of dorms with different shapes and configurations.

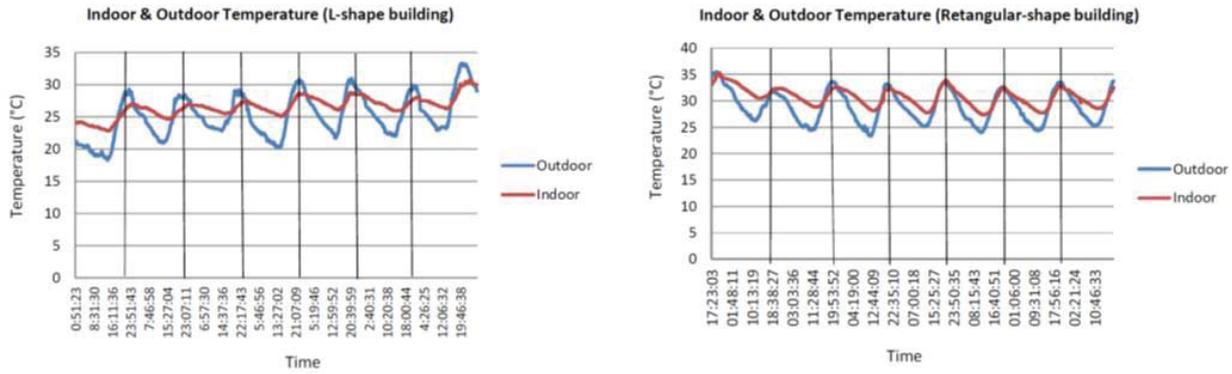


Figure 3 Interior thermal responses of dorms with different shapes and configurations

In terms of building orientation, the room located on the south-western side of both buildings showed the highest average indoor temperatures (35.5°C) compared to the southeastern and northeastern sides (Figure 4). As it was expected, the rooms located on the top floor demonstrated the higher interior temperature due to the heat transfer down through the roof and ceiling.

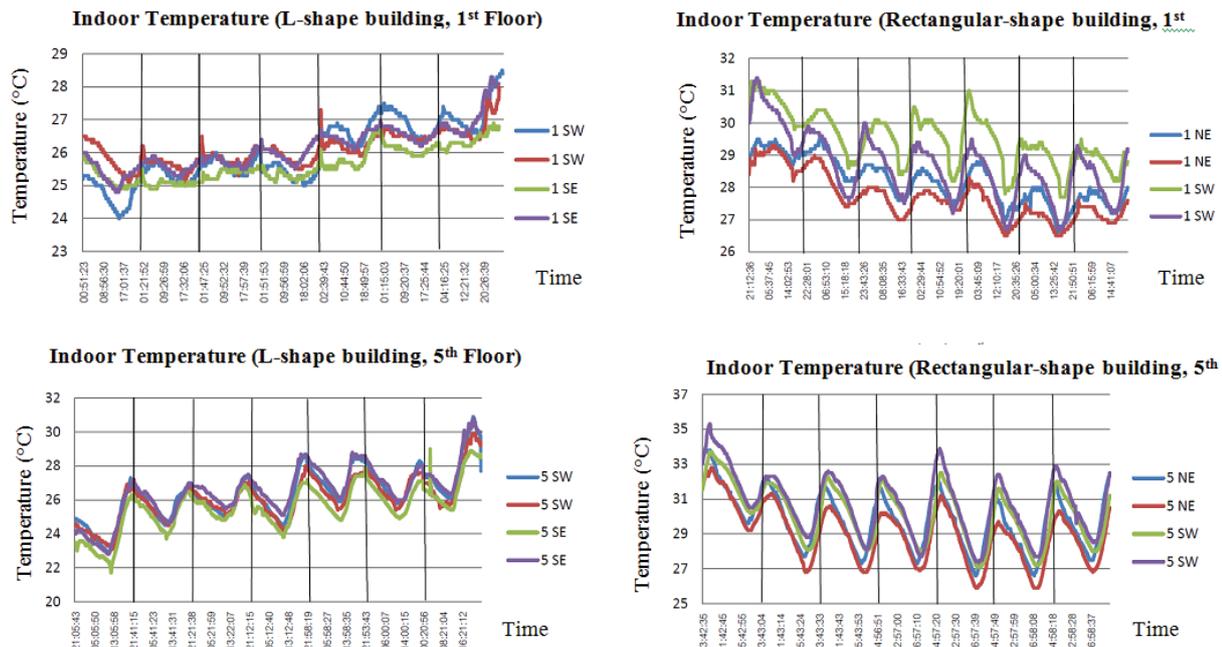


Figure 4 Effects of building orientation and room locations on the interior thermal responses

Occupant Perception and Behavior

Data from the questionnaire survey showed some results corresponding to the early mentioned indoor climate in different buildings. It was found that students lived in rectangular-shape building and in the rooms on the top floor tended to consume more energy for cooling purposes than those who lived in rectangular building (Table 1). Nevertheless, the study found that the room orientation did not contribute to the energy consumption as expected. The results revealed that students living on the northeastern side of the building consumed relatively higher energy.

CONCLUSION

The results retrieved from the study could contribute to the better understanding on the indoor climate in relation to the design features of campus dormitories and could help to achieve more comfortable indoor climate and more energy efficient buildings.

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Genetic Polymorphisms of Melanocortin 3 Receptor Gene on Growth Traits in Thai Indigenous Chickens

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Abstract: The Melanocortin 3 receptor (*MC3R*) gene plays an important role in the central control of energy homeostasis. The objectives of this study were to discover single nucleotide polymorphism (SNP) and analyze the association SNP of *MC3R* gene with growth traits in Thai indigenous chickens. A total of 220 samples of Praduhangdum chickens were genotyped by PCR-RFLP. The restriction enzyme *DdeI* was used to detect the SNP at position g.1424 (A>G). This marker was associated with body weight, average daily gain (ADG) and shank length traits ($P<0.05$). However, no association of *MC3R* marker with the breast wide trait was found in this study. The association of the *MC3R* marker with growth traits of Thai indigenous chickens indicates the importance of *MC3R* as a candidate gene for improvement the growth traits in Thai indigenous chickens.

Keywords: Genetic polymorphism, *MC3R*, Growth traits, Indigenous chickens

INTRODUCTION

Thai indigenous chickens have a unique taste, tough and strong muscles. Such meat is very popular among consumers and the market price is two or three times higher than the commercial broiler chickens [1]. The chemical composition, color, texture and structure of the Thai indigenous and commercial broiler chickens meat have been characterized [2-3]. Thai indigenous chickens has contained low fat and have slow growth rate. It takes about 4-5 months to get ready for the market, whereas commercial broiler chickens takes only 6 weeks. Nowadays, the progress of genetic knowledge forwards rapidly, it would be able to apply in the study of the association between growth traits in chicken and candidate genes such as *PIT-1*, *ATGL* and *GHSR* genes [4-6].

The *MC3R* protein is a G protein-linked receptor gene and plays an important role in energy homeostasis [7-10]. The *MC3R* gene expression occurs in brain, placenta, and gut but not in melanoma cells or in the adrenal gland [11]. The *MC3R* is also located on POMC expressing neurons in the arcuate nucleus, and may form part of a feedback loop which negatively regulates the anorexic tone of the *POMC* expressing neurons. Whereas, melanocortin peptides from activated *POMC* neurons negatively auto-regulate further *POMC* expression through their inhibitory actions at the *MC3R*. It exhibits restricted distribution in the central nervous system, and has a dominant role in inhibition of energy storage [12]. Thus the *MC3R* can be regarded as a fine tuner of specific mechanisms operating during inflammation, cardiovascular function and energy metabolism. The *MC3R* gene has been identified in several mammal species including human [11], mouse [13], rat [14] and pig [15]. However, information on molecular makers of *MC3R* gene in chickens is limited. The

objectives of this study were to analyze the association of *MC3R* gene with the growth traits in Thai indigenous chickens.

MATERIALS AND METHODS

DNA Extraction

A total of 220 Thai indigenous chickens namely Pradhuhangdum were taken blood samples. From these chickens, the growth traits were recorded in terms of body weight, ADG at birth weight to 24 weeks of age, shank length and breast wide at 8-24 weeks of age. DNA samples were extracted by using phenol-chloroform method. The concentration of DNA sample was measured with Nanodrop 2000c spectrophotometer (Thermo Scientific, USA). The integrity of DNA was checked on 1% agarose gel.

PCR Amplification and the PCR-RFLP Analysis

The PCR was performed in 20 μ l reaction mixture containing 100 ng genomic DNA, 1x NH_4SO_4 buffer, 0.4 μ l of each *MC3R* gene primers (forward: 5'-TTTCTATGCCCTCCTTTACC-3' and reverse: 5'-CCATACTGTGTCT GCTACAC-3'), 1.5 mM MgCl_2 , 50 μ M of each dNTP and 0.5 U *Taq* polymerase. The PCR condition was 95 °C 3 min, followed by 40 cycles of 95 °C for 30 s, 58 °C for 30s, 72 °C for 30 s, then extension at 72° C for 5 min. The PCR products were digested with restriction enzyme *DdeI*. The PCR fragments of chicken *MC3R* were separated on 6% polyacrylamide gel electrophoresis.

Statistic Analysis

Allele and genotype frequencies were calculated. Association analysis of *MC3R* genotype and the growth traits were examined using general linear model (GLM). This model was shown as follows;

$$Y_{ijkl} = \mu + A_i + S_j + YS_k + e_{ijkl}$$

Where: Y_{ijkl} = observed value

μ = average normalized of populations

A_i = fixed effect of *MC3R* marker i ($i = 0-2$)

S_j = fixed effect of sex k ($k = 1-2$)

YS_k = fixed effect of year-season l ($l = 1-4$)

e_{ijkl} = residual error

RESULTS AND DISCUSSION

Polymorphism of *MC3R* Gene

One SNP was found in 3'-flanking regions at position g.1424 (A>G) in *MC3R* gene. The PCR product of *MC3R* gene in Thai indigenous chicken was digested with by *DdeI* enzyme. The PCR fragments were 390, 270 and 112 bp for allele A and 390 bp fragments for allele B (Figure 1). The frequencies of genotypes AA, AB and BB were 0.45, 0.41 and 0.14, respectively. The frequencies of alleles A and B were 0.65 and 0.35, respectively (Table 1). These results were consistent with the previous study, which reported that the frequency of allele A was higher than the allele B [16].

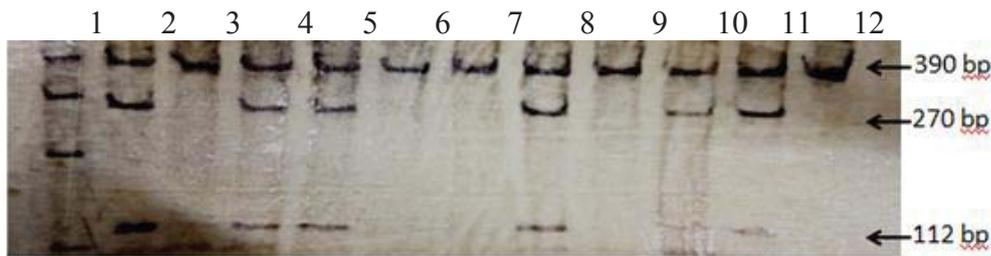


Figure 1 Polymorphism of chicken *MC3R* gene was detected with *DdeI*. Lane 1: 100 ladder; Lane 3, 6, 7 and 9: AA genotype; Lane 2, 4, 5, 8: AB genotype; Lane 12: PCR product

Table 1 The genotype and allele frequencies of the *MC3R* gene in Thai indigenous chickens

Marker	Genotype frequencies			Allele frequencies	
	AA	AB	BB	f (A)	f (B)
<i>MC3R</i>	0.45	0.41	0.14	0.65	0.35

Association of *MC3R* Gene with Growth Traits

The genetic marker of *MC3R* gene was significantly associated with body weight on 1, 2, 3, 4 and 8 weeks of age (Table 2). The chickens with AA and BB genotypes had higher body weight than those of the AB genotype ($P < 0.05$). The significant associations of *MC3R* gene with ADG are showed in Table 3. The chickens with AA genotype had higher ADG as compared to chicken with AB and BB genotypes ($P < 0.05$). Moreover, significant association with shank length trait was found at 8 weeks of age (Table 4). The chickens with AA genotype had higher shank length than those of the AB and BB genotypes ($P < 0.05$). However, no association of *MC3R* marker with the breast wide trait was found in this study (Table 5).

The previous study indicate that mutation *MC3R* gene affect the regulators of energy homeostasis. The *MC3R* is an inhibitory auto-receptor on POMC and arcuate NPY/GABA neurons as well as activating the α -MSH. An abnormal function of *MC3R* gene leads to an increase in food intake [17]. Additionally, *MC3R*-KO mice was increased fat mass and decreased lean mass [8]. This evidence indicated that the *MC3R* might affect feed efficiency rather than food intake and body weight. Therefore, the *MC3R* probably play a critical role in regulation of feeding efficiency and fat storage. Moreover, double KO mice lacking *MC3R* and had exacerbated obesity as compared to *MC3R* single gene KO mice [18]. All of these data suggested that the neuronal *MC3R* regulated different aspects of energy homeostasis. The results in this study indicate that the polymorphism of *MC3R* gene is associated with body weight, ADG and shank length traits in Thai indigenous chickens. This polymorphism of *MC3R* gene may be involved in energy homeostasis of chickens.

Table 2 Least square means (mean ± standard error) of body weight in Thai indigenous chickens

Age (weeks)	No.	Genotypes			P-value
		AA	AB	BB	
0	220	32.57±0.322	32.95±0.34	32.23±0.58	0.5161
1	214	62.93±0.75 ^a	59.36±0.78 ^b	60.24±1.36 ^{ab}	0.0040*
2	218	110.22±1.52 ^a	103.13±1.59 ^b	103.60±2.78 ^b	0.0036*
3	215	159.07±2.68 ^a	150.57±2.80 ^b	148.98±4.86 ^{ab}	0.0480*
4	206	235.22±4.19 ^a	217.48±4.65 ^b	223.60±7.78 ^{ab}	0.0176*
5	220	326.99±5.84	308.98±6.13	310.69±10.55	0.0844
6	211	418.06±7.21	399.18±7.72	394.87±12.83	0.1204
7	208	512.04±8.68	499.70±9.20	501.72±15.28	0.5989
8	220	630.06±10.70 ^a	592.05±11.25 ^b	618.97±19.36 ^{ab}	0.0494*
10	220	850.23±13.33	813.44±14.01	845.38±24.10	0.1483
12	208	1122.46±15.89	1075.47±16.84	1130.32±29.62	0.0851
14	178	1321.97±19.56	1280.42±21.04	1325.28±34.80	0.2973
16	179	1541.83±22.17	1484.86±23.73	1551.46±39.49	0.1544
20	166	1884.11±23.03	1858.27±25.29	1924.34±43.85	0.4115
24	134	2199.20±33.51	2200.82±36.67	2275.69±58.08	0.4878

* least squares means in the same row with different superscripts are significantly different at $P < 0.05$

Table 3 Least square means (mean ± standard error) of average daily gain (ADG) in Thai indigenous chickens

Age (weeks)	No.	ADG(g/d)			P-value
		AA	AB	BB	
1	214	4.32±0.11 ^a	3.81±0.11 ^b	3.99±0.19 ^{ab}	0.0088*
2	218	6.83±0.15 ^a	6.32±0.16 ^b	6.20±0.28 ^{ab}	0.0320*
3	215	7.04±0.23	6.81±0.24	6.65±0.42	0.6500
4	206	10.71±0.29 ^a	9.60±0.32 ^b	10.55±0.54 ^{ab}	0.0352*
5	220	13.20±0.34	12.81±0.38	12.77±0.63	0.6879
6	211	13.04±0.35	12.81±0.38	12.07±0.62	0.3993
7	208	13.33±0.40	13.71±0.44	14.92±0.70	0.1482
8	220	16.68±0.48	15.57±0.51	16.70±0.85	0.2459
10	220	15.94±0.36	15.30±0.37	16.17±0.64	0.3483
12	208	18.50±0.38	18.08±0.40	19.66±0.71	0.1570
14	178	13.93±0.52	13.89±0.56	14.80±0.92	0.6728
16	179	15.16±0.48	14.76±0.51	15.63±0.83	0.6471
20	166	12.21±0.36	12.87±0.39	12.67±0.67	0.4538
24	134	10.67±0.65	10.08±0.72	12.53±1.17	0.2056

* least squares means in the same row with different superscripts are significantly different at $P < 0.05$

Table 4 Least square means (mean \pm standard error) of shank length in Thai indigenous chickens

Age (weeks)	No.	Shank length(cm)			P-value
		AA	AB	BB	
8	220	5.99 \pm 0.04 ^a	5.84 \pm 0.04 ^b	5.83 \pm 0.07 ^b	0.0158*
12	208	7.69 \pm 0.04	7.58 \pm 0.05	7.68 \pm 0.08	0.1780
16	179	9.09 \pm 0.05	8.98 \pm 0.05	9.04 \pm 0.09	0.3353
20	166	9.50 \pm 0.05	9.53 \pm 0.06	9.59 \pm 0.10	0.7105
24	134	10.03 \pm 0.06	10.05 \pm 0.07	10.16 \pm 0.11	0.5500

* least squares means in the same row with different superscripts are significantly different at $P < 0.05$

Table 5 Least square means (mean \pm standard error) of breast wide in Thai indigenous chickens

Age (weeks)	No.	Breast wide (cm)			P-value
		AA	AB	BB	
8	220	4.15 \pm 0.03	4.06 \pm 0.03	4.15 \pm 0.06	0.0868
12	208	5.04 \pm 0.03	4.95 \pm 0.04	5.01 \pm 0.06	0.1571
16	179	5.83 \pm 0.04	5.76 \pm 0.04	5.79 \pm 0.06	0.4199
20	166	6.30 \pm 0.04	6.28 \pm 0.04	6.20 \pm 0.08	0.5080
24	134	6.47 \pm 0.05	6.48 \pm 0.05	6.36 \pm 0.08	0.4747

* least squares means in the same row with different superscripts are significantly different at $P < 0.05$

CONCLUSION

The polymorphism of chicken *MC3R* gene was associated with body weight, average daily gain and shank length traits. However, no association of *MC3R* gene with the breast wide trait was found in this study. The *MC3R* marker may be used as the molecular marker in selection to improve growth traits in Thai indigenous chickens.

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Finite Element Analysis on the Axial Crushing Responses of Aluminum and Composite Tubes

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Abstract: Tube geometry has been used as an energy absorption structure in automotive application. Its benefit was to reduce the impact energy of the crash on the occupants and to reduce fuel consumption of the vehicle. To determine the energy absorption capacity of a structure, the axially impact crushing test was performed. Axial crushing responses were determined. The responses of the crushing structure were mechanism failure and energy absorption parameters such as load-displacement curve and specific energy absorption. In this paper, numerical simulation was used to predict the axial crushing responses of tubes. Aluminum and composite tubes subjected to axially quasi-static compression and impact crushing were studied. Nonlinear finite element analysis was employed due to geometric nonlinearity. Details of numerical modeling with various failure criteria and contact algorithm were discussed and explained. Various contact algorithms were performed since the loading platen and the tube wall cannot be penetration. The simulations showed local buckling for aluminum tube and progressive crushing for composite tube. These simulations were in good agreement with the experimental results founded previously. The proposed technique would be applied to predict the axial crushing responses of hemp fiber-composite tubes.

Keywords: Energy absorption structures, Impact, Axial crushing, Finite element analysis, Numerical simulation

INTRODUCTION

Automotive structures must have a capability to reduce the impact energy of the crash on the occupants. Design of automotive structure must meet crash energy management that is one of the primary design requirements [1]. Various geometries such as circular, square, conical, and other complex geometries are used for this purpose. Their energy absorption capability depends on either material or geometry of the structures. The capability and failure mechanism of the structure can be determined by impact testing on a structure prototype.

Numerical simulation can be used to predict the axial crushing response of tube structures [2, 3, 4, 5]. Finite element analysis in combination with constitutive model of such material can simulate both the load versus displacement response and failure behavior. Almost publications studied the stable progressive crushing of composite tubes by implementing a user material model and contact interface between interacting parts in an explicit finite element code. It is found that numerical simulation can predict the axial crushing response well.

Crushing responses of metal and composite tubes are totally different. The former normally collapses by plastic buckling, whereas the latter collapses by a combination of fracture processes [6, 7, 8]. This study aimed to predict the axial crushing responses of aluminum and composite tubes. Nonlinear finite element analysis was employed due to geometric and material nonlinearities. Details of numerical modeling were discussed and explained.

MATERIAL AND METHOD

Energy Absorption Parameters

Structures having different geometries and materials can be compared their crushing responses by using energy absorption capability. During impact, crushing energy is dissipated by structural failure mechanism. The dissipated energy is evaluated from the load and displacement response that is occupied through-out a crash test. The well-known parameters which are used for comparing the energy absorption of such geometry and material are as follows:

Average Crush Load

This parameter indicates the absorbed energy relative to the crush distance (δ). It is used to compare the available deformation distance of the same material but having different structures. The average crush load is defined as:

$$P_{\text{ave}} = \frac{\int_0^{\delta_{\text{MAX}}} P \, d\delta}{\delta_{\text{MAX}}} \quad (1)$$

Specific Energy Absorption

This parameter indicates the value of absorbed energy per unit mass of deformed material. It is used to compare the structure having identical shape structure with different materials. The specific energy absorption is defined as:

$$E_s = \frac{\int_0^{\delta_{\text{MAX}}} P \, d\delta}{m} = \frac{\int_0^{\delta_{\text{MAX}}} P \, d\delta}{A\rho\delta_{\text{MAX}}} \quad (2)$$

where m is the mass of deformed material, A is the cross-sectional area, and ρ is the mass density.

Failure Mechanisms of Tubes

Failure mechanisms of crush tube materials behaving ductile and brittle characteristics are totally different. Under stable axial crushing of circular tubes, ductile materials such as aluminum show possible folding with two behaviors. They are axisymmetric and non-axisymmetric manners which are called concertina and diamond modes, respectively [6].

For composite materials, axial crush tubes can be failed with four different crushing modes. These are transverse shearing, brittle fracturing, lamina bending, and local buckling as described by Farley and Jones [7]. They stated that brittle fiber-reinforced composites exhibit the transverse shearing, brittle fracturing, or lamina bending modes. On the other hand, the local buckling crushing mode can be found by both ductile and brittle fiber-reinforced composites.

Finite Element Analysis

In the study of crash analysis, three types of nonlinearity are concerned. These are material, geometric, and force nonlinearities. Nonlinear finite element analysis is implemented because a large amount of plastic deformation is occurred during crash. According to the principle of virtual work, discrete equations of motion are defined as [9, 10]:

$$\mathbf{M}\mathbf{a} + \mathbf{f}^{\text{int}} = \mathbf{f}^{\text{ext}} \quad (3)$$

where \mathbf{M} is time independent mass matrix, \mathbf{a} is vector of nodal point acceleration, \mathbf{f}^{int} is vector of nodal point forces equivalent to the element stress, and \mathbf{f}^{ext} is vector of externally applied nodal point loads.

For contact analysis, a contact term is combined with the internal, external and inertial power, which gives [9]:

$$\delta \mathbf{v}^T (\mathbf{f}^{\text{int}} - \mathbf{f}^{\text{ext}} + \mathbf{M}\ddot{\mathbf{d}}) + \delta (\mathbf{v}^T \mathbf{G}^T \boldsymbol{\lambda}) \geq 0, \quad \forall \delta v_{ij} \notin \Gamma_u \text{ and } \forall \delta \lambda_i \leq 0 \quad (4)$$

where \mathbf{G} is a gap function for contact surface pair, \mathbf{v} is the velocity vector, and $\boldsymbol{\lambda}$ is the normal contact force vector. Because $\delta \mathbf{v}$ and $\delta \boldsymbol{\lambda}$ can be arbitrary, the equations of motion and the interpenetration condition can be obtained [9]:

$$\mathbf{M}\ddot{\mathbf{d}} + \mathbf{f}^{\text{int}} - \mathbf{f}^{\text{ext}} + \mathbf{G}^T \boldsymbol{\lambda} = \mathbf{0} \quad \text{and} \quad \mathbf{G}\mathbf{v} \leq \mathbf{0} \quad (5)$$

Standard procedures for the solution of differential equation can be used to calculate the solutions of Equations (3) and (5). Direct time integration such as central difference method and mode superposition can be used. More details of the methods can be found in references 9 and 10.

Failure Criteria

In order to predict the conditions of which solid materials fail under the action of external loads, various failure criteria can be considered. Maximum stress and strain failure criteria are the well-known methods that are used for isotropic materials. The selected components of stress and strain are individually compared to the corresponding critical values that define failure.

For arbitrary orthotropic materials such as laminated composite, one of the most efficient criteria is Chang-Chang [11] failure criterion. The criterion computes the material failure and stiffness degradation for tension and compression separately with either in the fiber or matrix directions. The matrix direction is assumed to be the transverse direction of fiber laminated layup. Failure criterion and stiffness degradation are given as follows [11, 12]:

Failure Criterion for the Tensile and Compressive Fiber Modes,

$$\left(\frac{\sigma_{aa}}{X_t}\right)^2 + \beta \left(\frac{\sigma_{ab}}{S_c}\right)^2 \geq 1 \quad \text{and} \quad \left(\frac{\sigma_{aa}}{X_c}\right)^2 \geq 1, \quad (6)$$

Failure Criterion for the Tensile and Compressive Matrix Modes,

$$\left(\frac{\sigma_{bb}}{Y_t}\right)^2 + \left(\frac{\sigma_{ab}}{S_c}\right)^2 \geq 1 \quad \text{and} \quad \left(\frac{\sigma_{bb}}{2S_c}\right)^2 + \left[\left(\frac{Y_c}{2S_c}\right)^2 - 1\right] \frac{\sigma_{bb}}{Y_c} + \left(\frac{\sigma_{ab}}{S_c}\right)^2 \geq 1 \quad (7)$$

where subscripts a and b indicate the properties in the fiber and transverse directions, respectively.

Simulation Examples

Finite element model was implemented in the LS-DYNA commercial software for numerical simulations of static compression and impact crushing of aluminum and composite tubes. Since numerical results were compared with those of experiments, materials used in this study were selected following the other previous works. Three material types were studied: aluminum, carbon/epoxy composite, and hemp/epoxy composite as did by Bouchet et al. [13], Huang and Wang [5], and Meredith et al. [14], respectively. Aluminum and carbon/epoxy composite were in cylindrical shape, but that of hemp/epoxy composite was cone. Details of test specimens are shown in Table 1. The material properties of aluminum and hemp/composite are given in Table 2. The mechanical properties of carbon/epoxy

composite can be found in the work of Huang and Wang [5]. It is noticed that the further of this study will implement the numerical simulation to predict the axial crushing responses of hemp fiber-composite tubes.

Finite element models used in this study are shown in Figure 1. The cylindrical model composed of three parts: rigid plate, tube specimen, and planar rigid wall. The rigid plate was used as the loading platen to compress the tube specimen. All translational and rotational degree of freedom (DOFs) of the planar rigid wall were constrained. The wall was used to retrieve the load data for generating the load versus displacement response. For cone specimen, the vertical translational DOF of the cone's base was free for compressing the cone to the planar rigid wall.

The material model 24 "mat piecewise linear plasticity" was selected to represent the mechanical behaviors of aluminum and hemp/epoxy composite. For carbon/epoxy composite, the material model 54 "mat enhanced composite damage" was used as recommended by Huang and Wang [5]. Various contact algorithms were used to prevent the penetration between the loading platen and the tube wall [5]. The contact interfaces were "contact automatic surface to surface tiebreak", "contact eroding single surface", "contact automatic nodes to surface" and "rigidwall planar finite".

RESULTS AND DISCUSSIONS

Failure behavior of the test specimens comparing with the experiment results are shown in Figure 2. It is found that failure responses of all specimens were in agreement as tested by the other previous works. Aluminum tube folded with local buckling or diamond mode, but carbon/epoxy tube and hemp/epoxy cone presented progressive crushing. However, there was no spraying of lamina bundles for carbon/epoxy tube as found by the experiment. The reason is that there are various damage accumulations that cannot accurately represent the quasi-brittle failure of laminates by the used failure criteria [5].

Table 1 Details of test specimen.

Material	Shape	Inside diameter (mm)	Apex angle (°)	Thickness (mm)	Height (mm)
Aluminum	Cylinder	46	0	1	100
Carbon/epoxy	Cylinder	50	0	1.92	100
Hemp/epoxy	Cone	-	15	3	149

Table 2 Mechanical properties of aluminum and hemp/epoxy composite.

Material	Density (kg/m ³)	Tensile strength (MPa)	Young's modulus (GPa)	ν
Aluminum	2,680	130	70	0.3
Hemp/epoxy	1,285	253.4	26.35	0.05

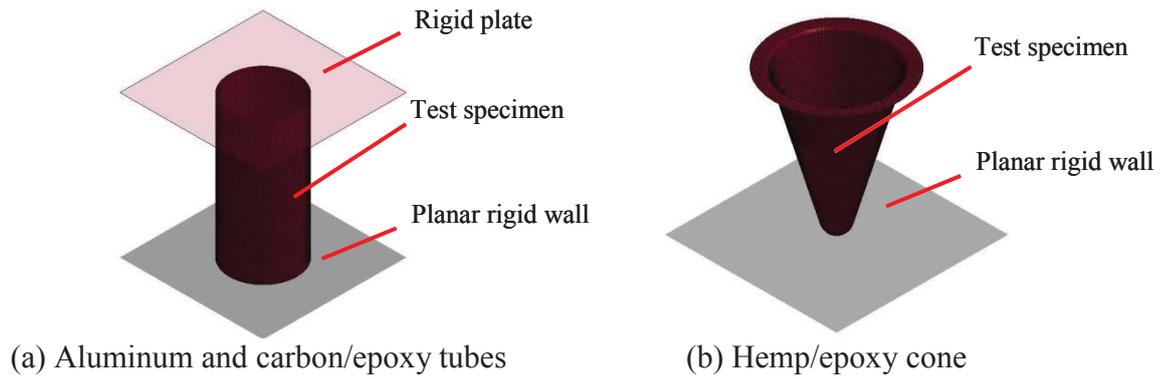


Figure 1 Finite element models.

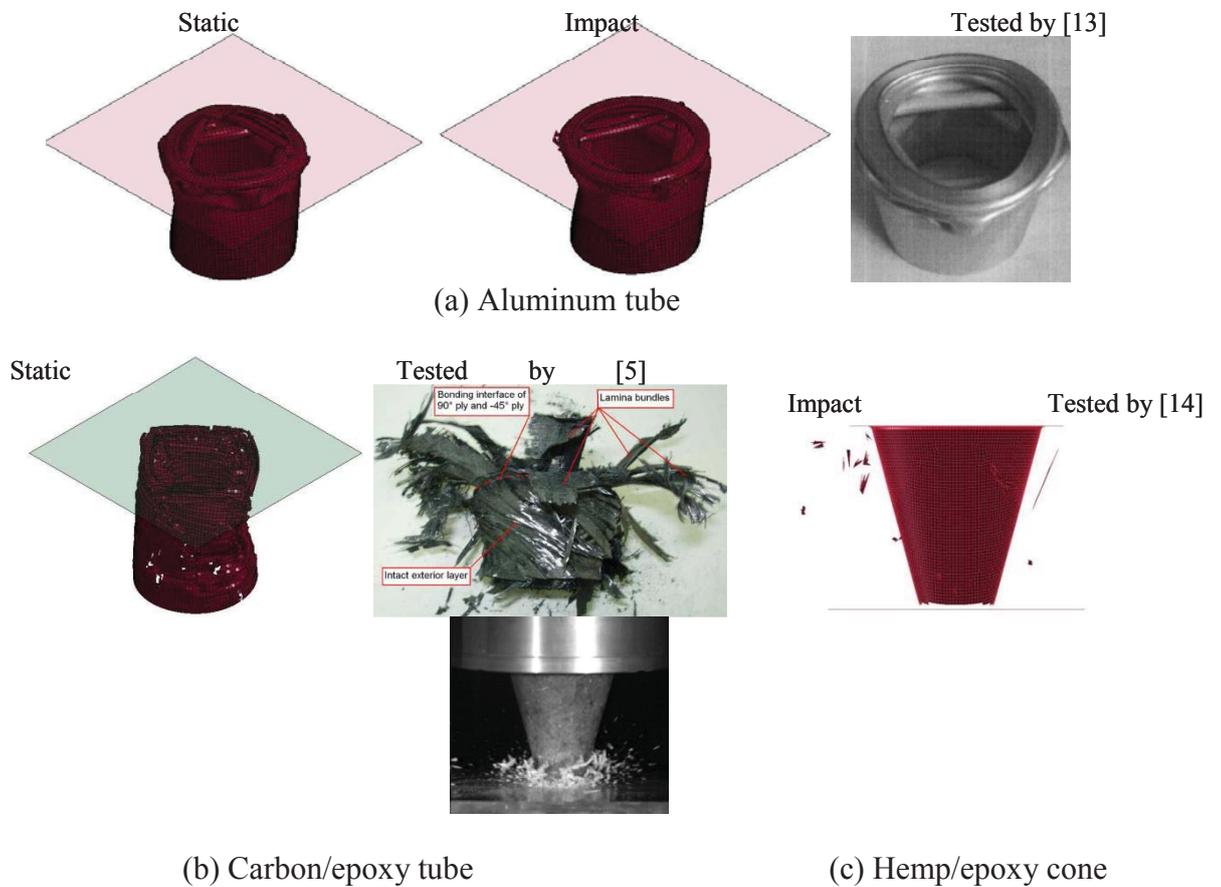


Figure 2 Numerical and experimental failure behaviors.

Load versus displacement responses of aluminum tubes obtained from numerical simulation are shown in Figure 3. The crush load of impact crushing was more fluctuated than that of static compression. Average crush load (P_{ave}) and specific energy absorption (E_s) were calculated by using Equations (1) and (2), respectively. Numerical and experimental values are presented in Table 3. It can be found that numerical predictions were in good agreement with the experimental results.

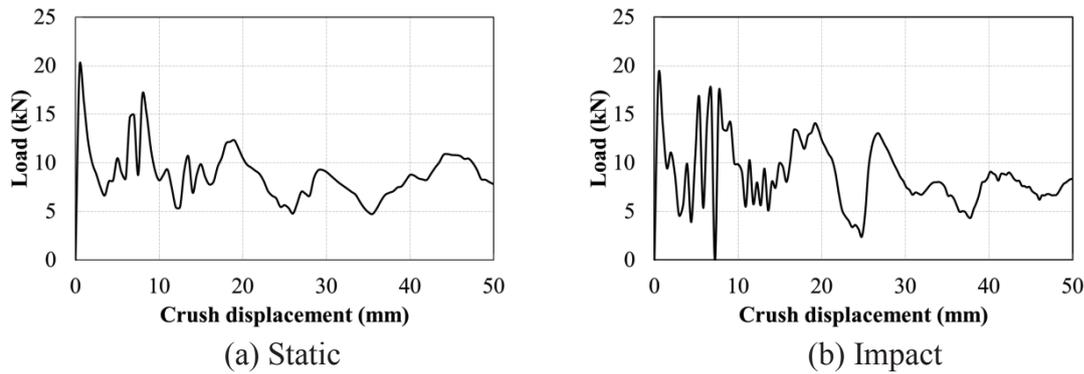


Figure 3 Numerical load versus displacement responses of aluminum tubes.

Table 3 Numerical and experimental results of aluminum tubes.

Parameter	Static compression		Impact crushing	
	Experiment [13]	FE	Experiment [13]	FE
Average crush load (kN)	9.7	8.75	9.7	8.26
Specific energy absorption (kJ/kg)	22.0	22.1	22.0	21.6

CONCLUSION

Axial crushing responses of aluminum tube, carbon/epoxy tube, and hemp/epoxy cone were numerically determined. Failure behaviors obtained by using failure criteria in LS-DYNA showed deformed pattern as occurred by the experiments. Energy absorption parameters calculated from the load versus displacement response were in good agreement with the experimental results. The exact methodology for numerical simulation will be improved for the further study. The method will be implemented to predict the axial crushing responses of hemp fiber-composite tubes.

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Design of Solar Heating System for Anaerobic Digestion of Organic Waste in the Cold Region of Thailand

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Abstract: Temperature is an important factor in the performance of anaerobic digestion. Therefore, the design of a solar heating system for anaerobic digestion of organic waste in the cold regions of Thailand was proposed. A 1 cubic meter digester was built with solar heating system. The temperature of fermentation process was kept in range of 35-39 degrees Celsius. Joint control between solar heating system and anaerobic reactor was developed to maintain the fermentation temperature in the proper range. It was founded that the biogas potential increased and biogas could be produced continuously in the cold weather.

Keywords: Anaerobic digestion, Organic waste, Solar heating system

INTRODUCTION

In Thailand, pollution of the air and water from community, industrial and agricultural operations continues to grow. The implementation of renewable energy has a great potential of mitigating several problems related to ecological imbalance, minimize crucial fuel demand, improve hygiene and health, and improvement in quality of life in rural and semi-urban areas [1]. The biogas technology is a key for environmental pollution control because methane is an important greenhouse gas, but if captured for use, it acts as a good renewable energy source.

The performance and efficiency of the anaerobic digestion process is dependent on the following factors [2-3]: Substrate temperature, available nutrients, retention time, pH level, nitrogen inhibition and C/N ratio, substrate solid content and agitation, inhibitory factors. However, temperature is an important factor that may affect the performance of anaerobic digestion [4]. The amount of gas produced increases with digester temperature, with retention time and with the percentage of total solid in the slurry. Typically for 25°C to 44°C, 0.25 m³ to 0.40 m³ of methane gas is produced for each kilogram of volatile solids destroyed [5]. Anaerobic digestion can take place at any temperature between 3°C and 70°C. Differentiation is generally made between three temperature ranges: The psychrophilic temperature range lies below 20°C, the mesophilic temperature range between 20°C and 40°C, and the thermophilic temperature range above 40°C [2]. Most of anaerobic digesters in Thailand are commonly designed to operate in the mesophilic temperature range. However, in the northern winter of Thailand has lower (< 20 °C) temperature than the mesophilic temperature. To keep the anaerobic digester temperature constant, external source of heating is used like electricity, oil, or part of the produced biogas. The use of such fuel is uneconomical [4]. Solar is high potentiality energy resource in the northern Thailand, which can be used for improving anaerobic digestion temperature. The utilization of solar energy is not only the achieved of digestion process efficiency, but also the environmental and economical are friendly.

The present article aims to design the solar heating system for treatment of anaerobic digestion process. The anaerobic digester in sizing of 1 m³ is developed in our laboratory. A solar and a heat exchanger are designed and manufactured. The controller is also designed and installed to maintain the temperature in range of 35 – 39 °C in the biogas digester.

MATERIALS AND METHODS

Anaerobic Digester

The anaerobic digester in this research was designed in sizing of 1,000 liters with same length, width and height of 100 centimeters as shown in Figure 1 The polyethylene was chosen as material to build the digester because of its durability on corrosion and high flexibility. Moreover, the outside of digester is supported with galvanized steel cage to protect the oversize of digester configuration when the biogas is produced. The anaerobic sewage inside the digester is maintained at 500 liters to leave the rest volume of digester for the biogas production space.



Figure 1 The cubical anaerobic digester in sizing of 1,000 liters.

Solar Heating System

The heating required for the anaerobic digester is performed by using a solar collector connected with a cylinder storage tank as shown in Figure 2 The hot water generated by solar collector circulated from the storage tank passes through the cubical digester within the stainless tube of ½ inch diameter, which performs as heat exchanger. Heating this volume of water to 40 °C formed the basis for the solar heating system design.

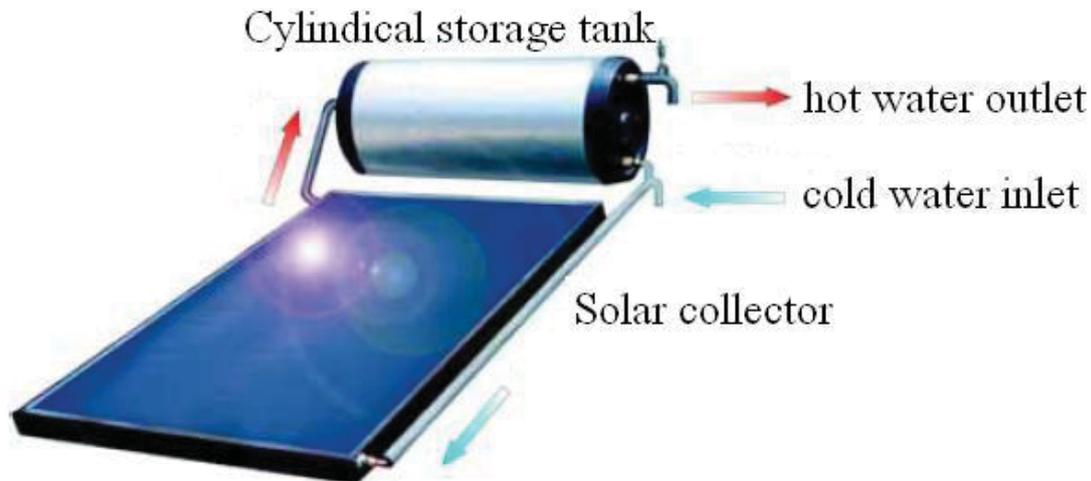


Figure 2 Solar collector and the cylindrical storage tank.

Solar Collector

The solar collector consists of a galvanized steel flat plate of 190 × 108 –cm dimensions. Water contained within the galvanized steel tube of the solar collector is 1.2 liter and the maximum pressure tested at 12 bar gauge.

Cylindrical Storage Tank

The sizing of cylindrical storage tank is 565 mm in diameter and 1,020 mm in length. The storage tank is manufactured by steel sheet and coating with enamel to protect the corrosion from various water conditions. The outside of storage tank is wrapped with the glass wool of 100 mm thickness and covered with another galvanized steel cylinder of 950 mm diameter for insulation purposes.

Heat Exchanger

The heat exchanger is installed inside the anaerobic digester. Eight tube of ½ inch diameter of stainless steel are arranged in the horizontal direction and jointed though top and bottom heads with the manifold tube of 1 inch diameter on the vertical direction as shown in Figure 3 These eight tubes are spread 10 cm center to center for balance of heat transfer to each level of the anaerobic sewage. Two heat exchangers are positioned at the bottom of digester and also connected together at the main tube at the outside of digester.

Figure 4 represents the schematic diagram of the integrated components of the biogas digester and solar heating system. Cold water is supplied through the bottom of the flat plate solar collector and the hot water is retained in the cylinder storage tank. The outlet water from the anaerobic digester is fed back to the cylindrical storage tank where it is reheated and then pumped back to the heat exchanger inside the digester again until it reaches to the setting temperature.



Figure 3 The heat exchanger inside anaerobic digester.

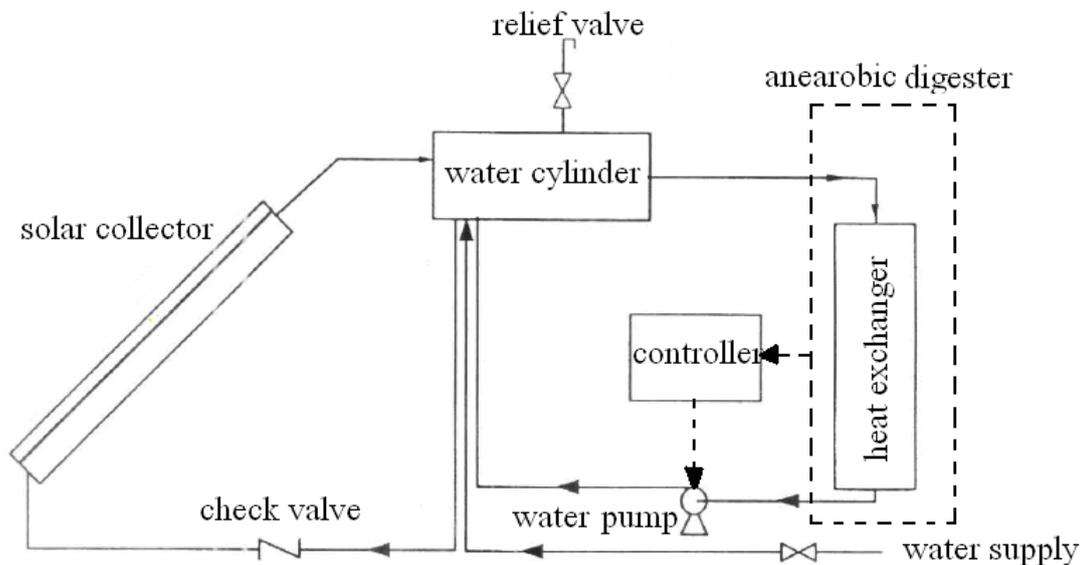


Figure 4 Schematic diagram of integration of biogas digester and solar heating system.

Temperature Controller

One of the objectives of this research is to keep a constant temperature inside the biogas digester. Therefore, an efficient temperature controller has to be implemented to guarantee a stable system. The functional diagram of temperature controller in this research is presented in Figure 5. It involves the heat exchanger inside the biogas digester, a temperature sensor, a controller, and a water pump.

The parameters of the controller will be set combining with thermal storage tank, real-time monitoring the temperature inside the anaerobic digester, of water and solar hot water. The water pump is controlled to circulate the hot water flow between the thermal storage tank and the heat exchanger inside the biogas digester. Therefore, the temperature inside the biogas reactor will be always within a constant scope by regulating the heat exchange and thermal storage tank.

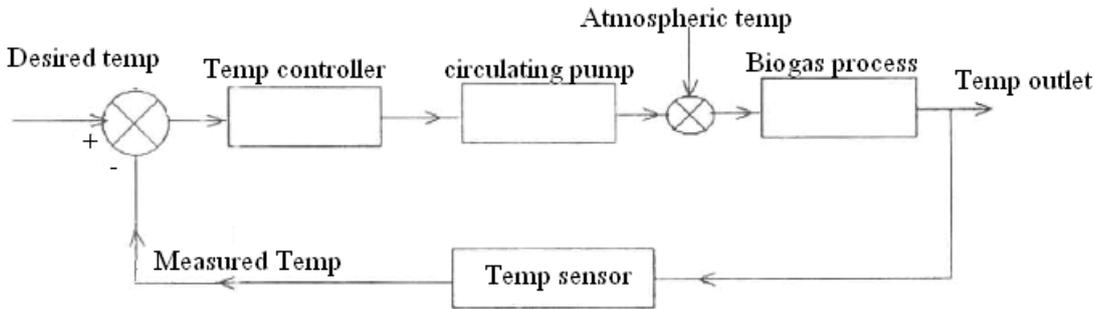


Figure 5 The functional diagram of temperature controller.

Design Basis and Efficiency Calculations of Solar Collector

Conventional solar energy equations were used for the purpose of computing the design parameter of the flat plate collector [6-7]. The theoretical efficiency (η) is based on the following equation:

$$\eta = q_0/[I_T * A] \tag{1}$$

where I_T represent the radiated flux on the collector, q_0 is the useful heat gained by fluid, and A represents the area of the collector. The radiated flux I_T is evaluated from the following equations:

$$I_T = I_b * R_b + I_d * R_d + (I_b + I_d) * R_r \tag{2}$$

where I_b and I_d are the hourly beam and diffuse radiation, respectively, and R_b , R_d , and R_r are the tilt factors for the beam, the diffuse and the reflected radiation, respectively.

The useful heat q_0 is also determined by the following equation:

$$q_0 = A * S - q_L \tag{3}$$

where S is determined by

$$S = I_b * R_b(\tau\alpha)_b + \{I_d * R_d + (I_b + I_d) * R_r\} * (\tau\alpha)_d \tag{4}$$

and q_L is evaluated from the following equation:

$$q_L = U_L * A(T_p - T_a) \tag{5}$$

where U_L is the overall heat loss (transfer) coefficient which includes loss (transfer) coefficients of the top, the bottom, and the sides of the collector; $(\tau\alpha)_b$ and $(\tau\alpha)_d$ represent of transitivity the glass (τ) and the absorbtivity of the plate (α) for both beam radiation and diffuse radiation, respectively. The term T_p and T_a represent the average plate temperature and ambient temperature, respectively. The theoretical efficiency can be calculated after the solar energy data in the above equation are obtain and it is compared with the experimental efficiency when the solar heating system is already developed in the next step.

RESULTS AND DISCUSSION

This research has to integrate the solar heating system and anaerobic digester for treatment the anaerobic fermentation process. The conceptual design of joint them together is corresponding to the several issues as following:

1. The limitation of the traditional biogas production when operated in the lower temperature than 20 °C that can't produce continuously will be solved by using solar thermal treatment
2. The designed solar heating system will maintain the anaerobic digester temperature in the desired range of 37±2 °C.
3. An intelligent control system must be developed in this research. The reasonable temperature will be determined by collecting of numerous local climatic conditions in the northern of Thailand. The sewage temperature inside the digester, solar hot water and surrounding temperature are monitored in real-time for using as the data to control the temperature inside the digester within a constant scope.

CONCLUSION

This research is on going now, the biogas digester as shown in Fig.1 was already developed in our laboratory and the solar heating system is under manufacturing. This design is used since its components are cheap and can be obtained easily in a market where prices are low in Thailand. Savings are a very important point in any experimental design.

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Isolation and Screening of Starch Hydrolyzing and Lactic Acid Producing Bacteria for Direct Lactic Acid Production from Starch

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Abstract: Starch hydrolyzing and lactic acid producing bacteria are important for many industries such as foods, pharmaceutical, leather, textile and other chemical industries. Bacteria from various sources were isolated on standard De Man, Rogosa and Sharpe (MRS) agar (adding 1% soluble starch) by pour plate technique. One hundred and sixty two isolates were obtained. Two hundred and eighty nine isolates from microbiology laboratory of Maejo University and 22 bacterial strains from microbial culture collection were included. Primary screening for their ability for starch hydrolysis and acid production of total 473 bacteria were done on MRS modified 1 agar (adding 1% cassava starch) by using point inoculation technique. Ten bacteria hydrolyzed starch and produced acid and one bacterium produced acid but did not hydrolyze starch. Lactic acid production from starch of eleven selected bacteria were examined in MRS broth modified 1 (adding 1% cassava starch). The bacterium NMPY1M produced highest amount of lactic acid at 3.85 g/l.

Keywords: Isolation, Screening, Starch hydrolyzing bacteria, Amylolytic, Lactic acid bacteria

INTRODUCTION

Lactic acid production has attracted considerable attention, because of its application as a precursor of polylactic acid (PLA) and can be used as material for produce biodegradable plastic. One of factors that affect the production cost in lactic acid production is raw material. Nowadays, most widely used substrate for lactic acid production are refined sugars, glucose and sucrose, which are expensive. Although lactic acid is also produced from abundant and renewable substances such as lignocellulosic materials, starch. Among starchy materials, cassava starch is being considered as an attractive raw material for industrial exploitation due to it is produced abundantly in the agricultural plant. Conventional production of lactic acid from starchy materials, requires pretreatment for gelatinization and liquefaction, and subsequent conversion of glucose to lactic acid by fermentation resulted in high cost production [1]. However, cost reduction of lactic production from starch can be performed by using the amylolytic lactic acid bacteria (ALAB). ALAB utilize starchy biomass and can convert starch directly into lactic acid in single step. The use of efficient ALAB producing bacteria reduce production cost, result in saving in liquefaction and /or saccharification cost. There are many attempts to isolate and screen ALAB from various sources. ALAB can ferment different types of amylaceous raw material, such as fermented maize starch [2] and potato [3]. Ouattara et al. [4] isolated ALAB, *Lactobacillus plantarum* from African cassava-based fermented products. ALAB, *Enterococcus faecium* was isolated from sago starch [5-6]. Sanni et al. [7] described amylolytic strains of *L. plantarum* and *L. fermentum* strains in various Nigerian traditional amylaceous fermented foods. *Lactobacillus*

plantarum was isolated from rice slurry in the Kanom jeen (Thai rice noodle) process [8]. Wang et al. [9] isolated *L. rhamnosus* strain CASL from the soil samples in a milk-producing factory in China.

To isolate and screen for the potential amylolytic lactic acid bacteria (ALAB) with high volumetric productivity and product yield of lactic acid are very interesting because of their potential industrial applications. There were extensive commercial applications in starch liquefaction, brewing, sizing in textile industries, paper and detergent manufacturing processes. The aims of this study are to isolate and screen of potential amylolytic lactic acid bacteria strains from various sources.

MATERIALS AND METHODS

Isolation of Bacteria

Starch hydrolyzing and acid producing bacteria were isolated from several different sources (fermented foods, Thai fermented rice noodle starch, food waste, waste water and soil from noodle processing factories). Each sample was serially diluted and appropriate dilutions plated onto standard De Man, Rogosa and Sharpe (MRS) agar (pH 7.0) (adding 1% soluble starch) by pour plate technique. The agar plate was incubated in candle jar at 37 °C for 24-48 hours. Thirty to three hundred colonies were randomly (different colony types) picked from plates. Several representative strains displaying the general characteristics of lactic acid bacteria were chosen from each plate for further studies. Each of the isolates were repeatedly streaked in order to purify the isolates, which were maintained on MRS agar slants and kept in 20% glycerol for storage at -20 °C until further use. All of isolates and two hundred and eighty nine isolates (from microbiology laboratory of Maejo University) and 22 bacteria strains (from microbial culture collection) were collected. Total 473 bacteria were screened the starch hydrolyzing and lactic acid producing bacteria and then used for further study.

Screening of Starch Hydrolyzing and Acid Producing Bacteria

Plate assays for detection of starch hydrolysis and acid production of total 473 bacteria were done on MRS agar modified 1 (pH 7.0) using point inoculation technique. The composition of MRS agar modified 1 were (g/l) : peptone 10.0; beef extract 10.0; yeast extract 5.0; sodium acetate 5.0; tri-sodium phosphate 2.0; di-ammonium hydrogen citrate 2.0; Tween80 1.0; magnesium sulphate (7H₂O) 0.1; manganese sulphate monohydrate 0.05 (adding 1% soluble starch). Incubation at 37 °C was carried out for 24-48 h. The acid production of bacteria was observed as yellowish zone on agar plate. Iodine solution was flooded on the surface of the plates for 30 seconds. The plates were examined for the starch clear zone surrounding the bacterial colonies is a typical positive starch hydrolysis. The colonies with clear zone forming were selected for further study.

Lactic Acid Production from Cassava Starch of Selected Bacteria in Culture Broth

Lactic acid production from starch was examined in MRS modified 1 broth. Twenty four hours of bacterial cell suspension was inoculated as 2% (v/v) to culture medium and incubated in candle jar (no shaking) at 37 °C for 24 hours. The cells were harvested by centrifugation 8,000 rpm for 10 min. The lactic acid concentration was determined by titration method.

RESULTS AND DISCUSSION

Isolation of Bacteria

Table 1 Number of isolated bacteria from various sources on standard MRS agar

Sources	Bacterial code	Number of isolate bacteria
Fermented Thai rice noodle starch (Khanom jeen)	PKJ, PS, UNP	21
Fermented foods	NCR, NCM, NMPY, NNPY, PSCR, PSPY, PK, MCR, MPY, ON, YK ,PD	94
Food waste	RM	9
Waste water (waste water (from noodle factory, foods)	NK, NP, NS, SF, SW	16
Soil (from noodle factory)	SC, SM5 SN, SO, SS,UN	22
Total		162

Table 2 Bacteria used for primary screening of starch hydrolyzing and acid producing bacteria

Bacteria	Number
Isolated bacteria	162
Stocked culture of bacteria from microbiology laboratory of Maejo University	289
Microbial collection (TISTR, BCC)	22
Total	473

Primary Screening of Starch Hydrolyzing and Acid Producing Bacteria

Table 3 Primary screening of starch hydrolyzing and acid producing bacteria in MRS agar modified 1

Number	Bacteria code	Appearance on MRS agar modified 1	
		Diameter yellowish zone (acid production) (mm)	Diameter of clear zone after stained with iodine solution(starch hydrolysis) (mm)
1	NMPY1M	5	6
2	NMCR1N	6	6
3	NP-1	7	5
4	ON-4	8	4
5	SF-2	5	2
6	SF-5	6	3
7	SF-6	4	2
8	SW-1	6	4
9	SW-6	5	5
10	SW-42	4	4
11	TISTR450	7	-

Total 473 bacteria were preliminary screened of acid producing and starch hydrolyzing activity on MRS agar modified 1. It was found that 11 isolates (NMPY1M, NMCR1N, NP-1, ON-4, SF-2, SF-5, SF-6, SW-1, SW-6, SW-42 and TISTR450 presented acid production and starch hydrolyzing, except TISTR450 could not hydrolyzed starch. Fossi and Tavea [10] preliminary screened of amylolytic lactic acid bacteria from soil sample in cameroon by observed clear zone on MRS-starch agar. They found that 9 isolates (04BBA15, 04BBA19, 05BBA22, 05BBA23, 14BYA42, 20BBA60, 17BNG51, 23BYA21, 26BMB81) presented high amylolytic power and were qualified as amylase overproducing isolates. Boontawan [11] isolated and screened lactic acid producing and starch hydrolyzing bacteria from fermented cassava waste in Thailand on starch agar plates containing 2.0% agar and 1% starch at pH 7.0. The most efficient strain identified was *Pediococcus pentosaceus*. ALAB, *Streptococcus* sp. and *Lactobacillus* sp.were isolated and screened from pla-som (Thai fermented fish product) [12].

Lactic Acid Production from Cassava Starch of Selected Bacteria in Culture Broth

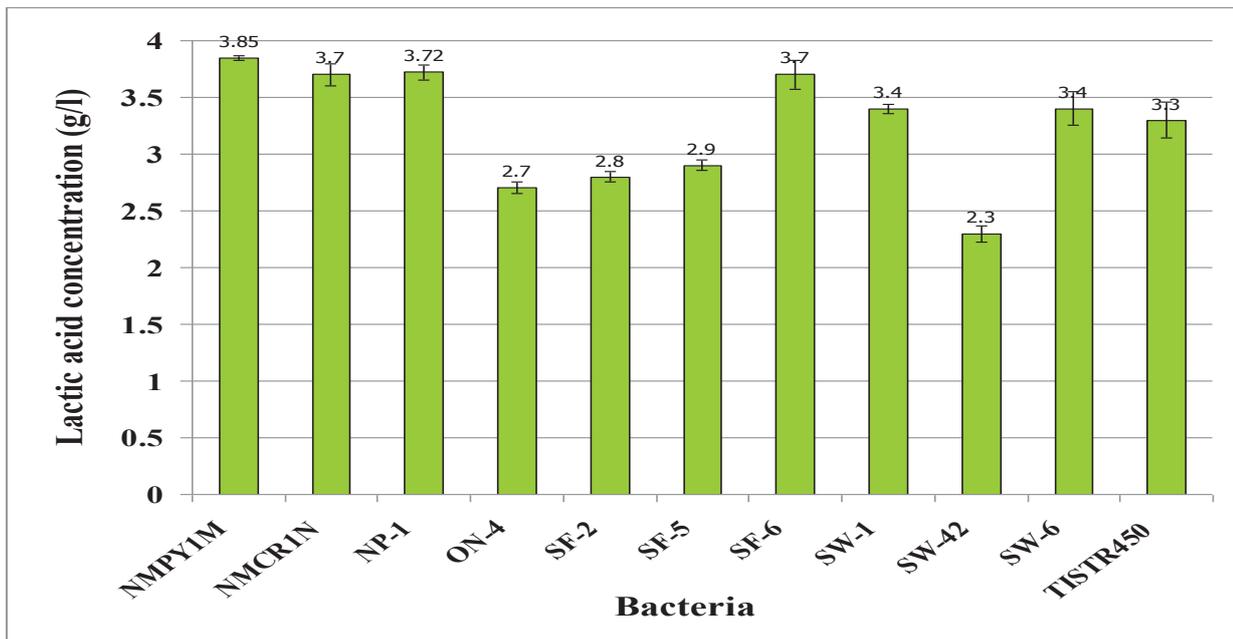


Figure 1 Lactic acid production from starch in MRS broth modified 1 containing in test tube incubated at 37 °C for 24 hours.

The lactic acid production from cassava starch was carried out in MRS broth modified 1 (adding 1% cassava starch) containing in test tube incubated at 37 °C for 24 hours. It was found that isolate NMPY1M produced highest lactic acid from cassava starch at 3.85 g/l. Vishnu et al. [13] isolated *L. amylophilus* GV6 from starch industry waste. Afifi [14] produced lactic acid from liquid potato wastes by *Lactobacillus casei* EMCC 11093, by obtained lactic acid at 16.09 g/l. Quintero et al. [15] produced lactic acid from *Lactobacillus brevis* The highest lactic acid production in HY1 medium 24.3 g/l for 120 h. Yuwono and Hadi [16] produced lactic acid from fresh cassava roots by *Streptococcus bovis*, the lactic acid concentration were 15.7 g/l. In this study, bacterial NMPY1M (isolated from thai fermented pork, Nham) showed high lactic acid production and showed amyolytic activity. Olympia et al. [17] characterized amyolytic strains of *L. plantarum* isolated from burong isda, a fermented food made from fish and rice in Philippines. Amyolytic lactic acid bacteria (ALAB) have been reported from different starchy raw material and fermented amyloaceous foods. Starchy biomass appears as an important eco-niche for the screening and isolation of ALAB, which can be industrially applied to convert starch into sugar for lactic acid fermentation. The composition of the microbiota and in particular the occurrence of ALAB is determined by the way the raw material is processed [18].

CONCLUSION

The starch degrading and lactic acid producing bacteria were isolated from different samples on standard MRS starch agar. Bacterial NMPY1M (isolated from fermented pork; Nham) showed starch hydrolyzing and lactic acid producing on MRS agar modified 1 agar. This bacteria produced highest lactic acid at 3.85 g/l in MRS broth modified 1 broth. Amyolytic lactic acid bacteria could be used for eliminate the two step process of lactic acid production from starch to make it economical. For further studies we will focus on optimize condition for direct lactic acid from starchy material by bacterial NMPY1M.

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Usage of Carrot, Pumpkin, and Corn Powders for Oxidation Retardation in Cookies

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Abstract: Cookies, popular bakery product, can develop rancid flavor during storage due to the high fat content. Supplementation of natural products with antioxidant activity in cookies could be an option to retard oxidation in cookies. The objectives of this research were to study the optimum drying temperature of carrot, pumpkin, and corn and to investigate the effects of flour substitution in cookies using dried carrot, pumpkin, and corn powders on oxidation retardation and sensory acceptance. The antioxidant activities of samples were conducted using DPPH and ABTS. It was found that heating at 50, 60, and 70°C reduced the antioxidant activities of the carrot, while the antioxidant activities of pumpkin increased compared to unheated samples. Heating at 50°C reduced the antioxidant activities of corn but heating at 60, and 70°C increased the antioxidant activities of corn compared to fresh sample. The optimum drying temperature of the carrot, pumpkin, and corn at 60, 60, and 70°C, respectively were selected to make the dried powders with the highest antioxidant activities for further use of flour substitution in cookies. The 30% flour substituted cookies with fresh carrot, pumpkin, and corn or dried sample powders were packed in polypropylene film or aluminum foil in a storage at room temperature. The courses of oxidation were conducted using peroxide and TBA values compared to cookies without substitution (control). It was found that the peroxide and TBA values of all cookies samples increased during storage for 14 days. The packaging materials did not influence the peroxide value of flour substituted cookies with fresh or dried sample powders. An increase of TBA value of flour substituted cookies packed in polypropylene film was higher than of flour substituted cookies packed in aluminum foil during storage ($p < 0.05$). There were no significant differences of overall acceptance scores of flour substituted cookies with fresh carrot, pumpkin, and corn compared to control ($p > 0.05$). The overall acceptance scores of flour substituted cookies with dried carrot, and pumpkin powders were lower than of control ($p < 0.05$).

Keywords: Carrot, Pumpkin, Corn, Cookies, Antioxidant activity

INTRODUCTION

Carotenoid compounds, especially beta-carotene, have antioxidant activity. Beta-carotene contents in carrot, pumpkin, and corn are 6994 [1], 1079.6 [2], and 47 [3] $\mu\text{g}/100\text{ g}$ fresh samples, respectively. Carotenoids can act as primary antioxidants by trapping free radicals or as secondary antioxidant by quenching singlet oxygen. However, in the absence of singlet oxygen (low oxygen partial pressure), carotenoids may also prevent oxidation by trapping free radicals and acting as chain-breaking antioxidant [4]. At 90°C drying temperature, the degradation of beta-carotene in carrot was found [5]. However, the antioxidant activity of carotenoid compounds might increase when the optimum heating temperature achieved [6].

Butter cookies were the popular bakery worldwide with 20% fat content [7]. The rancidity of the cookies developed during storage due to oxidation reaction of fat which could affect consumer acceptance. In the previous studies, many attempts had been made for oxidation retardation in cookies including wheat flour substitution and optional packaging materials. Arora and Camire [8] found that 15% flour substitution with potato peels reduced oxidation in cookie. Sharif et al. [9] reported that the thiobarbituric acid (TBA) number of shortening substituted cookie with rice bran oil decreased with an increase of percent of substitution when compared to control without substitution. Lu and Xu [7] studied the effect of packaging materials with different oxygen-barrier properties on the oxidation of cookies during storage. The result showed that an increasing rate of the peroxide value (PV) of the sample packed in polyethylene terephthalate/aluminum/oriented nylon/polyethylene (PET/AL/ONY/PE) with high oxygen-barrier ability was lower than of the samples packed in oriented nylon/polyethylene (ONY/PE), bi-oriented polypropylene/vacuuming aluminized casting polypropylene (BOPP/VMCPP), or bi-oriented polypropylene/polyethylene (BOPP/PE). Gupta et al. [10] reported that wheat flour substituted cookie with barley flour packed in paper/aluminum foil/polyethylene (PFP) had less increasing trend of PV but more increasing trend of TBA value than cookie sample packed in metallised/polyethylene terephthalate/low-density/linear low-density (Met.Pet.). The sensory acceptance score of 30% wheat flour substituted cookie with barley flour had no significant difference compared to control. Inthariya et al. [11] found that an increase of percent substitution of wheat flour with durian powder increased the firmness of wheat flour substituted cake but did not affect the firmness of wheat flour substituted cookie. There were no significant differences of sensory acceptance scores between 30% wheat flour substituted cake, cookie, and bread with durian powder and control.

The objectives of this study were to evaluate the antioxidant activities of fresh and dried carrot, pumpkin, and corn at different drying temperatures and to investigate the oxidation retardation in butter cookies by 30% wheat flour substitution using fresh and dried carrot, pumpkin, and corn as sources of natural antioxidant. The effect of packaging materials for wheat flour substituted cookies was also investigated during storage.

MATERIALS AND METHODS

Materials and Chemicals

Carrot, pumpkin, corn, wheat flour, butter, shortening, egg, vanilla flavor, baking powder, castor sugar, and salt were purchased from local supermarket in Chiang Mai, Thailand. Methanol, boric acid, sulfuric acid, 1-butanol, isopropyl alcohol, sodium hydroxide, phenolphthalein, and barium chloride were supplied by Labscan, Ireland. Chloroform, sodium chloride, anhydrous sodium sulfate, copper sulfate, potassium persulfate, and hydrochloric acid were supplied by Merck, Germany. Xylenol orange and 2-thiobarbituric acid were supplied by Sigma, USA. 2,2'-azino-bis (3-ethylbenzthiazoline-6-sulphonic acid), 2,2-Diphenyl-1-picrylhydrazyl, and ferrous sulfate were supplied by Carlo Erba, France.

Preparation of Dried Carrot, Pumpkin, and Corn Powders

Carrot, pumpkin, and corn were peeled, chopped, and dried in hot air oven at 50, 60, and 70°C. The drying of carrot, pumpkin, and corn were done up to final moisture content of 10, 10, and 25%, respectively. The dried samples were grinded, packed in polyethylene/aluminum foil/polyethylene laminate (PE/AL/PE) under vacuum and stored at -4°C before analyzed.

Determination of Antioxidant Properties of Fresh and Dried Carrot, Pumpkin, and Corn

The extraction of fresh and dried carrot, pumpkin, and corn were performed using modified method of Arslan and Ozcan [12]. Approximately 400±1 mg of fresh or dried sample was added in a centrifuge tube with 5 mL of the solvent mixture MeOH-H₂O (80:20, %v/v). The centrifuge tube was placed in a sonicator bath at ambient temperature for 30 min, and then centrifuged at 6000 rpm for 10 min. The supernatant of the mixture was transferred to a 10 mL volumetric flask. The residue was extracted again using the same previous procedure. The supernatant was combined with the initial extract and the volume of combined supernatant was made up to 10mL with the extraction solvent. The sample extract was further assayed for antioxidant activity.

The DPPH and ABTS radical scavenging activities of the sample extract were assayed according to Zhang et al. [13]. For DPPH assay, the 0.1 mL sample extract was added to the 3.9 mL of 63 µM freshly prepared DPPH radical (DPPH•) methanol solution. An equal volume of methanol and DPPH• served as a control. The reaction mixture was vortexed and kept in the dark for 1 h at 37°C. The absorbance (Abs) was read at 517 nm.

$$\% \text{ DPPH radical scavenging activity} = [1 - (\text{Abs sample} - \text{Abs sample blank}) / \text{Abs control}] \times 100$$

ABTS radical cation (ABTS^{•+}) was generated by reacting 7 mM ABTS solution with 2.45 mM potassium persulfate. The mixture was allowed to stand in the dark at room temperature for 16 h. The ABTS^{•+} solution was diluted with methanol to give a 0.70 ± 0.02 Abs at 734 nm in a 1-cm cuvette. After addition of 2.0 mL diluted ABTS^{•+} solution to 20 µL sample extract, the Abs was read at 30°C exactly 6 min after initial mixing. An equal volume of methanol and ABTS^{•+} was served as a control.

$$\% \text{ ABTS radical scavenging activity} = [1 - (\text{Abs sample} - \text{Abs sample blank}) / \text{Abs control}] \times 100$$

Preparation of Cookies

The 90 g butter, 37 g shortening, and 115 g caster sugar were beaten in a kitchen mixer until light and fluffy, then 50 g whole eggs and 2.5 mL vanilla flavor were added. The mixture was mixed thoroughly with sifted flour blends of 215 g wheat flour, 2.5 g salt, and 2.5 g baking powder. The dough was shaped by cookies press to a circular form of 3 cm diameter and 5 mm thickness, baked at 180°C for 15 min, cooled down to room temperature, and then packed in polypropylene film (PP) or PE/AL/PE. The 30% flour substituted cookies was made by replacing the wheat flour with fresh or dried carrot, pumpkin, and corn. The cookie without flour substitution was used as a control. The oxidations of the samples were monitored during storage at room temperature for 0, 7, and 14 days.

Determination of Oxidation in Cookies

The oil extraction from cookie sample for oxidation determination was performed using modified method of Rafecas et al. [14]. The 12.5 g sample was homogenized in a mincer and 25 mL of chloroform-methanol (2:1, v/v) was added. The mixture was stirred using magnetic bar for 30 min, and then filtered by filter paper. The solid residue was extracted and separated by paper filtering again using the same previous procedure. The oil residue on filter paper was rinsed using 13 mL of chloroform-methanol (2:1, v/v). The three extracted fractions were collected in a separatory funnel and 9 mL of a saturated sodium chloride solution was added to help the separation of the chloroform phase. This phase was

filtered through anhydrous sodium sulfate, and then evaporated by a vacuum evaporator at 33°C. The extracted oil was used for further oxidation determination.

PV was determined using modified method of Pegg [15]. The iron (II) chloride solution was prepared by adding the barium chloride solution (0.4 g barium chloride in 50 mL water) to the iron (II) sulfate solution (0.5 g ferrous sulfate in 50 mL water) with constant stirring, followed by 2 mL of 10 M HCl. The barium sulfate precipitate was filtered off using filter paper. The PV of the sample was performed by adding 9.9 mL of chloroform-methanol (7:3, v/v) to 0.100 g oil extract sample, and the solution vortexed for 4 sec. The 1 mL solution was transferred to a new test tube and diluted with 8.9 mL chloroform-methanol (7:3, v/v). To the diluted solution, 50 µL of 10 mM xylenol orange solution was added and vortexed for 4 sec, and then 50 µL iron (II) chloride solution was added and vortexed for 4 sec. The solution mixture was allowed to stand exactly 5 min at room temperature, and then determined the Abs at 560 nm by using chloroform-methanol (7:3, v/v) as a solvent blank.

TBA value was determined using modified method of AOCS [16] official method Cd 19-90. The 0.070 g of oil extract sample was weighted into a 10 mL volumetric flask, dissolved in a small volume of 1-butanol and the solution made up to volume with 1-butanol. The 5 mL sample solution was transferred to a new test tube and 5 mL of 0.2% 2-thiobarbituric acid solution was added. The test tube was closed with a ground-glass stopper, vortexed thoroughly, and placed into a water bath at 95°C. After 2 h, the test tube was removed from a water bath, cooled under running tap water for about 10 min until it reached room temperature. The reaction solution was measured the Abs at 530 nm. The reagent blank was prepared at the same time as the sample.

$$\text{TBA value} = (50 \times (A - B)) / m$$

when A = Abs of the test solution, B = Abs of the reagent blank, and
m = mass of the test portion (mg)

Sensory Analysis

Overall acceptance scores of cookie samples were evaluated using 9-point hedonic scale with 1 indicating dislike extremely and 9 indicating like extremely by 15 students from the Department of Food Science and Technology, Faculty of Engineering and Agro-Industry, Maejo University, Thailand.

Experimental Design and Statistical Analysis of Data

The experiments were designed as a factorial experiment in randomized complete block. The data were evaluated by analysis of variance (ANOVA), and Duncan's multiple comparison tests were used to establish the significance of differences among the mean values at the 0.05 significance level. SPSS (version 15) software was used to perform the statistical analyses.

RESULTS AND DISCUSSION

Antioxidant Activities of Fresh and Dried Carrot, Pumpkin and Corn

The antioxidant activities of fresh and dried carrot, pumpkin, and corn were evaluated by DPPH and ABTS radical scavenging activity methods. For the fresh samples, carrot had higher antioxidant activity than corn and pumpkin, respectively (Figure 1 and 2). The beta-carotene contents of carrot, corn, and pumpkin are 6994 [1], 47 [3], and 1079.6 [2] µg/100 g fresh samples, respectively. The antioxidant activities not only depend on the amount of Beta-carotene in foods, but also the food matrices which correspond to the carotenoid bioavailability [17].

The drying process affected on the antioxidant activities of the samples. Heating at 50, 60, and 70°C decreased the antioxidant activity of carrot, while increased the antioxidant activity of pumpkin compared to unheated samples. For drying of corn, heating at 50°C decreased the antioxidant activity but heating at 60, and 70°C increased the antioxidant activity compared with fresh sample. The results indicated that heat treatment influenced the antioxidant activities of the samples. Dutta et al. [18] found that the drying process at high temperature and long period of time accelerated oxidative degradation and isomerization of beta-carotene from *trans-isomers* to *cis-isomer* which decreased the bioavailability of *trans-isomers*. On the other hand, Howard et al. [6] reported that appropriate heat treatment inactivated some of oxidative enzymes and damaged some part of the beta-carotene structure that led to a greater bioavailability and antioxidant activity of beta-carotene.

In this study, the suitable drying temperature and time of carrot, pumpkin, and corn were 60°C 6 h, 60°C 12 h, and 70°C 9 h which gave the final moisture contents at 10, 10, and 25%, respectively. The highest antioxidant activity samples were used for wheat flour substitution in cookies.

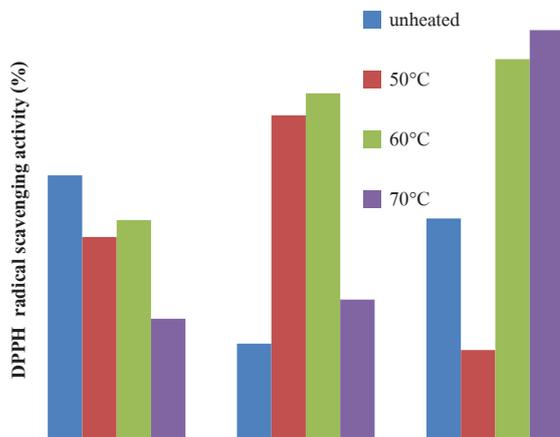


Figure 1 DPPH radical scavenging activity of fresh or dried carrot, pumpkin, and corn

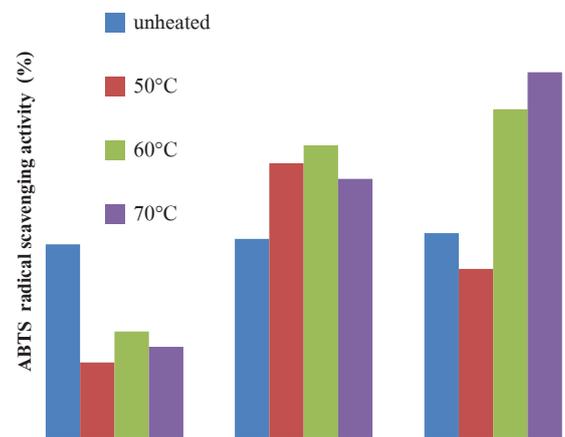


Figure 2 ABTS radical scavenging activity of fresh or dried carrot, pumpkin, and corn

Changes of Oxidation in Cookies

The PV and TBA value of cookie samples were evaluated for the development of rancidity during storage at room temperature for 14 days. The PV and TBA value of flour substituted cookies increased during storage (Table 1 and 2). An increase of PVs of flour substituted cookies with all dried sample powders were lower than of flour substituted cookies with fresh samples and control during 14 day storage. An increase of TBA values of flour substituted cookies with dried carrot and pumpkin powders was higher than of flour substituted cookies with fresh samples. The TBA values revealed the more oxidation reaction in flour substituted cookies with dried sample powders occurred compared to flour substituted cookies with fresh samples. However, PVs of flour substituted cookies with dried sample powders were lower than of flour substituted cookies with fresh samples due to the degradation of primary oxidation products (e.g. hydroperoxide) into secondary oxidation products (e.g. aldehyde) [19].

An increase of TBA value of flour substituted cookie with dried carrot powder was higher than of flour substituted cookies with dried pumpkin and corn powders. These results are in close agreement with the antioxidant activity of dried pumpkin and corn powders being higher than of dried carrot powder. When compared to control, the TBA values of flour

substituted cookies with fresh or dried carrot were higher, while the TBA values of flour substituted cookies with fresh or dried pumpkin, and corn were lower ($p \leq 0.05$).

The packaging materials did not influence the PVs of flour substituted cookies with fresh or dried sample powders (Table 1). An increase of TBA values of flour substituted cookies packed in PP was higher than of flour substituted cookies packed in PE/AL/PE (Table 2) as a consequence of translucent characteristic and more 137 times water permeability of PP compared to aluminum foil [20].

Sensory Acceptance of Cookies

As shown in Table 3, the packaging materials did not influence the overall acceptance scores of flour substituted cookies with fresh carrot, pumpkin, and corn or dried carrot, and pumpkin powders ($p > 0.05$). Although an increase of TBA values of all cookie samples packed in PP was higher than of all cookie samples packed in PE/AL/PE, the rancid flavor might not reach the flavor threshold of the panelists as a consequence that the flavor differences could not be detected among the samples. A decrease of the overall acceptance score of flour substituted cookie with dried corn powder was influenced by packaging materials and 14 days of storage as a result of color dissolution of the sample.

The overall acceptance scores of flour substituted cookies with fresh carrot, pumpkin, and corn or dried corn powders were not significantly different compared to control ($p > 0.05$). The overall acceptance scores of flour substituted cookies with dried carrot and pumpkin powders were lower than of control ($p \leq 0.05$) due to off-flavor perception.

CONCLUSION

The highest antioxidant activity of carrot, pumpkin, and corn powders were achieved by drying processes at 60°C 6 h, 60°C 12 h, and 70°C 9 h, respectively. Factors affecting lipid oxidation of flour substituted cookies were types of wheat flour substituted materials, packaging materials, and storage time. Packaging materials and storage time influenced the overall acceptance score of flour substituted cookie with dried corn powder. The overall acceptance scores of flour substituted cookies with dried carrot and pumpkin powders were lower than of control.

Table 1 PV of wheat flour substituted cookies with fresh or dried carrot, pumpkin, and corn and cookie without substitution (control) packed in PP or PE/AL/PE during storage

Packaging materials	Storage (days)	Control	Carrot		Pumpkin		Corn	
			Fresh	Powder	Fresh	Powder	Fresh	Powder
PP	0	0.2929 ^{D,ab}	0.3173 ^{C,a±}	0.2703 ^{C,bcd}	0.2955 ^{C,ab}	0.2433 ^{C,d±}	0.2736 ^{C,bc}	0.2524 ^{C,cd}
		±0.0161	0.0118	±0.0153	±0.0068	0.0076	±0.0393	±0.0132
	7	0.3407 ^{C,ab}	0.3376 ^{B,ab}	0.3231 ^{C,c±}	0.3430 ^{B,a±}	0.3453 ^{B,a±}	0.3369 ^{B,ab}	0.3343 ^{B,b±}
		±0.0037	±0.0048	0.0043	0.0040	0.0042	±0.0062	0.0076
	14	0.5402 ^{A,a±}	0.5321 ^{A,a±}	0.4305 ^{B,b±}	0.5346 ^{A,a±}	0.5352 ^{A,a±}	0.5343 ^{A,a±}	0.5364 ^{A,a±}
		0.0096	0.0018	0.0094	0.0021	0.0021	0.0045	0.0063
PE/AL/PE	0	0.2929 ^{D,ab}	0.3173 ^{C,a±}	0.2703 ^{C,bcd}	0.2955 ^{C,ab}	0.2433 ^{C,d±}	0.2736 ^{C,bc}	0.2524 ^{C,cd}
		±0.0161	0.0118	±0.0153	±0.0068	0.0076	±0.0393	±0.0132
	7	0.3285 ^{C,ab}	0.3313 ^{B,ab}	0.3234 ^{C,b±}	0.3335 ^{B,ab}	0.3357 ^{B,a±}	0.3287 ^{B,ab}	0.3347 ^{B,ab}
		±0.0016	±0.0063	0.0026	±0.0085	0.0096	±0.0061	±0.0102
	14	0.5226 ^{B,b±}	0.5257 ^{A,ab}	0.5223 ^{A,b±}	0.5331 ^{A,ab}	0.5315 ^{A,ab}	0.5471 ^{A,a±}	0.5297 ^{A,ab}
		0.0066	±0.0080	0.0060	±0.0125	±0.0107	0.0340	±0.0047

Different capital letters are significantly different among the same column and lowercase letters are significantly different among the same row (p≤0.05)

Table 2 TBA value of wheat flour substituted cookies with fresh or dried carrot, pumpkin, and corn and cookie without substitution (control) packed in PP or PE/AL/PE during storage

Packaging materials	Storage (days)	Control	Carrot		Pumpkin		Corn	
			Fresh	Powder	Fresh	Powder	Fresh	Powder
PP	0	0.1878 ^{E,c±}	0.2014 ^{E,a±}	0.1974 ^{E,b±}	0.1126 ^{D,f±}	0.2044 ^{C,a±}	0.1543 ^{D,d}	0.1444 ^{D,c±}
		0.0007	0.0056	0.0014	0.0027	0.0006	±0.0010	0.0009
	7	0.2370 ^{C,c±}	0.3353 ^{C,b±}	0.4450 ^{C,a±}	0.2063 ^{B,d±}	0.2339 ^{B,c±}	0.1594 ^{C,f±}	0.1720 ^{BC,e}
		0.0053	0.0010	0.0147	0.0130	0.0089	0.0017	±0.0012
	14	0.4690 ^{A,b}	0.4446 ^{A,c±}	0.5265 ^{A,a±}	0.2199 ^{A,f±}	0.2840 ^{A,e±}	0.3008 ^{A,d}	0.1987 ^{A,g±}
		±0.0018	0.0023	0.0012	0.0090	0.0008	±0.0006	0.0008
PE/AL/PE	0	0.1878 ^{E,c±}	0.2014 ^{E,a±}	0.1974 ^{E,b±}	0.1126 ^{D,f±}	0.2044 ^{C,a±}	0.1543 ^{D,d}	0.1444 ^{D,e±}
		0.0007	0.0056	0.0014	0.0027	0.0006	±0.0010	0.0009
	7	0.1937 ^{D,b}	0.2892 ^{D,a±}	0.3049 ^{D,a±}	0.1448 ^{C,c±}	0.1926 ^{D,b}	0.1538 ^{D,c±}	0.1572 ^{C,c±}
		±0.0023	0.0480	0.0090	0.0018	±0.0012	0.0014	0.0269
	14	0.3329 ^{B,c±}	0.3907 ^{B,b±}	0.4717 ^{B,a±}	0.1514 ^{C,g±}	0.1965 ^{D,e±}	0.2784 ^{B,d±}	0.1796 ^{B,f±}
		0.0066	0.0011	0.0245	0.0005	0.0002	0.0028	0.0003

Different capital letters are significantly different among the same column and lowercase letters are significantly different among the same row (p≤0.05)

Table 3 The overall acceptance scores of wheat flour substituted cookies with fresh or dried carrot, pumpkin, and corn and cookie without substitution (control) packed in PP or PE/AL/PE during storage

Packaging materials	Storage (days)	Control ^{ns}	Carrot		Pumpkin		Corn	
			Fresh ^{ns}	Powder ^{ns}	Fresh ^{ns}	Powder ^{ns}	Fresh ^{ns}	Powder
PP	0	7.53 ^a ±0.5	7.27 ^a ±0.4	4.87 ^b ±0.8	7.27 ^a ±0.5	4.67 ^b ±0.4	7.47 ^a ±0.6	7.73 ^{A,a} ±0.5
		2	6	3	9	9	4	5
	7	7.40 ^a ±0.5	7.27 ^a ±0.4	4.47 ^c ±0.6	7.13 ^a ±0.3	4.87 ^b ±0.6	7.20 ^a ±0.4	7.40
		1	6	4	5	4	1	AB ^a ±0.51
	14	7.47 ^a ±0.5	7.33 ^a ±0.4	4.60 ^b ±0.5	7.33 ^a ±0.4	4.73 ^b ±0.5	7.20 ^a ±0.4	7.47
		2	9	1	9	9	1	AB ^a ±0.52
PE/AL/PE	0	7.47 ^a ±0.5	7.20 ^a ±0.4	4.87 ^b ±0.8	7.47 ^a ±0.5	4.73 ^b ±0.5	7.33 ^a ±0.4	7.33
		2	1	3	2	9	9	AB ^a ±0.51
	7	7.53 ^a ±0.5	7.13 ^a ±0.3	4.87 ^b ±0.7	7.13 ^a ±0.5	4.73 ^b ±0.8	7.07 ^a ±0.5	7.40
		2	5	4	2	0	9	AB ^a ±0.51
	14	7.47 ^a ±0.5	7.27 ^a ±0.4	4.60 ^b ±0.5	7.13 ^a ±0.6	4.80 ^b ±0.5	7.13 ^a ±0.5	7.27
		2	6	1	4	6	2	B ^a ±0.59

A nine-point hedonic scale with 1 dislike extremely and 9 like extremely was used

Different capital letters are significantly different among the same column and lowercase letters are significantly different among the same row ($p \leq 0.05$)

^{ns} means values in the same column are not significantly different

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Morphometric Comparison and Growth Performances of Fingerings of *Pangasianodon Gigas* and their Hybrids

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Abstract: All of the members of this catfish species display similar external characteristics. Therefore, four fingering catfish of the size of 15 cm were compared for their external characteristics using 14 morphometric measurements. *Pangasianodon gigas* and their 3 hybrid catfish strains, which consisted of 1) hybrid (male of *P. gigas* x female of *P. hypophthalmus*), 2) Buk Siam Maejo Hybrid (hybrid x hybrid) and 3) Backcross Hybrid (male of *P. gigas* x female of hybrid), were examined in this study. It was found that *P. gigas* had the shortest maxillary barbell length at the upper marble, as well as having the biggest head and eyes, and the eye position was located at the lower mouth angle, which was lower than those of the other strains ($p < 0.05$). The Backcross Hybrid had the smallest head and eyes, whereas it possessed the longest anal fin. The Buk Siam Hybrid had the longest pelvic and dorsal fins. Interestingly, three striped lines on the body were shown on only the hybrid and Buk Siam Hybrid. The principal component and/or discriminate functions revealed a relatively high distinction of 100%. From a growth performance study of over 4 months, it was found that length gain, weight gain, average daily growth (ADG) and specific growth rate (SGR) were highest among the *P. gigas* (3.3 cm, 23.6 g, 0.2 g/day and 0.6%/day, respectively). The survival rate was highest in the Backcross Hybrid (66%), whereas, the feed conversion rate (FCR) was lowest in *P. gigas* (3.2). The results indicate that all species were highly different from each other and could be utilized for identification of the 4 Pangasiid catfish, while the Backcross Hybrid strains were suitable for aquaculture.

Keywords: Morphometric, Pangasiid, Catfish, Growth

INTRODUCTION

At present, many hybrid catfish strains were produced for aquaculture because the best hybrid strains displayed results with increased growth rates and yields, as well as greater disease resistance than pure line species [1-3]. Freshwater catfish in the family Pangasiidae, such as *Pangasianodon hypophthalmus*, *Pangasius bocourti* and their hybrids (*P. hypophthalmus* X *P. bocourti*), are considered very important economically and there is a great commercial demand for their culture in Southeast Asia, particularly in Thailand and Vietnam. [4-5]. Hybridization as a technique for genetic improvement in the aquaculture industry has been recognized as a tool for stock improvement and management purposes. Since the possible use of these pangasiid hybrid strains in aquaculture faces the problem of the potential negative impact on the wild population, therefore, scientists have needed to provide quick identification tools for use in the field [6]. We have successfully produced Backcross Hybrid {*Pangasianodon gigas* (male) x hybrid (female), *P. gigas*, (male) x *P. hypophthalmus*, (female)}, Buksiam Hybrid (hybrid x hybrid), Hybrid (*P. gigas*, male x *P. hypophthalmus*, female) and *P. gigas*. However, at the fingering stage (total length of 10-15 cm) the particular species are very difficult to identify because they have similar morphology

and there is a lack of reference data on the growth performance of these species. Morphometric measurements have been widely used to identify differences between fish populations [7-9]. Therefore, this study investigated the morphological characteristics and the growth performance of *P. gigas* and their hybrids in captivity.

MATERIALS AND METHODS

In the morphometric study, 114 specimens consisting of: (24 *P. gigas*, 29 Backcross Hybrid, 31 Buksiam Hybrid and 30 hybrid), as well as four specimens of fingerling catfish at a total length of 15 cm, were examined under the morphological experiments. The body length was measured using a graduated ruler. 14 morphometric measurements were made using the dial calipers according to [10] anal fin height (AFH), anal fin length (AFL), dorsal fin length (DFL), body width (BW) body dept (BD) and head length (HL), and were adjusted to standard length (% SL), maxillary barbell length (MB), pre dorsal length (PDL), pectoral fin length (PFL), Head depth (HD). Head depth (HD) was adjusted to head length (% HL) and eye dimension (ED) was adjusted to maxillary barbell length (% MB).

In the growth performance study, 12 cm of total length for four species of fingerling fish were reared in captivity (20 fish/m²) for 4 months. The fish were fed 3% of their body weight two times daily with commercial feed containing 30 % protein. At four-week intervals, the fish were sampled to monitor growth. Parameters were computed as follows:

$$\begin{aligned} \text{weight gain (WG)} &= \text{final weight} - \text{initial weight} \\ \text{average daily growth (ADG)} &= \frac{\text{final weight} - \text{initial weight}}{\text{days}} \\ \text{specific growth rate (\% SGR)} &= \frac{\text{in final weight} - \text{in initial weight} \times 100}{\text{days}} \\ \text{feed conversion rate (FCR)} &= \frac{\text{total feed (g)}}{\text{weight gain (g)}} \\ \text{survival rate (\%SR)} &= \frac{\text{no. of animals survived (fish)} \times 100}{\text{no. of fisher leased (fish)}} \end{aligned}$$

Statistical Analysis

For the morphometric study, size-adjusted data were standardized and submitted to a principal component analysis (PCA) and a canonical variate analysis (CVA) using SPSSv.17.0. Individuals were assigned to the samples using the canonical functions, and the percentage of correctly assigned fish was determined with an additional measurement of the differentiation among the samples. This output shows the number of cases correctly and incorrectly assigned to each group was based of a discriminant analysis. In the growth performance study, univariate analysis of variance (ANOVA) revealed significant differences at varying degrees between the means of the 4 species.

RESULTS AND DISCUSSION

Morphometric Analysis

Stepwise discriminant analysis identified 14 morphometric characters as the most important characters for differentiating species; therefore, these characters were incorporated into PCA analyses. A Kaiser – Meyer – Olkin value of 0.892 was found to be sufficiently

high for all the body traits. The overall significance of the correlation matrix test was determined with Bartlett’s Test of Sphericity for the morphometric traits of the four fish species (chi-square = 1529.49; P < 0.01), and provided support for the validity of the factor analysis of the data set [9]. The first four principle components (PC) cumulatively account for 85.73% of the total morphological variations (Table 1)

Table 1 Principle component loading for the morphometric characteristics

Morphometric characters	PC1	PC2	PC3	PC4
DFL	0.590	-0.762	-0.047	0.022
AFH	0.035	0.940	-0.133	0.072
AFL	0.081	0.902	-0.084	0.084
BW	-0.202	0.891	-0.084	-0.023
BD	0.065	0.873	-0.084	-0.195
HD	0.240	-0.036	-0.024	-0.098
HW	-0.034	-0.018	0.210	0.102
PDL	-0.715	-0.322	0.876	-0.154
PFL	0.868	0.002	0.905	0.166
DSI	-0.134	0.048	0.215	0.939
ED	0.748	-0.303	0.001	-0.224
MB	0.906	-0.032	0.037	-0.231
HLSL	-0.788	0.380	-0.341	-0.031
EDMB	-0.873	-0.138	0.216	0.207
Eigen value	5.20	3.74	1.70	1.10
Cumulative (%)	37.16	63.85	77.92	85.73

HLSL (head length was adjusted to standard length)

EDMB (eye dimension was adjusted to maxillary barbell length)

The first principal component (PC1) accounting for 37.16 %, of PC2, PC3 and PC4 were 26.69 %, 14.07 % and 7.80 % of the total variation, respectively. Results consisted of PC1 with ED, MB (large positive loading), HLSL, EDMB (large negative loading), PC2 with DFL (large negative loading), AFH, AFL, BW and BD (large positive loading), PC3 with PDL and PFL (large negative loading), and PC4, with only DSI located on the positive loading. The canonical function 1 and canonical function 2 were plotted to allow visual examination of the distribution of each sample of each of the species that showed a clear difference between species. In the output, all the species except the Hybrid and the Buksiam Hybrid were clearly distinct from each other. Moreover, The *P. gigas* and Backcross Hybrid were mostly isolated from the other species.

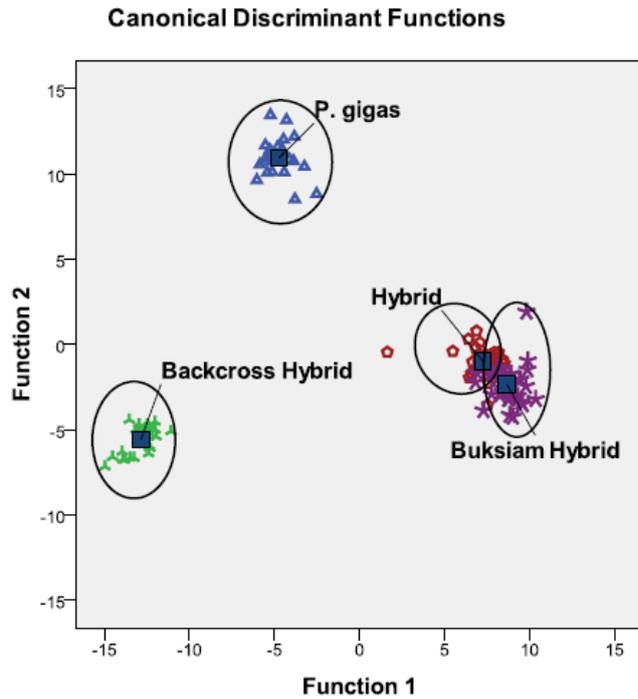


Figure 1 The first canonical function accounts for 67.6%, while the second accounts for 29.1% of the group variability.

Buksiam Hybrid and Hybrid appeared to have overlapping characteristics, but could be identified because Buksiam Hybrid MB and BD were found to be longer. However, they were shorter than that of the ED, HL and DSI of the Hybrid (Figures 1 and 2). The original group cases and cross-validated correctly classified results were very high (100%) in all species.



Figure 2 The external characteristics of *P. gigas* and their hybrids, A: top view and B: side view.

Wanpen et al. [11] reported that fingerlings of the Mekong Giant Catfish (*Pangasianodon gigas*) and the Striped Catfish (*Pangasianodon hypophthalmus*) are very similar, but both species are slightly different in head size, spine on the dorsal caudal and pectoral fin and shape. PCA and CVN were used to identify the characteristics of the fish. Specziar, et al. [12] used PCA to identify morphological characteristics of Hybrid Pikeperch

(*Sander lucioperca* x *Sander volgensis*) and they found fin morphology had a special importance in assigning the fish into distinct groups. Turan et al. [13] used these techniques to identify the morphology of *Clarias gariepinus* populations from six rivers in Turkey and the results showed that the observed differences were mainly from the head of the fish and they suggested that the characteristics of fish depend on the present environmental conditions. Gustiano [5] found the reciprocal hybrid strains, *Pangasius djambal* x *Pangasianodon hypophthalmus*, have intermediate characteristics and the hybrid strain has a tendency to be like *P. hypophthalmus* rather than *P. djambal*. However, genetic techniques should be used to confirm the detected phenotypic differentiations [14].

Growth Performance

In the initial experiment, four fish species were not found to be different in terms of total length at 12 cm. At the end of experiment, *P. gigas* showed the highest difference in Length gain, Weight gain, ADG, SGR and the lowest FCR than the other species. Backcross Hybrid had the highest survival rate than all the others. Remarkably, Backcross Hybrid showed a similar trend, with *P. gigas* displaying a higher significant difference ($P < 0.05$) than Buk Siam Hybrid and Hybrid (Table 2). It was my observation that the time period of my study, which was the cold season (October – February), may have affected the feeding behavior resulting in a high FCR, low weigh gain and low length gain of the 4 species. According to Supaporn and Wirawan [15], the culture of the snail eater *Pangasius (Pangasius conchophilus)* at different stocking densities in earthen ponds found that the ADG and the weight gain from November-January (2007-2008) were 0.26 and 23.3 g, respectively. Moreover, effective protection of the fish’s natural predators, such as birds, etc., can result in higher survival rates.

Table 2 Growth performance of four species of catfish after 4 months

Growth Parameters	<i>P. gigas</i>	Backcross hybrid	Buksiam hybrid	Hybrid
Initial length) cm(12.8 ± 0.30 ^a	12.3 ± 0.4 ^a	12.0 ± 2.9 ^a	12.2 ± 0.70 ^a
Initial weight (g)	12.7 ± 0.3 ^a	12.3 ± 0.2 ^a	12.8 ± 0.4 ^a	12.2 ± 0.5 ^a
Length gain) cm(3.3 ± 0.40 ^a	2.4 ± 0.7 ^{ab}	2.3 ± 0.4 ^{ab}	1.7 ± 0.50 ^b
Weight gain (g)	23.6 ± 6.9 ^a	10.6 ± 4.8 ^b	9.3 ± 3.0 ^b	5.1 ± 2.60 ^b
ADG	0.2 ± 0.06 ^a	0.09 ± 0.04 ^b	0.08 ± 0.03 ^b	0.04 ± 0.02 ^b
SGR	0.6 ± 0.10 ^a	0.38 ± 0.2 ^{ab}	0.38 ± 0.1 ^{ab}	0.21 ± 0.11 ^b
Survival rate (%)	31.8 ± 16.0 ^b	66.7 ± 5.8 ^a	41.7 ± 2.9 ^{ab}	63.3 ± 20.2 ^{ab}
FCR	3.2 ± 0.8 ^a	3.4 ± 0.7 ^{ab}	3.7 ± 1.9 ^b	3.8 ± 1.20 ^b

Values with different superscripts in the same row are significantly different ($p < 0.05$)

This paper is the first publication that compares the growth performance of three hybrid catfish, especially the Backcross Hybrid and the Buksiam Hybrid with *P. gigas* and Hybrid, *P. gigas* (male) x *P. hypophthalmus* (female). Several studies reveal that the hybrid, *Clarias gariepinus* (male) x *Heterobranchus bidorsalis* (female) exhibit a higher rate of growth, survival and hardiness than the pure line [16-17]. Mengamphan and Seaengkrachang [18] found that the highest growth and survival rate were obtained from the hybrid strain of *P. bocourti* X *P. hypophthalmus* in all of the 3 hybrids (*P. bocourti* X *P. hypophthalmuse*, *P. gigas* X *P. hypophthalmus* and *P. hypohthalmus* X *P. hypophthalmus*), when cultured in an aquarium over a period of 42 days, whereas Sittichai et al. [18] reported that the growth performance of the Stripped Catfish was higher than the three hybrids mentioned above. Ndimele et al. [20] found the reciprocal hybrid, *Clarias gariepinus* x *Heterobranchus*

bidorsalis (clariabranchnus), showed higher percentage weight gain and specific growth rate than the hybrid *Heterobranchus bidorsalis* x *Clarias gariepinus* (heteroclarias) and they have recommend this strain for commercial aquaculture practices.

CONCLUSIONS

Four species of catfish, *P. gigas* and their hybrid strains, can be identified from each other by PCA and CAN techniques, which reveal a highly correct rate of classification. Moreover, both the Buksiam Hybrid and the Hybrid reveal three striped lines on the body side, which *P. gigas* and the Backcross Hybrid did not reveal. The highest growth rate found in this study was found with the *P. gigas*, followed by the Backcross Hybrid, Buksiam Hybrid and the Hybrid, but the survival rate of the Backcross Hybrid displayed the highest results of all three. According to our study, we recommend that the Backcross Hybrid is a strong candidate for the aquaculture industry because this hybrid shows a faster growth rate, which is similar to *P. gigas*. The Backcross Hybrid has been determined to be the most suitable strain for use in the aquaculture industry, over the other hybrids

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***Agrobacterium tumefaciens*-Transient Genetic Transformation of Patumma “Blue Moon” (*Curcuma* sp.) Retarded Shoots Explants**

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Abstract: The effects of different concentrations of kanamycin (0-200 mg/l) on regeneration from retarded shoots of Patumma “Blue Moon” (*Curcuma* sp.) were investigated. It was found that the concentration of kanamycin at 100 mg/l was the lowest concentration that retarded shoot growth. To investigate the action of this effect, the retarded shoots were transformed using a pStart plasmid, containing the uidA gene coding for β -glucuronidase (GUS) gene expression driven by the CaMV 35S promoter and the npt II gene for kanamycin resistance immobilized into *Agrobacterium tumefaciens* LBA4404. It was found that GUS expression was able to be visualized in the retarded shoots.

Keywords: *Agrobacterium tumefaciens*, Patumma, uidA gene, Genetic transformation

INTRODUCTION

Patumma “Blue Moon” (*Curcuma* sp.) is a monocotyledonous perennial, a member of the ginger family (Zingiberaceae) originating from tropical and subtropical areas of northern Thailand and Cambodia [1]. *Curcuma* also known as the Siam tulip or Pathumma, is a native plant of South-East Asia with attractive flowers which occur as a re-collective group of tulips [2]. *Curcuma* flowers present with wide variations in shape and bract color and have been heavily cultivated for ornamental use to have colorful, long-lasting inflorescences with few pest problems. They are used as cut flowers, flowering pot plants and as garden plants [3]. The annual export value of rhizomes is reported to be 20-30 million baths [4] with the most important markets being the United States of America, Japan, the Netherlands, Germany and Australia [5]. *Curcuma* has become an important crop for breeding new varieties with novel or improved traits, due to its high economic value as a tropical ornamental [6].

Flower color is one of the most important characters for ornamental plants. The creation of new flower colors is therefore one of the most important targets for breeding. By controlling expression levels of genes related to the biosynthetic pathway of flower color pigments we can breed novel varieties with respect to flower color. Genetic transformation can be done by either introducing and expressing a new gene or re-introducing an existing gene in the sense or antisense orientation to inactivate an endogenous gene [7]. In this regard, genetic engineering can assist with the genetic improvement of Patumma “Blue Moon” to create new varieties. Recently, genetic modification of plants using *Agrobacterium tumefaciens* has become a routine procedure for a large number of plant species [8-12]. Therefore, in this study we developed a protocol for *Agrobacterium* mediated genetic transformation of Patumma “Blue Moon” (*Curcuma* sp.) using retarded shoots explants.

MATERIALS AND METHODS

Plant Material

Retarded shoots of Patumma “Blue Moon”(Curcuma sp.) were used as explants for genetic transformation by *Agrobacterium tumefaciens*. During the initiation stage, Patumma “Blue Moon” were removed from each pouch of inflorescence, and used as starting materials. They were cultured in a modified [13] containing 10 mg/L 6-bezylaminopurine)BA(and 0.1 mg/L 3-indoleacetic acid)IAA(. After 1 month in culture, the tissues were subcultured in the regeneration medium, which was MS medium containing 0.1 mg/l 3-indoleacetic acid)IAA(, 0.5 mg/l thidiazuron (TDZ) and 4mg/l imazalil (IMA) for use with the genetic transformation [14]. All the cultures were incubated at 25±2°C with 16 hours photoperiod of 40 μmol/m²/s¹ provided by fluorescent light.

Antibiotic Sensitivity of Explants

To test the effectiveness of kanamycin in selecting for the transformants, retarded shoots explants were cultured on MS medium containing 0.1 mg/l IAA, 0.5 mg/l TDZ and 4 mg/l IMA and kanamycin (0, 50, 100, 150, 200 mg/l). All the cultures were incubated at 25±2°C with a 16 hour photoperiod of 40 μmol/m²/s¹ provided by fluorescent light. After 4 weeks, the callus formation and adventitious shoots were counted and regeneration frequencies were determined.

Agrobacterium tumefaciens Strain and Binary Vector

Agrobacterium tumefaciens LBA4404 harboring the binary vector pStart which contained the selectable marker nptII gene and a screenable marker GUS gene)Figure 1 (were grown on Luria-Bertani (LB) medium containing 50 mg/l kanamycin and 50 mg/l rifampicin. The culture was allowed to grow at 28°C to obtain the optimum population of *Agrobacterium* for infection and co-cultivation of explants. The density of the bacteria was adjusted to OD₆₀₀= 0.5 with 10 mM glucose and 100 mM acetosyringone (AS) [15].

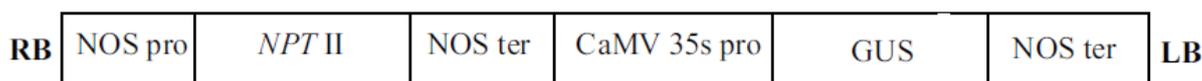


Figure 1 Schematic diagram of the T-DNA region of the transformation vector pStrat RB, Right border; LB, Left border; NOS-PRO, nopaline synthase promoter; NPT II, neomycin phosphotransferase gene; NOS-TER, nopaline synthase terminator; CaMV 35S-PRO, 35S promoter of cauliflower mosaic virus; GUS, β-glucuronidase gene.

Agrobacterium-mediated Transformation

The *Agrobacterium* grown in liquid LB media were used for infection and incubation. Prior to this, the “optical density” of the bacterial suspension was determined at 600 nm with the help of a spectro-photometer. Following the density determination, to get a suitable and sufficient infection of the explants, retarded shoots of Patumma “Blue Moon” were cut into 0.5 cm lengths and incubated in the bacteria suspension for 30 min and washed before being transferring to the co-cultivation medium. Following infection and incubation, the explants were co-cultured on MS media with acetosyringone (100 μM). All of the explants were maintained in co-cultivation media for 2 days in darkness at 25°C. To avoid *Agrobacterium* leaching, the co-cultivation medium was regularly changed.

After 2 days of co-cultivation, the explants were washed with sterile-distilled water followed by a liquid shoot induction medium containing 250 mg/l cefotaxime and inoculated onto retarded shoot induction MS medium containing 0.1 mg/l IAA, 0.5 mg/l TDZ and 4mg/l IMA, 100 mg/l kanamycin and 250 mg/l cefotaxime and subcultured every 2 weeks. After 4

weeks in culture, the explants were transferred onto the selective elongation medium, which is MS medium containing 100 mg/l kanamycin. The elongated and surviving shoots were inoculated into rooting medium, which is an MS medium containing 0.1 mg/l IAA and 100 mg/l kanamycin and subcultured every 2 weeks. All of the cultures were incubated at $25\pm 2^\circ\text{C}$ with a 16 hour photoperiod of $40\ \mu\text{mol}/\text{m}^2/\text{s}^1$ provided by fluorescent light. The transformation frequency was calculated according to the GUS assay.

GUS Histochemical Assay

A histochemical assay of GUS was performed according to Jefferson et al. [16]. The retarded shoots grown on MS medium containing 100 mg/l kanamycin were used for the GUS assay. The plantlets were incubated overnight at 37°C in 2 mM X-Gluc (5-Bromo-4-chloro-3-indolyl β -D-glucuronide) in a phosphate buffer (pH 7.0) containing 0.5 mM potassium ferricyanide, 0.5 mM potassium ferrocyanide, and 0.1% (v/v) Triton X-10. The chlorophyll was removed by using 95% ethanol after X-Gluc staining.

RESULTS AND DISCUSSION

Antibiotic Sensitivity of Explants

Prior to transformation, an effective concentration of antibiotic for the selection of the transformed cells was determined by culturing retarded shoots on MS medium containing 0.1 mg/l IAA, 0.5 mg/l TDZ and 4 mg/l IMA and kanamycin (0, 50, 100, 150, 200 mg/l). Explants became dry and yellow (Figure 2) on MS containing 100 mg/l of kanamycin. Kanamycin at concentration of 150, 200 mg/l caused complete necrosis of the explants after three weeks. On kanamycin free MS medium, explants development shoots while kanamycin at 100 mg/l concentration caused total inhibition of shoot induction in the retarded shoots. These results showed that kanamycin is an effective selection marker for Patumma “Blue Moon”. Hence this concentration was used for the selection of transformed retarded shoots. A similar observation has been reported for Patumma “Chiang Mai Pink” (*Curcuma alismatifolia*) by Saetiew and Arunyanart1 [17] while in another study Phogat et al. [18], selected the transformed calli of *Vigna radiata* on 100 mg/l of kanamycin concentration.



Figure 2 Kanamycin sensitivity of)A(non-transformed retarded shoots at 100 mg/l concentration where the explants became dry and yellow.)B(un-transformed control explants.

Agrobacterium-Mediated Transformation

Agrobacterium-mediated genetic transformation of the retarded shoots of Patumma “Blue Moon” was performed. After 2 days in darkness of co-cultivation, the explants were transferred onto the shoots induction on MS medium containing 0.1 mg/l IAA, 0.5 mg/l TDZ

and 4mg/l IMA, 100 mg/l kanamycin and 250 mg/l cefotaxime. Shoot initiation was observed in the selective medium with in 3 weeks of culture (Figure 3A), while un-transformed control explants on the selective medium turned yellow and died (Figure 3B). The shoots were then cultured on elongation medium (MS medium containing 100 mg/l kanamycin) for three additional weeks. Shoots that survived this selection stage were putatively transgenic and were transferred to rooting medium (MS medium containing 0.1 mg/l IAA and 100 mg/l kanamycin) and cultured for 3 weeks (Figure 3C).

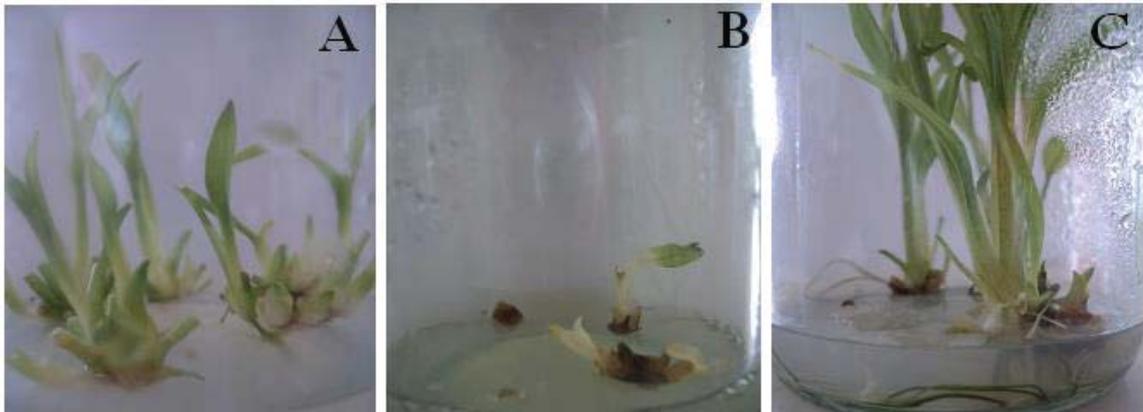


Figure 3 Transgenic plants from retarded shoots of Patumma “Blue Moon”. (A) Shoot initiation from retarded shoots on MS medium containing 0.1 mg/l IAA, 0.5 mg/l TDZ and 4mg/l IMA, 100 mg/l kanamycin and 250 mg/l cefotaxime. (B) Non-transgenic retarded shoots cultured on MS medium containing 0.1 mg/l IAA, 0.5 mg/l TDZ and 4mg/l IMA, 100 mg/l kanamycin and 250 mg/l cefotaxime. (C) Rooting of elongated transformed shoots on MS medium containing 0.1 mg/l IAA, 100 mg/l kanamycin.

GUS Histochemical Assay

After infection of the explants in the *Agrobacterium* suspension culture, the explants were transferred to the co-cultivation medium. Following incubation and co-cultivation with *Agrobacterium*, the transformation ability was monitored using the histochemical assay of the GUS reporter gene in the explants tissues. A transient GUS assay was also done at the end of the co-cultivation with randomly selected inoculated explants tissue. In the GUS assay, conspicuous GUS positive (blue color) regions were detected in the explant surface (Figure 4). Control explants did not show a response to the assay. Similar reports have been made earlier about high levels of early detection of GUS activity within three days of agrobacterial infection due to transcription and translation of non-integrated T-DNA. However, 28 days after infection the number of explants showing GUS expression decreased, indicating that many of the GUS expressing cells were not stably transformed due to inefficient T-DNA integration into the genome or if integrated gene silencing occurred at later stages [19-20].

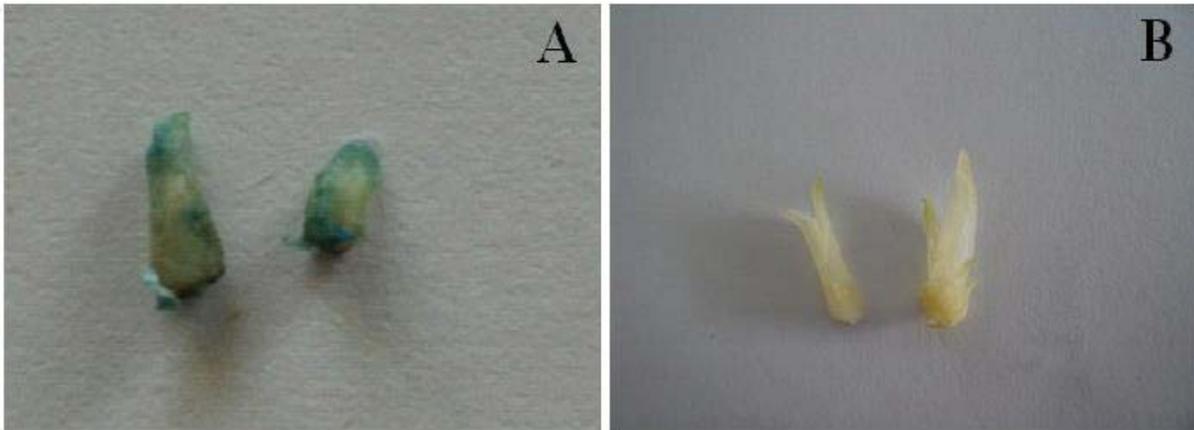


Figure 4 GUS gene expression in transgenic Patumma “Blue Moon”. (A) GUS expression as observed in retarded shoots two weeks after infection. (B) GUS assay for the non-transformed retarded shoots two weeks after infection.

CONCLUSION

In this study, we successfully developed a simple protocol for the genetic transformation of Patumma “Blue Moon” which will enable future studies of the modification of flower color in Patumma “Blue Moon” (*Curcuma* sp.) genetically transformed with genes involved in modifying inflorescence color.

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Use of Soil Sediment from Water Treatment as Growing Media for Lettuce

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Abstract: Sediment from water treatment process is abundant by-product possibly rich in plant nutrients. To reuse this sediment as growing media for potted plants, this research determined how plant response to the sediment existing in soil-based media. The growing media treatments were varied in the sediment proportion as 11, 20, 27 or 33% by volume in common horticultural growing media mixed from rice husk: carbonized rice husk : coir : manure as 1 : 1 : 1 : 1 by volume. Seedlings of lettuce (*Lactuca sativa*) were transferred into plastic pots filled with particular growing media and were monitored until harvest. The experiment was conducted in CRD with 5 replications. The plant growth revealed that the media containing 11% sediment yielded the largest in plant height, diameter, leaf number and leaf fresh weight compared to others at harvest while leaf area and dry weight were not different among the treatments. The larger in percentage of the sediment was the more adverse effect to the plant growth. Furthermore, the sediment and mixed media were evaluated for physical and chemical properties. The sediment was rich in potassium, calcium, magnesium and cation exchange capacity. When consisted in the media, an increase in proportion of sediment resulted in larger medium bulk density. This indicated that the lettuce responses well to 11% of the sediment in the growing media. High sediment percentage associates with poor medium physical properties. Therefore, the soil sediment from water treatment process is probably reused by replacing common topsoil in soil-based media for potted plants.

Keywords: *Lactuca sativa*, Reused substrate, Pot plant, Soil mixture

INTRODUCTION

Soil sediment is abundant by-product waste from water treatment process. In Bangkok, the capital city of Thailand with over 10 million people, Metropolitan Waterworks Authority functions as main water supplier. The raw water is pumped continuously into the treatment process. This process results in soil sediment or sludge over 350 tons a day from sedimentation [1]. This sediment comes from land leached into the river. Thus the sediment is potentially rich in nutrients including plant elements due to the top soil fertility. The sediment analysis showed that there is more than 5% organic matter, 6-21 ppm available phosphorus, 112-207 ppm available potassium and very high cation exchange capacity but poor in physical properties [2].

Soil-based media had been a major commercial growing mixture in Thailand in few decades ago. The media component comprises agricultural wastes available in local areas such as dry rice husk, carbonized rice husk, coco-coir, manure and top soil etc. Recently utilization of soil-based growing media for pot plant has been declined due to inconsistency

of media quality and quantity. Moreover, availability of fertile top soil has been limited since severe agricultural land use and urban expansion whereas other components still available.

Although peat moss has become more popular replacing the soil-based media due to its uniformity and cleanness, collection of moss from forest areas can ruin natural resources and is not allowed in many countries) [3]. Alternative materials which are environmental friendly and economical are potentially utilized for sustainable agriculture. Many research have reported that sludge or sediment from municipal waste [4, 5], manure [6], sawdust, bark and coco-coir [7], including sediment from river [3] can be used as plant growing media. Agricultural wastes are also other potential materials for making pot plant growing media [8].

Thoughtfully, soil-based growing media are still necessary for pot planting in Thailand and other countries since availability of components. The soil sediment from water treatment process is another promising option which is continuously available as by-product and low-cost. The responses of certain pot plants to this growing media are required to investigate. Consequently, this research aims to investigate how the lettuce growth response to the sediment portion existing in soil-based media.

MATERIALS AND METHODS

Growing media preparation – The sediment samples were collected from sediment field of Bangkok Metropolitan Waterworks Authority in Bangkok, Thailand. The samples were air-dried before partitioning for analysis and following experiment. Common pot growing medium was prepared by mixture of rice husk, carbonized rice husk, fine coco-coir and cow manure as 1:1:1:1 by volume. The medium was added with the ground sediment in proportions of 11, 20, 27 or 33% by volume as four treatments.

Planting of lettuce seedling – The two weeks old seedlings in peat-moss were transplanted into six inch plastic pots filled with the particular sediment media and placed in a greenhouse. The regular practices, irrigation and fertilization, were conducted during plant growth.

Data records – Plant height and canopy width were weekly monitored for 4 weeks. Leaf number, leaf area and plant weight were recorded at harvest. Fresh and dry weight was measured after hot air drying for 3 days. The media samples were evaluated for physical and chemical properties followed Spomer [9]. The experiment was Completely Randomized Design (CRD) with 5 replications, 20 plants in each treatment. Analysis of variance and mean comparison were conducted by DMRT.

RESULTS AND DISCUSSION

Growth and Biomass of Lettuce

The lettuce growth increased throughout four weeks of development until harvest by increasing in plant height and plant width (Table 1, 2). All of the lettuce responded to the treatments varied in the sediment proportion in same manner during first three weeks resulting in no significant difference of the height and width among the treatments. Afterward, statistical differences were observed during the fourth week due to larger in the plant height and width found in the treatments contained 11 and 20% of the sediment. Leaf number at harvest was 12.33 for the 11%-sediment treatment higher than those (10.4 leaves/plant) for the 33% sediment treatment (Table 3). The leaf area was not significantly different among the treatments ranging from 979 to 1,147 cm²/plant, however, being similar tendency with the leaf number.

The biomass at harvest was different among the treatments (Table 4). The lettuce grown in 11% sediment medium was 88 g of leaf fresh weight higher than those grown in the

rest treatments. The increase in sediment percentage resulted in decrease in leaf fresh weight. Leaf dry weight demonstrated the similar trend to the fresh weight but not statistically different. Although root fresh and dry weight were not significantly different among the treatments, a reverse tendency was observed that increasing in the sediment in media caused higher in root fresh and dry weight. Generally increasing in the sediment percentage from 11 to 33 (by volume) resulted in decreasing in plant growth.

Table 1 Plant height of the lettuce grown in soil-based growing media composed of various sediment percentages during plant development

Sediment percentage	Weeks				means
	1	2	3	4	
11%	10.80	14.20	18.78	24.31 ^b ^{1/}	17.02
20%	10.59	14.03	18.42	23.50 b	16.64
27%	10.55	13.70	18.02	22.62 a	16.22
33%	10.73	13.52	17.28	21.04 a	15.64
F-test	ns	ns	ns	*	
CV (%)	9.80	8.10	9.80	6.90	

Table 2 Plant canopy width of the lettuce grown in soil-based growing media composed of various sediment percentages during plant development

Sediment percentage	Weeks				means
	1	2	3	4	
11%	13.90	21.13	29.58	38.13 c ^{1/}	25.69
20%	14.66	20.64	28.64	36.60 bc	25.14
27%	13.78	20.10	28.00	35.61 b	24.37
33%	14.88	21.73	27.41	32.98 a	24.25
F-test	ns	ns	ns	**	
CV (%)	9.80	8.80	9.40	4.80	

Table 3 Leaf number and leaf area of the lettuce grown in soil-based growing media composed of various sediment percentages at harvest

Sediment percentage	Leaf number	Leaf area (cm ³)
11%	12.33 b ^{1/}	1147.13
20%	12.07 b	1075.92
27%	11.13 ab	1009.92
33%	10.40 a	979.03
F-test	*	ns
CV (%)	9.30	17.80

ns No difference of means among the treatments

1/ Different letters in the same column indicate significant difference, P<0.05

Table 4 Fresh and dry weight of leaf and root of the lettuce grown in soil-based growing media composed of various sediment percentages at harvest

Sediment percentage	Fresh weight (g)		Dry weight (g)	
	Tree	Root	Tree	Root
11%	88.40 b	25.53	4.68	3.25
20%	81.80 ab ^{1/}	26.60	4.56	2.94
27%	76.53 ab	29.40	3.56	3.20
33%	68.13 a	30.73	3.27	4.59
F-test	*	ns	ns	ns
CV (%)	13.40	15.60	29.00	27.20

Properties of Sediment and Growing Media

The soil sediment sample was analyzed for physical and chemical properties at Department of Soil Science, Kasetsart University, Thailand. The sediment texture was composed of 51% clay, 22% silt and 27% sand. The properties were 0.9 g/cm³ of density and 23.6 me/100g of cation exchange capacity (CEC). It composed of 1.9% organic matter, 20 ppm phosphorus, 200 ppm potassium, 410 ppm calcium, 2 ppm aluminium, respectively. These agreed with a Suasamsem [2] reported that the sediment was mainly composed of clay particle accounting for dispersion as soil colloid in the river. Moreover, this clay particle could cause the high CEC and rich in plant nutrient due to high negative charge. Aluminum from alum used for sedimentation was more concerned which might be negative effect to plants. The data revealed that there was only 2 ppm in the sediment sample which agreed with Leeprakhon [10] reported that even increase in acidity, soluble aluminium was still very low. This confirms that the aluminum residue in the sediment is possibly not harmful to the plants.

The medium physical properties showed that bulk density gradually increased with the higher in sediment proportion but total porosity, air-filled pore and water-filled pore were not associated with the sediment content (Table 6). The medium EC after planting ranged from 170 to 240 μ S/cm for 11 to 30% sediment in media, respectively (Table 5). The larger in EC was probably due to high clay particle resulting in less cation leaching (Data not showed). All of the media treatments were similar in the pH after planning which increased slightly. Eleven percent of sediment in the media seemed to be appropriate for the lettuce growth as a result of highest leaf fresh weight and plant width. This result agreed with Zinnia [11] and other pot plants [12] that 10% of clay mixed in growing media was suitable for growth of plants.

Table 5 Electrical conductivity and pH of soil-based growing media of the lettuce measured after plant harvest

Sediment percentage	EC (μ S/cm)	pH
11%	170	7.26
20%	220	7.16
27%	210	7.19
33%	240	7.34

Table 6 Medium bulk density and porosities of soil-based growing media of the lettuce measured after plant harvest

Sediment percentage	bulk density (g/cm ³)	total porosity (%)	air-filled pore (%)	water-filled pore (%)
11%	0.60	45.00	9.00	36.00
20%	0.77	49.00	7.00	42.00
27%	0.76	45.00	8.00	37.00
33%	0.79	47.00	8.00	37.00

CONCLUSION

The data indicated that the lettuce responded well to 11% of the sediment in the growing medium. Therefore, the soil sediment from water treatment process is probably reused in soil-based media for pot plants.

ACKNOWLEDGEMENTS

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An Estimation Fractal Dimension of Soil Images for Soil Classification

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Abstract: This paper proposes a soil classification technique by using fractal dimension estimation of soil images. Soil is an important for plants because it holds roots that provide support for plants and stores nutrients. A cultivation of each plant needs a suitable type of soil in order to get the high quality yield. Due to the structure of the soil properties called “self similarity”. This is a feature that can estimate the value of the fractal dimension. An image analysis is a sophisticated tool for the identification of soil. The results of the estimation of fractal dimension can be used to identify the type of soil to be useful for the next crop.

Keywords: Fractal Dimension, Soil Images, Soil Classification International

INTRODUCTION

Soil structure is critical for the seed germination and growth of plants [1] because it holds roots that provide support for plants and stores nutrients and for the transport of water and contaminants through the unsaturated zone underlying agricultural fields [2-3]. Soil structure may be defined as ‘the spatial heterogeneity of the different components or properties of soil’. In other words, it is the variation of solids and voids as a function of scale that defines soil structure [4]. A cultivation of each plant needs a suitable type of soil in order to get the high quality yield. Due to the structure of the soil properties called “self similarity”. This is a feature that can estimate the value of the fractal dimension [5]. Fractals are becoming increasingly popular in soil physics research as a means for characterizing various properties of porous media. They have been used both in theoretical and practical studies to model. Estimation of soil spatial variability is an important issue in agriculture. Several authors discussed about fractal to analyze spatial characteristic of soil texture by Mohammad R. N. and et al. [6] and it was used for the analysis of pore distribution patterns and particle size distribution in variously-compacted soil [7-8], soil spatial variability [9], soil pore interface [10], modeling the dynamics of the soil pore-size distribution [11], soil pore size distributions [12], pore scale image of soil [13]. In this research, the method for calculation the fractal dimension of soil image for soil type classification is proposed. This paper is organized as follows. In the next section, the basic concept of fractal dimension and procedures of box-counting method are introduced. In the third section, the results from the calculation of fractal dimension in soil image are presented. The conclusion is proposed in the last section.

MATERIALS AND METHODS

Fractals

A fractal is a geometrical object characterized by “self similarity” property. A self-similar object is exactly or approximately similar to a part of itself and that can be continuously subdivided in parts each of which is (at least approximately) a reduced-scale copy of the whole. Furthermore, a fractal generally shows irregular shapes that cannot be simply described by Euclidian dimension, but, fractal dimension (FD) has to be introduced to extend the concept of dimension to these objects. However, unlike topological dimensions the FD can take non-integer values, meaning that the way a fractal set fills its space is qualitatively and quantitatively different from how an ordinary geometrical set does [14]. Nature presents a large variety of fractal forms, including soil, trees, rocks, mountains, clouds, biological structures, water courses, coast lines, galaxies [15]. Moreover, it is possible to construct mathematical objects which satisfy the condition of self-similarity and that present FD (Figure 1).

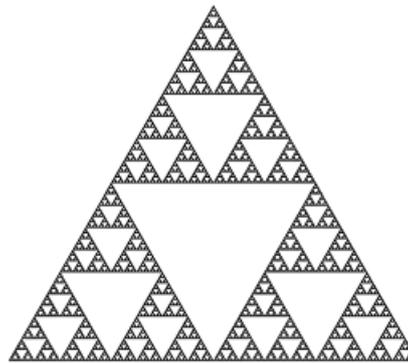


Figure 1 Sierpinski triangle.

Sierpinski triangle, starting with a simple initial configuration of units or with a geometrical object then the simple seed configuration is repeatedly added to itself in such way that the seed configuration is regarded as a unit and in the new structure these units are arranged with respect to each other according to the same symmetry as the original units in the seed configuration. And so on. The objects in Figure 1 are self-similar since a part of the object is similar to the whole and the fractal dimension can be calculated by the equation as follows

$$FD = \frac{\log N}{\log S} \quad (1)$$

where N is the number of the auto-similar parts in which an object can be subdivided and S is the scaling, that is, the factor needed to observe N auto-similar parts. According to the Eq. (1), the following value is obtained for the Sierpinski triangle,

$$FD = \frac{\log 3}{\log 2} \approx 1.58. \quad (2)$$

Box Counting Method

The box counting method [16] consists in partitioning the image space into square boxes of equal size. The box covers the image space of the function or pattern of interest and the number of boxes that contain at least one pixel of the function is counted. The process is repeated with different box sizes. The fractal dimension is obtained from the slope of the best fitting straight line to the graph plotting the log of the number of boxes counted versus the log of the magnification index for every stage of partitioning. For example, an image measuring size $M \times M$ pixels is scaled down to $s \times s$, where $1 < s < M / 2$, and s is an integer. Then, $r = s / M$. Fractal dimension FD is given by,

$$FD = \frac{\log(N_r)}{\log(1/r)} \quad (3)$$

The Eq. (3) is computed for different box size s (so for different r) and the FD can be estimated from the least squares linear fit of $\log(N_r)$ versus $\log(1/r)$.

Soil Images

The digitized images were taken to 2592×1944 pixels from sand and loam, with 20 samples each. A Samsung PL120 camera with 4.7–23.5 mm lens was mounted from a fixed position 20 cm above and parallel to the soil surface. Images were exposed onto Auto ISO color slide film using early morning ambient lighting. The digitized images were cropped to 1800×1800 pixels, then convert to digital gray scale images. An example of the soil images as shown in Figure 2.

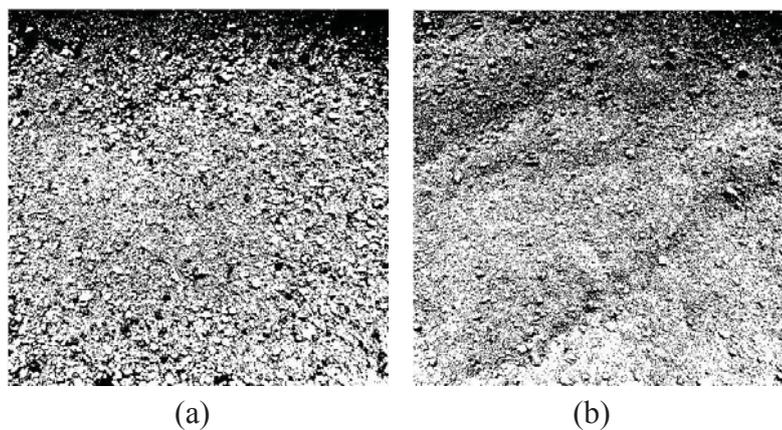


Figure 2 Example of soil images (a) sand (b) loam.

RESULTS AND DISCUSSION

The fractal dimension is a measurement of the roughness or irregularity degree of the surface. Estimation FD values obtained from both soils are shown in Table 1.

Table 1 Fractal dimension of soil types.

Soil Types	Fractal Dimension
Sand	1.77-1.78
Loam	1.79-1.81

The objective of this study is to calculate the fractal dimension in order to identify the type of soil. It can be seen that the intervals of the fractal dimension of the each soil type are not much difference but still enough to identify. This may be a reason from the resolution of the image is too small. The images were analyzed with the fractal dimensions a little rough.

CONCLUSION

Fractal is a tool to characterize the irregularity of soil image. The box counting method is once estimator that can calculate the fractal dimension of soil image. The limitation of this method is that the image resolution should be adopted to suit the dimensions analyzed. However, fractal dimensional analysis for soil image that is a site-specific agriculture.

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Track-Risk-Impact-Policy (TRIP) Modeling of Tropical Cyclones for the Agricultural Sector

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Abstract: Tropical cyclone, a recurring meteorological cataclysm, has been the eye for the diminution of the immense impacts and colossal risks to the populace and to the agricultural panorama. Track-Risk-Impact-Policy (TRIP) Modeling, a newly disaggregated approach, is used to provide a dynamic impetus to address the threats of the environmental tumult. The tropical cyclones at their most intense from the period 1950 to 2009 were considered and assessed using the decadal and monthly analyses in order to identify the tracks and hotspots. Monte Carlo simulation was done to determine the optimum risk in terms of hazard (tropical cyclones), exposure (population), and vulnerability (poverty incidence) for the risk modeling. The use of Quantum Geographic Information Systems (QGIS) was also utilized to model the impacts (e.g. agricultural damages and losses) during the mutilated visits of the most destructive tropical cyclones. With the integration of the Hyogo Framework for Action (HFA), environmental policies that respond to the catastrophic patterns and processes were expansively analyzed and ensured for the attainments of the Millennium Development Goals.

Keywords: Tropical cyclones, Tracks, Risks, Impacts, Policies, Hyogo Framework for Actions (HFA), Millennium Development Goals (MDG)

INTRODUCTION

Tropical cyclones are the most ruinous of natural peril both because of the loss of human life they cause and the significant economic losses they rouse. Vulnerability to tropical cyclones is becoming more prominent because the fastest population growth is in tropical regions like the Philippines. Understanding tropical cyclone genesis, development and associated characteristic attributes has been a challenging focal point over the last several decades. In recent years, attempts to associate tropical cyclone trends with climate change resulting from greenhouse warming has led to additional attention being paid to tropical cyclone prediction (e.g., Emanuel 1987; Evans 1992; Lighthill et al. 1994). Exploring possible changes in tropical cyclone activity due to global warming is not only of theoretical but also of practical importance.

A tropical cyclone (TC) as described in Figure 1.1 is the generic term for a non-frontal synoptic scale low-pressure system originating over tropical or sub-tropical waters with organized convection and definite cyclonic surface wind circulation. Tropical cyclones with maximum sustained surface winds ranging from 45 to 61 kph are generally called "tropical depressions (TD)". Once a tropical cyclone achieves surface wind strengths of 62 to 117 kph, it is typically called a "tropical storm (TS)". If the surface wind reaches 118-239 kph, the storm is called a "typhoon (TY)". And if the surface wind achieves more than 240 kph, then it is called "super typhoon (STY)".

The main effects of tropical cyclones include heavy rain, strong wind, flooding, squalls, large storm surges at landfall, and tornadoes. The destruction from a tropical cyclone depends mainly on its intensity, its size, and its location. Tropical cyclones act to remove

forest canopy as well as change the landscape near coastal areas, by moving and reshaping sand dunes and causing extensive erosion along the coast. Even well inland, heavy rainfall can lead to mudslides and landslides in mountainous areas. Together with the changes in the average temperature and rainfall and rises in sea level, these tropical cyclones relentlessly impinge on key pillars of socio-economic development, which include natural resources, infrastructure, water resources, agriculture and also bequeath tremendous annual losses in lives and destruction to properties.

In the Philippines, despite the high annual losses, the broad macroeconomic impacts are relatively difficult to trace. This is because only the major disasters (e.g. Tropical Storm Ketsana or Ondoy in 2009, Super Typhoon Megi or Juan in 2010, Tropical Storm Washi or Sendong in 2011 etc.) are generally regarded as economically significant events. The macroeconomic ramifications of, cumulatively, considerable direct damage as a consequence of annual tropical cyclones is ignored except in years of exceptional losses.

In order to highlight the challenges posed to the Philippine economy both now and in the future, it is therefore necessary to take a more disaggregated approach, focusing on some of the country's most vulnerable sectors and sub-sectors - the agriculture. A disaggregated approach, exploring the direct impacts and risks of the major hazard, which is the tropical cyclone, on specific sectors or sub-sectors and tracking the indirect and secondary effects through the economy may be far more illuminating in understanding vulnerability and the challenges posed to sustainable development and in identifying opportunities to strengthen resilience both of individual sectors and sub-sectors and the economy more broadly.

MATERIALS AND METHODS

The data and other types of information that were used in this study were provided by the United Nations International Strategy for Disaster Reduction (UNISDR), Ateneo De Manila University (ADMU), Manila Observatory (MO), National Disaster Risk Reduction and Management Council (NDRRMC) and the Bureau of Agricultural Statistics (BAS).

The period from 1950 to 2009 was utilized in the study.

TRIP (Track-Risk-Impact-Policy) Modeling Framework was formulated and used in the study in order to address the enigmatic conditions brought by the tropical cyclones.

Track (T) Modeling

The number, the track and the trend of the tropical cyclones (TC) for the last sixty (60) years or six decades were determined using Decadal Analysis Modeling (DAM) (1950-1959, 1960-1969, 1970-1979, 1980-1989, 1990-1999, and 2000-2009). The most intense wind strength was considered in the research. Monthly analysis was also performed to determine which months are in peril due to tropical cyclone frequencies. The Global Climate Model (GCM) was used in order to identify the most hotspots to tropical cyclones.

Risk (R) Modeling

In a quantitative risk modeling, risk (R) was estimated using the United Nations International Strategy for Disaster Reduction (UNISDR) framework, where risk (R) as a function of hazard (H), exposure (E) and vulnerability (V). Tropical cyclone was the type of hazard (H) that was considered in the study. Population for exposure (E) was determined; and the Poverty Incidence for the vulnerability (V) was also simulated. Monte Carlo simulation was used to model the risk that arose from (a) temporary or permanent changes in hazard patterns (b) changes in the exposure, and (c) changes in the vulnerability profiles (e.g. poverty incidence).

Impact (I) Modeling

In this modeling aspect, Wroclaw Quantum Geographic Information Systems (QGIS) was used to determine the various areas that were affected by the most destructive tropical cyclones in the history from the year 1980 to 2009. 1950-1979 was not included since there are no available data. Damages/losses in the agricultural sector were analyzed and mapped.

Policy (P) Modeling

For this aspect, three national policies/acts/laws were evaluated and assessed. These were the following: (a) the Republic Act 7160, which is also known as the Local Government Code (b) Republic Act 10121, which is the Disaster Risk Reduction and Management Act; and (c) the Republic Act 9729, which is the Climate Change Act. These were analyzed to check their conformance with the international laws/policies/actions such as the Hyogo Framework for Action (HFA) and Millennium Development Goals (MDG). Strategic responses were further recommended to address the frequency, duration and intensity of the impacts and risks brought by the hazard. Identification of the gaps and constraints on the existing policies were also taken into consideration.

RESULTS AND DISCUSSION

Track Modeling

Using the Decadal Analysis Modeling (DAM), six decades were analyzed and modeled as described in Figure 2. Figure 1 describes the summation of the tropical cyclones from 1950-2009.

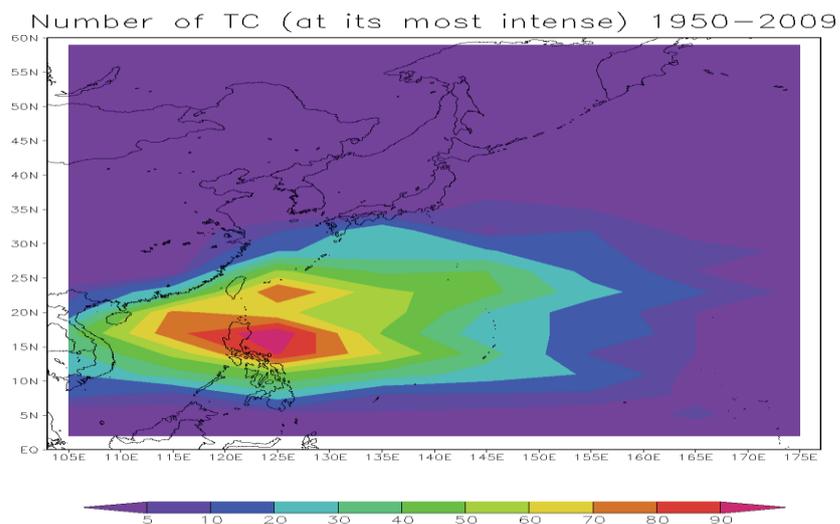


Figure 1 Tropical Cyclones (1950-2009)

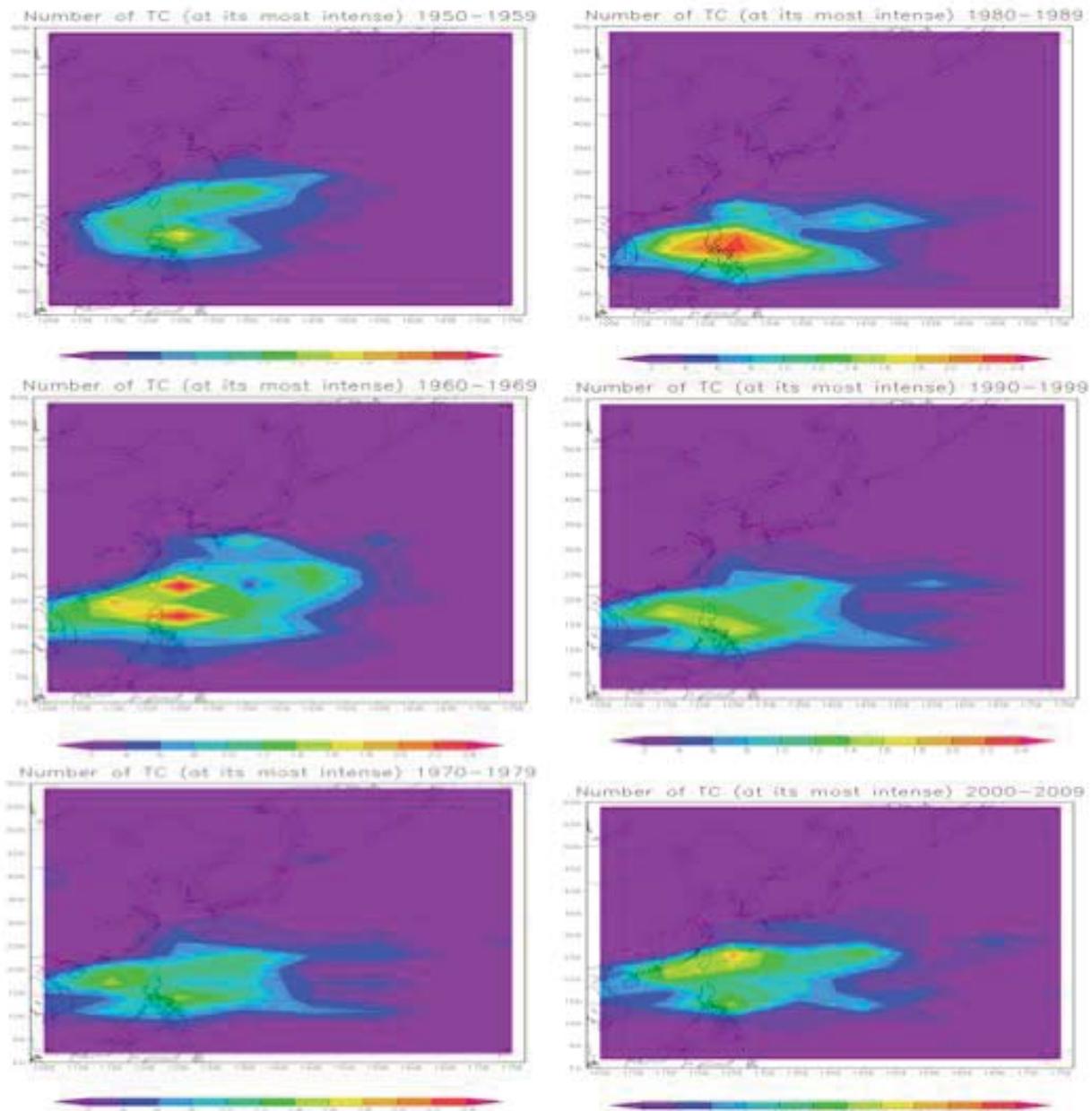


Figure 2 Decadal Analysis Modeling (1950-2009)

Based on Figure 1, the tropical cyclones at their most intense made their landfall on the provinces of Bicol, Cagayan, and Central Luzon. Other areas in Luzon such as CALABARZON, Cordillera, National Capital Region, Ilocos, MIMAROPA have lesser number of cyclones while Visayas and Mindanao have the least.

There are 1785 tropical cyclones at their most intense entered the Philippine Area of Responsibility for the last six decades. Figure 2 explains that the highest number of cyclones occurred from 1960 to 1969, which constitutes 20% of the total cyclones. This is followed by the 1990-1999 decade that comprises 19% of the whole. It is also stipulated that 17% of the cyclones occurred in the period 2000-2009 followed by the 1970-1979, which comprises 16%. The two decades, 1980-1989 and 1950-1959, share the 15% and 12% of the totality.

Risk Modeling

For tropical cyclones, the results of the 1000 experiments demonstrated that there is a tremendous increase in the number of tropical cyclones that would enter in the Philippine Area of Responsibility and apparently would put Luzon, Visayas, and Mindanao at a vulnerable scenario. It exhibited a total number 2088 tropical cyclones in the next sixty years with an average of 348 cyclones per decade. Based on the simulations, one tropical cyclone would stay in the main area for a maximum of five (5) days.

In terms of exposure, similar replications were also done to calculate the optimum number of people that may be exposed to the hazard. The total population of the city is 92 Million. The simulated value is 96 Million individuals. This signifies that this augmented average number of population would be in a probable fatal outcome.

In terms of vulnerability, the simulated Poverty Incidence value is 26.9 in the entire country. This value is 9% higher than the estimated data conducted by the National Statistics Coordination Board (NSCB) in 2009. Table 1 provides the summary of the simulations.

Table 1 Summary of the Simulated Risk Parameters using Monte Carlo Simulation

Risk Parameters	Simulated Values	Interpretation
Hazard	2088 Tropical Cyclones for the next sixty years	There is a tremendous increase of tropical cyclones in the coming decade. One particular landfall of tropical cyclone will stay for a maximum of five (5) days.
	348 Tropical Cyclones per decade	
	35 Tropical cyclones a year	
Exposure	96 Million individuals	There is an increase of people who will be at risk to hazard.
Vulnerability	Poverty Incidence: 26.9	There is an escalation of poverty incidence in the country.

Impact Modeling

In this particular modeling, the damages and losses from the most destructive tropical cyclones in the history were analyzed as described in Figure 3.

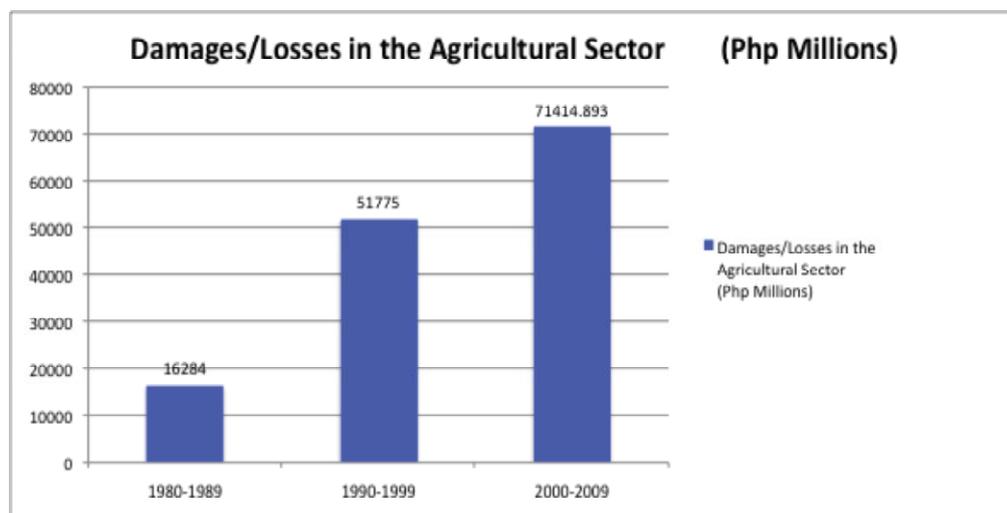


Figure 3 Decadal Analyses of Damages and Losses in the Philippine Agricultural Sector

For the last three decades, there is a colossal upsurge of damages and losses that were brought by the most destructive tropical cyclones in the agricultural sector with an estimated cost of Php 138,488.893 Millions. This is an alarming condition since the increase happens in a decadal state of affairs. From 1980 to 1989, Php 16,284 Millions worth of agricultural goods were devastated. Sixty-nine (69%) escalation, which is around Php 51,775 Million, ensues after the mutilation. The damage also augments by twenty-eight (28%) from 1990-1999 to 2000-2009. This decadal rise of damage is a validation of the findings of the Intergovernmental Panel on Climate Change (IPCC) Assessment Report 2007 wherein the effects of intensity and frequency of tropical cyclones may exacerbate the socio-economic and environmental conditions of the country.

Policy Modeling

There are three Republic Acts that were assessed. They are as follows: (a) the Republic Act 7160, which is also known as the Local Government Code (b) Republic Act 10121, which is the Philippine Disaster Risk Reduction and Management Act of 2010; and (c) the Republic Act 9729, which is the Climate Change Act.

According to Section 324-d of the Local Government Code, five (5%) of the total revenue of the local government unit (LGU) should be allotted to the calamity fund. This is also stipulated on the other Republic Act No. 10121 under Section 21 wherein a local calamity fund, which is the Local Disaster Risk Reduction and Management Fund, amounting to not less than five percent (5%) shall be set aside to support disaster risk management activities. Thirty-percent (30%) of this allocated amount shall be used for the Quick Response Fund. The same allotment is also mentioned in Section 18 of the Climate Change Act but there are no specific details how much a certain LGU or any government agency will provide.

For instance, the unforgettable mutilated visit of Tropical Storm Ketsana or “Ondoy” in one of the urban areas of the metropolis, the Marikina City. Sixty million (Php 60 Million) was allotted for the calamity fund. It was found out that this was not adequate when sixty percent (60%) of the population was affected. It was estimated that the budget allocated was only Php 5.21 per individual.

This condition in Marikina was also validated in a rural coastal area in one of the Municipalities of Camarines Sur, Bicol. Cabusao, which is a fifth-class municipality, is also a hotspot of tropical cyclones. Using the revenue allotment of 2009, the Municipality of Cabusao registered a total collection of Php 10,053,996. And using the five percent (5%) of the total revenue, the local government of Cabusao allotted Php 502,699.80 for calamity fund. It was calculated that this financial resource is inadequate to provide assistance to the affected individuals. A budget of Php 8.00 was given when sixty percent (60%) of the population was impinged on.

In the agricultural sector, Super Typhoon Megi, “Juan”, a peril that entered in the Philippine Area of Responsibility (PAR), brought a pandemonium in the economic panorama of the country. More than Php 6,000,000,000.00 (Php 6 Billion) worth of agricultural lands, plantations, fishponds, and commodities were lost due to its meteorological strength. Provinces such as Abra, Apayao, Benguet, Ifugao, Kalinga, Mt. Province, Ilocos Norte, Ilocos Sur, La Union, Pangasinan, Cagayan, Isabela, Aurora, Bulacan, Nueva Ecija, Pampanga, Tarlac, and Zambales were affected. Their collective calamity funds for the affected individuals or households were not sufficient to address the said quandary.

Based on the aforementioned actual occurrences brought by the tropical cyclones, the allotment of the-so-called budget by the local government is considered to be derisory, which means that the budget is not enough to suffice the needs of the individual whenever there is a negative impact brought by the meteorological tumult. This is not also sufficient to address the enigma of the agricultural sector at whatever time a disaster like tropical cyclone attacks.

Climate Change Adaptation and Disaster Risk Reduction and Management

Table 2 provides the different disaster risk reduction strategies (based from the Hyogo Framework for Action) and climate change adaptive capacities.

Table 2 CCA-DRRM Strategies

CCA	DRR
<p><i>Food crop and fruit sector</i></p> <p>a. Introduction and Evaluation of crop varieties and lines to different agro climatic conditions</p> <p>b. Breeding of new varieties (e.g. onion, bean etc.)</p> <p>c. Introduction of new crops (e.g. soya bean)</p> <p>d. Evaluate varieties suitable for changing agro-climatic conditions (drought, heat stress, high salinity, disease-resistance, etc)</p> <p>e. Evaluation of crop production under protected culture (greenhouse, shade house, hydroponics)</p> <p>f. Optimizing water use efficiency</p> <p>g. Drip irrigation in vegetable and fruits</p> <p>h. Promote Sustainable Agricultural practices (soil conservation, integrated plant nutrient management , integrated pest management etc)</p> <p><i>Livestock Sector</i></p> <p>a. Modify the environment to minimize heat stress (e.g. cooling, shading, etc)</p> <p>b. Provide adequate water</p> <p>c. Lower stocking densities (e.g. less poultry head/m²) to minimize mortality.</p> <p>d. Provide better quality feed (additives and mineral supplements)</p> <p>e. Breeding for breeds resistant to heat stress</p> <p><i>Capacity Building</i></p> <p>Improve environmental education; build staff capacity and infrastructure to implement flood warning system; build capacity in weather forecasting; Hydro-climatic network monitoring; strengthen commodity value chains and find new markets; build knowledge and capacity</p>	<p><i>1. Ensure that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation</i></p> <p>Methodical local risk assessment with the help of the different institutions such as Manila Observatory may coalesce downscaled climate models that focus on projected changes with local-level vulnerability assessments that focus on current threats in order to increase understanding of climate change/natural disaster impacts on human life, food security, access to natural resources, agriculture, fisheries, marshland other industries. This will require:</p> <p>a. Reviewing climate risk information available at the local level;</p> <p>b. Determining capacities for data collection and use;</p> <p>c. Undertaking wide risk profiling with a focus on vulnerable areas, and sectors</p> <p>d. Reviewing the zoning and land use plan taking into account the danger areas.</p> <p><i>2. Identify, assess and monitor disaster risks and enhance early warning</i></p> <p>Knowing the risks and taking action involves identifying, assessing and monitoring disaster risk and enhancing early warning are some of the most important things that needs to be undertaken and applied in affected areas. Enhanced people-centered early warning systems and mechanisms are necessary to allow for early alerts to trigger early action taking into consideration issues of trust and differences in access to information because of gender, social status or age and people mobility potential</p> <p><i>3. Use knowledge, innovation and education to build a culture of safety and resilience at all levels.</i></p> <p>Improved use of climate change/natural disaster information that requires more investment in networks of climate stations, capacity building for interpreting information, user-friendly forecasting tools, linkages between service providers (researchers and hydro-meteorological services) and service users (humanitarian actors and climate-sensitive sectors), and production of impact outlooks for specific audiences. Also, raising awareness and educating all sectors in the society, through school curricula and segmental trainings to reduce vulnerability have to be done. These trainings should also be given not only to the educated and professionals but also to the marginalized sectors in the society. Seminars, conferences, and forums should be organized by the overseers to be given to all</p>

Policy

Design and implement zoning regulations and building codes; inter-sectoral allocation; facilitate access to credit; water conservation and demand management (including metering and price structure); compensation for flood damages; develop coastal resource management plans at the barangay levels

Infrastructure

Coastal resource management; sand pumping; River dredging; lining of river channel; installation of collectors, storm gates and pumps; construction of water gate; development of food storage facilities; rain gauge installation; upgrading seawall

New Practices

Incorporation of risk assessment and mitigation information into micro-watershed management plans; rainwater harvesting; documentation of best practices and case studies

the barangays. Apparently, these trainings will be conducted and taught by the barangay officials to their different cohorts and subsidiaries.

4. Reduce the underlying risk factors

Reducing communities' vulnerability and risk in sectors through land-use zoning and building codes, by protecting ecosystems and natural defenses, and developing insurance and microfinance initiatives can be done by integrating the risk mitigation measures and climate change adaptation. Some of the specifics are the following:

- a. Adapting agriculture, fisheries, and other industry practices through, for example, adjustment of crop and fishing calendars, and introduction of climate-resilient crop and tree varieties;
- b. Climate proofing of post-production management practices such as storage, drying and processing;
- c. Improving sustainable natural and coastal resource management to increase resilience of food production systems;
- f. Investing in infrastructure and hazard proofing critical facilities;
- g. Diversifying livelihoods through decreasing dependence on the usual activities, and increasing small-scale enterprise development.

5. Strengthen disaster preparedness for effective response at all levels

Being prepared and ready to act, which can be maximized by developing and testing contingency plans, establishing emergency funds and coordination systems are vital and essential at all times. In strengthening this preparedness, the following have to be taken into consideration:

- a. Expanded contingency planning, especially in areas prone to flood, windstorms or drought, that considers new and evolving risk scenarios and integrates the three (3B's) "build back better" principle to induce prevention and adaptation in rehabilitation;
 - b. More flexible funding mechanisms at the international level that allow development and humanitarian resources to be invested in preparedness;
 - c. Preparedness for diversified livelihoods response options combined with social protection measures both to individuals and households
 - d. Proper communication through responsible avenues with the use of TV and radio stations.
-

CONCLUSION AND RECOMMENDATIONS

In this study, the evidence implies that the frequency and intensity of tropical cyclones is a mounting and increasing phenomenon and becoming a vital issue not only in the national and international arena and policy-making entities but also to the communal parties. Track-Risk-Impact-Policy (TRIP) Modeling provides a dynamic impetus that created a panorama of genesis, resiliency, and progress. The colossal figure of the meteorological hazard would continue to intensify in the future and would give immense bearing and massive impacts to the populace and to the agricultural assets. The uncovering issue of worst-case scenario might be idyllic due to its plausible outcome but should be dealt with apposite solution and recommendations. The policies and frameworks that are only emerging right now due to sequential extreme events lack coherent conceptual accounts on specific areas (e.g. financial assistance, structural limitation, normative frameworks) that need particular attention. These must be altered and modified in order to provide an effective backcloth both for national and local action for the people and the environment.

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Comparison on the Removal Efficiency of *Escherichia Coli* and *Pseudomonas Aeruginosa* using Monochloramine Disinfection

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Abstract: Water reclamation and reuse has been recognized in agricultural activities. However, the biological risk associated with water reclamation and reuse is a major factor to consider. Appropriate treatment for reclaimed water will increase the water quality significantly. The aim of this research is to evaluate the removal efficiency of two selected pathogenic bacteria, *Escherichia coli* and *Pseudomonas aeruginosa* in secondary effluent and river water using monochloramine disinfection process. It was observed that approximately 2 to 2.5 logs removal could be achieved with multistage treatment by filtration and monochloramine disinfection. *Ps. aeruginosa* was more resistant than *E. coli* in monochloramine disinfection. It was concluded that with appropriate treatment, reclaimed water was found suitable for agricultural activity.

Keywords: *Escherichia coli*, *Pseudomonas aeruginosa*, Monochloramine, Water reclamation

INTRODUCTION

Malaysia socio-demographic and changes in the environment create unprecedented challenges to public. The changes caused by population growth, urbanization and industrialization yielded amplification in water demand. Two major issues to fulfill water demand are water pollution and water shortage. First issue is water pollution from industry, aquaculture effluent, agriculture activities, and wastewater discharge and water treatment residual dumped in the river. This research emphasized on biological aspect of pollution namely *Escherichia coli* (*E.coli*) and *Pseudomonas Aeruginosa*. Partially treated or untreated wastewater contained a lot of biological hazard which increased human health risk. The second issue is water shortage due to the growing population, extensive industrialization and high urbanized societies. Mismanagement of water resources and less stringent enforcement were identified as key factors [1]. Water reclamation and reuse was considered as one of the alternative to replenish natural water resources. Increasing of water demand and raising awareness to the environment reinforced the efforts to improve the treatment and reuse water for agriculture and recreational activities. The efficacy of conventional wastewater treatment processes in removing pathogenic microorganisms has been investigated in several studies [2, 3]. In order to select an appropriate treatment for removing pathogenic microorganisms a few factors should be considered including raw water quality, initial concentration of pathogens, hydraulic condition, dosage requirement, contact time, energy consumption and maintenance cost. The aim of this research was to investigate the removal efficiencies of *E.coli* and *Pseudomonas Aeruginosa* in secondary effluent and river water by multistage treatment. Filter media from treated water treatment residue and monochloramine was tested in this research to achieve a few logs removal.

MATERIALS AND METHODS

Tested Water

River water and secondary effluent

River water samples were collected from River Aur located in Klang, Selangor. The river received final discharge of municipal wastewater. The land use and land cover of surrounding areas are residential, agricultural (banana, mango and vegetables) and industrial. Samples were collected in sterilized tube and stored in 4°C and were measured within 24 hours. Secondary effluent samples were collected from activated sludge process. Sampling period for both tested water was nine (9) month from March 2012 until November 2012.

Microorganism’s Selection and Detection

E.coli and Pseudomonas Aeruginosa

E.coli belongs to the family Enterobacteriaceae and almost invariable enteric. *E.coli* is facultative anaerobe, gram-negative with rod-shaped bacterium. *E.coli* lives in intestinal tracts of warm blooded animals including humans. A number of outbreaks have been reported from recreational use of waters and storm water because of runoff discharging wastes directly into the water [4, 5]. When these waters are used as sources of drinking water and the water is not treated or inadequately treated, *E.coli* may end up in drinking water. The acute disease tends to be moderately severe and of moderate duration.

Pseudomonas Aeruginosa is a gram-negative, aerobic rod belongs to Pseudomonadaceae bacterial family. *Pseudomonas Aeruginosa* has a single polar flagellum where it can be seen in hay infusion and pond water sample. *Pseudomonas Aeruginosa* is free living bacteria in water and is commonly found in watering system for animal and human. *Pseudomonas Aeruginosa* caused severe nosocomial and community acquired infections like at the urinary track, cornea and lower respiratory tract [6, 7].

Sample collection, preservation, storage and detection of *E.coli* and *Pseudomonas Aeruginosa* were conducted based on Standard Methods for Examination of Water and Wastewater , Part 9000 [8]

Data Analysis

The removal efficiency of *E.coli* and *Pseudomonas Aeruginosa* were calculated by using the following equation 1[9]:

$$\text{Log} \frac{N}{N_0} \dots(1)$$

Where N = number of organisms remaining after disinfection at time t
 N₀ = number of organisms presents before disinfection
 T = contact time, min

In order to calculate the C_RT value the following equation 2 was used:

$$C_R \times T \dots(2)$$

Where C_R = residual chlorine
 T = contact time

Experimental Setup

Filtration Preparation

Figure 1 shows the experimental set up for filtration unit. Treated water treatment residue was used as filtration media in this research. The different size of sludge balls were arranged in the cylinder with an opening at the bottom where the effluent passes through the

filter. The water spiked with known concentration of the *E.coli* and *Pseudomonas Aeruginosa* that was cultured to examine the removal efficiency of the bacteria using this filtration. Then the removal efficiency of this filtration was measured based on an hourly basis. The concentration of *E.coli* and *Pseudomonas Aeruginosa* was recorded hourly in order to analysis the removal efficiency of the filtration.



Figure 1 Filtration unit for removing *E.coli* and *Pseudomonas Aeruginosa* Disinfection preparation

Monochloramine was used as disinfectant for filtered water. The analysis was done using Jar test where the concentration and contact time was controlled. Jar test method was used to determine the required monochloramine dosage and the contact time. Different dosage concentration and contact time were selected to analyze the removal efficiency as shown in Table 1. The concentration of the monochloramine were set up which is 0ppm, 5ppm, 10ppm, 15ppm and 20ppm. The contact time was set up at 1, 3, 5, 10 min. The rotation per minute (RPM), pH and temperature was constant. Monochloramine with different concentration was spiked in the beaker containing the sterilized distill water. In the same beaker the known concentration of the *E.coli* and *Pseudomonas Aeruginosa* were spiked. The sample from each beaker was analyzed for the residual chlorine at the end of contact time. The plate count test was running in order to calculate the reduction of the *E.coli* and *Pseudomonas Aeruginosa*.

Table 1 Condition of monochloramine disinfection

Parameter	Condition
Temperature	25°C
pH	8
Concentration(ppm)	2,5,10
Ratio	Chlorine : Ammonia (5:1)
Contact time(min)	1,3,5,10

RESULTS AND DISCUSSION

Figure 2 shows the removal efficiencies of *E.coli* and *Pseudomonas Aeruginosa* using treated water treatment sludge as filter media. Approximately 0.3-0.4 logs removal of *E.coli* could be achieved in secondary effluent and river water respectively. Removal efficiency of *Pseudomonas Aeruginosa* ranged from 0.25 logs in secondary effluent and 0.15 logs removal

in river water. Treated water treatment residue was found failed to achieve more than 1log removal of both targets.

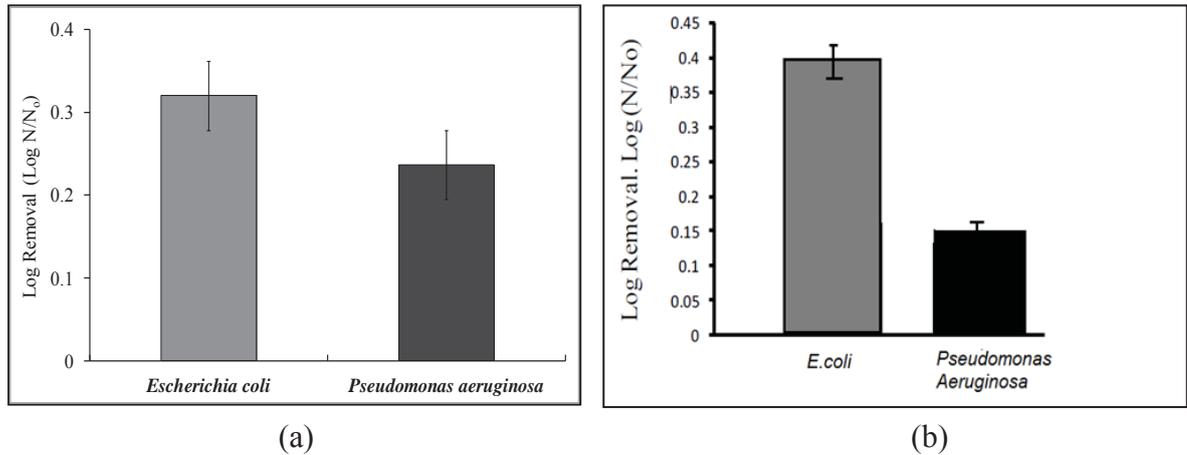


Figure 2 Removal of *E.coli* and *Pseudomonas Aeruginosa* by filtration in (a) secondary effluent (b) River water

Figure 3 shows the removal efficiencies of *E.coli* by monochloramine. Log inactivations were found increased with increasing of monochloramine concentration for *E.coli*. Inactivation of *E.coli* in river water was more rapid than secondary effluent. Complex matrix in secondary effluent influenced the inactivation rate of *E.coli*. Maximum approximately, 2.0-2.5 logs inactivation could be achieved for *E.coli* in secondary effluent and river water under the condition of this study.

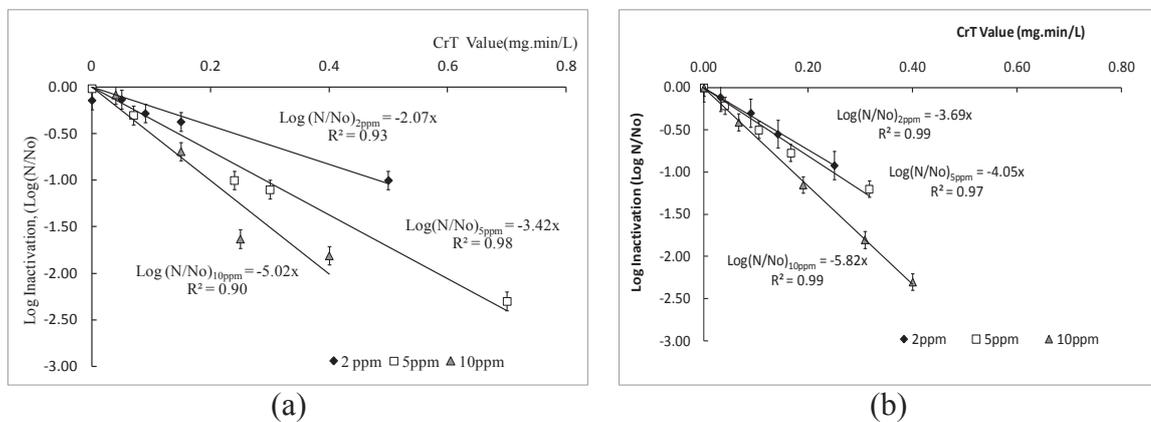


Figure 3 Removal of *E.coli* by filtration and monochloramine in (a) secondary effluent (b) River water

Figure 4 shows the removal efficiencies of *Pseudomonas Aeruginosa* in secondary effluent and river water using monochloramine. Log inactivation was increased with increasing of monochloramine concentration for *Pseudomonas Aeruginosa*. Inactivation of *Pseudomonas Aeruginosa* in river water was more rapid than secondary effluent. Highest removal at 10ppm could achieve only 1.0 – 2.0 logs removal of *Pseudomonas Aeruginosa* in secondary effluent and river water. Based on the condition of this study, *Pseudomonas Aeruginosa* was found more resistant than *E.coli* during disinfection with monochloramine. For agricultural purposes, 3-logs removal is needed [10]. Therefore with increasing of contact time and monochloramine dosage, higher removal efficiency could be achieved and suitable for agricultural activity.

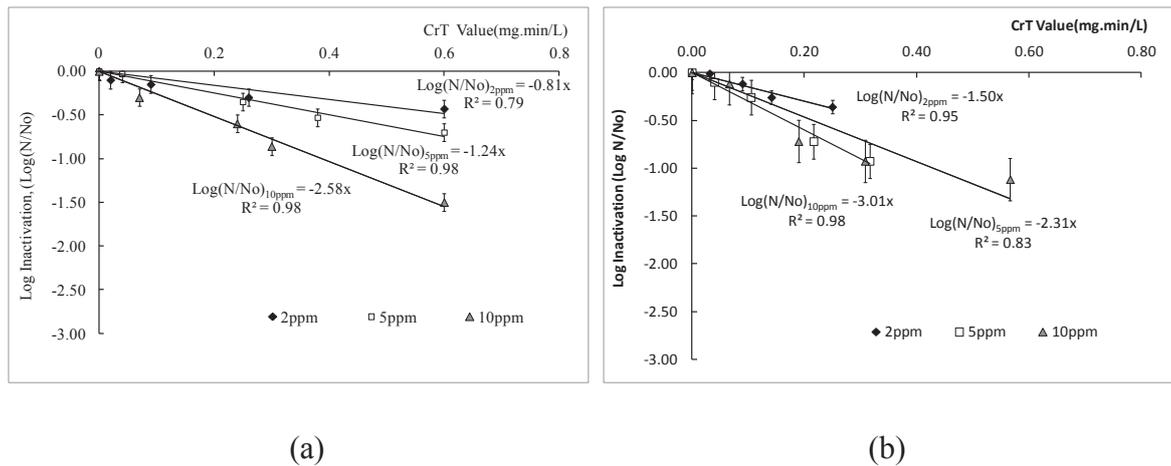


Figure 4 Removal of *Pseudomonas Aeruginosa* by filtration and monochloramine in (a) secondary effluent (b) River water

CONCLUSION

Multistage treatment using treated water treatment residue and monochloramine was investigated for inactivation of *E.coli* and *Pseudomonas Aeruginosa* in secondary effluent and river water. The objective of the study was achieved.

- Approximately 0.15 – 0.25 log removal could be achieved with filtration process.
- 2.0-2.5 logs inactivation could be achieved for *E.coli* in secondary effluent and river water
- 1.0 – 2.0 logs removal of *Pseudomonas Aeruginosa* in secondary effluent and river water
- *Pseudomonas Aeruginosa* was found more resistant than *E.coli* during disinfection with monochloramine

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Acidified Ethanol Extraction of Antioxidants in Black Rice Bran (cv. Hom Nin) and Antioxidant Activities of the Extracts

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Abstract: Rice bran is a rich source of antioxidants such as phenolic compounds, γ -oryzanol and tocopherols. Moreover, anthocyanins are also found in pigmented rice bran. These antioxidants provide many health benefits and have been used to extend shelf life of food products. Black rice bran (cv. Hom Nin) was extracted by 97% ethanol and ethanol acidified with 1, 2 and 3% of acetic acid. The crude extracts were determined for total phenolics, γ -oryzanol, α -tocopherol and anthocyanins contents. It was found that the extraction efficiency increased with increasing of acetic acid concentration. The extraction using acidified ethanol with 3% acetic acid showed 1.71-folds higher in extraction efficiency than 97% ethanol extraction. This crude extract contained the highest amounts of total phenolics, anthocyanins, γ -oryzanol and α -tocopherol ($3,720.69 \pm 35.50$, 352.20 ± 3.68 , $2,570.48 \pm 41.86$ and 59.91 ± 1.94 $\mu\text{g/g}$, respectively). In addition, the extract showed the strong antioxidant activities in all test including DPPH radical scavenging activity ($\text{EC}_{50} = 0.20 \pm 0.014$ mg/ml) and metal chelating activity ($\text{EC}_{50} = 0.29 \pm 0.047$ mg/ml). These results suggested that the acidified ethanol extract from black rice bran (cv. Hom Nin) can be used as a natural antioxidant.

Keywords: Antioxidants, Antioxidant activity, Black rice bran, Extraction

INTRODUCTION

Pigmented rice bran is a rich source of many bioactive compounds both low and high polar molecules such as tocopherols, γ -oryzanol, phenolic compounds and anthocyanins [1-3]. These compounds have been proved about their health benefits such as lowering of blood cholesterol, decreasing platelet aggregation and anti-inflammation [4-6]. Furthermore, many studies have reported that they are capable to inhibit lipid peroxidation resulting in the longer shelf life of food products [4, 7]. In the recent years, extraction of rice bran was interested to recover the antioxidants for using in food industry. The most favorable extraction method is solvent extraction because of its simplicity and low cost. Methanol, ethylacetate, isopropanol and hexane are usually used as extractants [1, 6, 8-9]. However, their toxicological issues are concerned when using the extract in food product. Then, the permitted solvent to use in food such as ethanol is an alternative solvent to study. Ethanol is suitable organic solvent to extract the low polar antioxidants including γ -oryzanol and α -tocopherol; while, high polar antioxidants such as phenolic compounds and anthocyanins were extracted in lower amounts than higher polar solvents. The first objective of this study was to improve the extraction efficiency of low polar and high polar antioxidants in rice bran using acidified ethanol. The second objective was to investigate the antioxidant activity of the acidified ethanol extract.

MATERIAL AND METHODS

Material

Rice grains *cv.* Hom Nin was purchased from Multiple Cropping Center (MCC), Faculty of Agriculture, Chiang Mai University, Chiang Mai, Thailand. The rice grains was milled with a laboratory miller, and then passed through a 20-mesh sieve and kept in polypropylene bag at -18 °C for further analysis.

Extraction

The extraction method was followed by Lai *et al.* [6] with slightly modification. Rice bran (10 g) was extracted by electrical shaker for 90 min at room temperature with 200 mL of ethanol and ethanol acidified with 1, 2 and 3% of acetic acid, followed by filtering through Whatman filter paper. The supernatant were evaporated to dryness by rotary evaporator. The final volume of crude extracts was adjusted to 50 mL with ethanol (HPLC Grade) and stored in brown glass bottles (covered by foil) at -18 °C for further analysis. The extraction was done in triplicate.

Determination of Total Phenolic Content

Folin–Ciocalteu reagent was diluted with distilled water 1:9 (v/v) followed by 1.25 mL of this reagent and 50 µL of crude extract were mixed. One milliliter of Na₂CO₃ (7.5%) was added. The mixture was incubated for 15 min at 50 °C. The absorbance at 760 nm was measured by using a UV-Vis spectrophotometer within 15 min. Gallic acid was used as a standard, and results were calculated as gallic acid equivalents (µg GAE/g of rice bran).

Determination of Anthocyanin Content

Anthocyanin content was determined by the pH differential method [10]. To measure the absorbance at pH 1.0 and 4.5 within 20-50 min after preparation, the crude extract was diluted about 20 times with pH 1.0 potassium chloride buffer and pH 4.5 sodium acetate buffer, respectively followed by mixing with vortex equipment. The absorbance of test portion was determined at both 513 and 700 nm. The diluted test portions are read versus a blank cell filled with distilled water. The concentration of monomeric anthocyanin pigment was calculated by the following equation: Monomeric anthocyanin pigment (mg/L) = $[A_{\text{diff}} \times \text{MW} \times \text{DF} \times 1000] / \epsilon$, where MW represents molecular weight of cyanidin-3-glucoside (449.2 g/mol), DF is the dilution factor, ϵ is molar absorptivity of cyanidin-3-glucoside (26,900 l/mol cm) and A_{diff} was calculated from the following equation: $A_{\text{diff}} = [A_{513} - A_{700}]_{\text{pH}1.0} - [A_{513} - A_{700}]_{\text{pH}4.5}$

Determination of α -tocopherol and γ -oryzanol Contents

α -Tocopherol and γ -oryzanol were separated following method as described by Aguilar-Garcia *et al.* [2] with slightly modification, using an analytical Shimadzu High performance liquid chromatography (HPLC) system (Kyoto, Japan). Samples were injected onto a C₁₈ column (250 mm×4.6 mm (i.d); Restec) using the manual sampler. The flow rate of elution is 1 ml/min. The initial composition of the mobile phase (45% acetonitrile, 45% methanol and 10% isopropanol) was held for 6 min, followed by a linear gradient to 25% acetonitrile, 70% methanol and 5% isopropanol in 10 min; the final composition was held for 12 min. α -Tocopherol was monitored using the fluorescence detector at an excitation wavelength of 298 nm and an emission wavelength of 328 nm. γ -Oryzanol was monitored with PDA detection at 325 nm.

DPPH Radical Scavenging Activity

The free radical scavenging activity was measured using the method of Mao *et al.* [11]. The 0.1 mM DPPH radical in ethanol was prepared and 2 mL of this solution was

added to 3 mL of the extracts. The absorbance was measured at 517 nm after 30 min. BHT was used as positive standard. The scavenging of DPPH radical in percent was calculated by the equation: Scavenging activity (%) = $(1 - A_1 / A_0) \times 100$, where A_0 was the absorbance of the control reaction and A_1 was the absorbance in the presence of extracts and reported as EC_{50} (mg/ml) value.

Metal Chelating Activity

The chelating activity on Fe^{2+} was measured using the method of Mao *et al.* [11]. 1 mL of the extracts was mixed with 3.7 mL of distilled water and then the mixture was reacted with 0.1 mL of 2 mM $FeCl_2$ and 0.2 mL of 5 mM ferrozine. The absorbance was measured at 562 nm after 20 min. EDTA was used as positive standard. The percentage of ferrozine- Fe^{2+} complex formation was calculated by the equation: Chelating activity (%) = $(1 - A_1 / A_0) \times 100$, where A_0 was the absorbance of the control reaction and A_1 was the absorbance in the presence of extracts and reported as EC_{50} (mg/ml) value.

Statistical Analysis

All trials were carried out in triplicate and all data were reported as means \pm SD (standard deviation). The statistics significance was evaluated using Duncan's New Multiple Range Test and $P < 0.05$ was taken as significant.

RESULTS AND DISCUSSION

Antioxidant Contents

Total Phenolics and Anthocyanins Contents

In order to examine the effect of acetic acid concentration on the extraction efficiency of total phenolics and anthocyanins contents, acetic concentrations were varied from 0% to 3% (v/v) in ethanol (Figure 1. A and B). It can be observed that the extraction efficiency of total phenolics and anthocyanins contents were higher in the case of acidified ethanol when compared to 97% ethanol. The extraction efficiency increased with increasing of acetic acid concentration. The ethanol acidified with 3% acetic acid extract showed the highest amounts of total phenolics and anthocyanins contents ($3,720.69 \pm 35.50$ and 352.20 ± 3.68 $\mu\text{g/g}$, respectively). The solubility of phenolics compound is affected by the polarity of solvents used. Because of solvent polarity was increased by acidification. Thus, the high polar phenolics molecule can be dissolved in higher polar solvent [12].

However, beside the effect of solvent polarity on anthocyanins extraction, the lower pH values are also affected on the higher stability of anthocyanins than higher pH values [10]. The results of this study demonstrate that acidified alcohol are effective in extracting total phenolics and anthocyanin contents, which is in agreement with previous studies for total phenolics extraction from black glutinous rice [4] and anthocyanin extraction from red cabbage [13].

γ -Oryzanol and α -tocopherol Contents

The effects of acetic acid concentration on the extraction efficiency of γ -oryzanol and α -tocopherol contents are shown in Figure 1. C and D. It can be observed that the extraction efficiency of γ -oryzanol and α -tocopherol contents have increased with an increasing of acetic acid concentration. The maximum γ -oryzanol ($2,570.48 \pm 41.86$ $\mu\text{g/g}$) and α -tocopherol (59.91 ± 1.94 $\mu\text{g/g}$) contents were obtained from ethanol acidified with 3% acetic acid extract. The increase in γ -oryzanol and α -tocopherol contents could be mainly due to this acidified solvent destroys the cell membrane of rice bran, or the acid may breaking down the complex

molecule between antioxidants and other part [12]; then, the releasing of these antioxidants were higher when compared to 97% ethanol. However, the polarity of acidified solvent had less effect on these low polar antioxidants extraction.

Thus, ethanol acidified with 3% acetic acid extract was selected to investigate the antioxidant activities including DPPH radical scavenging activity, metal chelating activity.

Antioxidant activities

Metal Chelating Activity

The EC_{50} value of ethanol acidified with 3% acetic acid extract using metal chelating determination is shown in Figure 2(A). Higher EC_{50} value indicates lower effectiveness in antioxidant properties. The extract showed an EC_{50} value of 0.29 ± 0.047 mg/ml; while, EDTA showed lower EC_{50} value at about 0.03 ± 0.002 mg/ml. With regard to EC_{50} value of metal chelating activity, the activity of ethanol acidified with 3% acetic acid extract was better than the extracts from Thai long-grain rice bran such as Khoa Chainat and Khao Gokho13 (0.55 ± 0.03 and 0.45 ± 0.04 , respectively) [4]. The result suggested that the acidified ethanol extract from black rice bran (*cv.* Hom Nin) can be used as a metal chelating agent.

DPPH Radical Scavenging Activity

Figure 2 (B) demonstrates that the EC_{50} value of ethanol acidified with 3% acetic acid extract is higher than EC_{50} of BHT at about 4-folds (0.20 ± 0.014 and 0.05 ± 0.003 mg/ml, respectively). Lower EC_{50} values indicate higher effectiveness in antioxidant properties. The extract showed lower EC_{50} value than Thai rice bran *cv.* Khoa Dawk Mali105 (0.52 ± 0.02 mg/ml) and Khoa Pathum Thani 60 (0.38 ± 0.02 mg/ml) [4]. Moreover, it also showed the lower EC_{50} value than black glutinous rice (*cv.* Kum Doisaket) that extracted by acidified mixed solvent between acetone and water (0.43 ± 0.02 to 0.78 ± 0.05 mg/ml) [10]. The result suggests that acidified ethanol extracts have high ability for donating hydrogen atoms to DPPH-free radical.

CONCLUSION

Extraction of antioxidants from black rice bran (*cv.* Hom Nin) with acidified ethanol produced a significantly greater total antioxidant contents than ethanol. Furthermore, 3% acidified ethanol extract showed the high antioxidant activities in all test including DPPH radical scavenging activity and metal chelating activity. The strong antioxidative activity of rice bran extracts might be due to the presence of phenolic contents, anthocyanins, γ -oryzanol and α -tocopherol or the synergistic effect of these antioxidants.

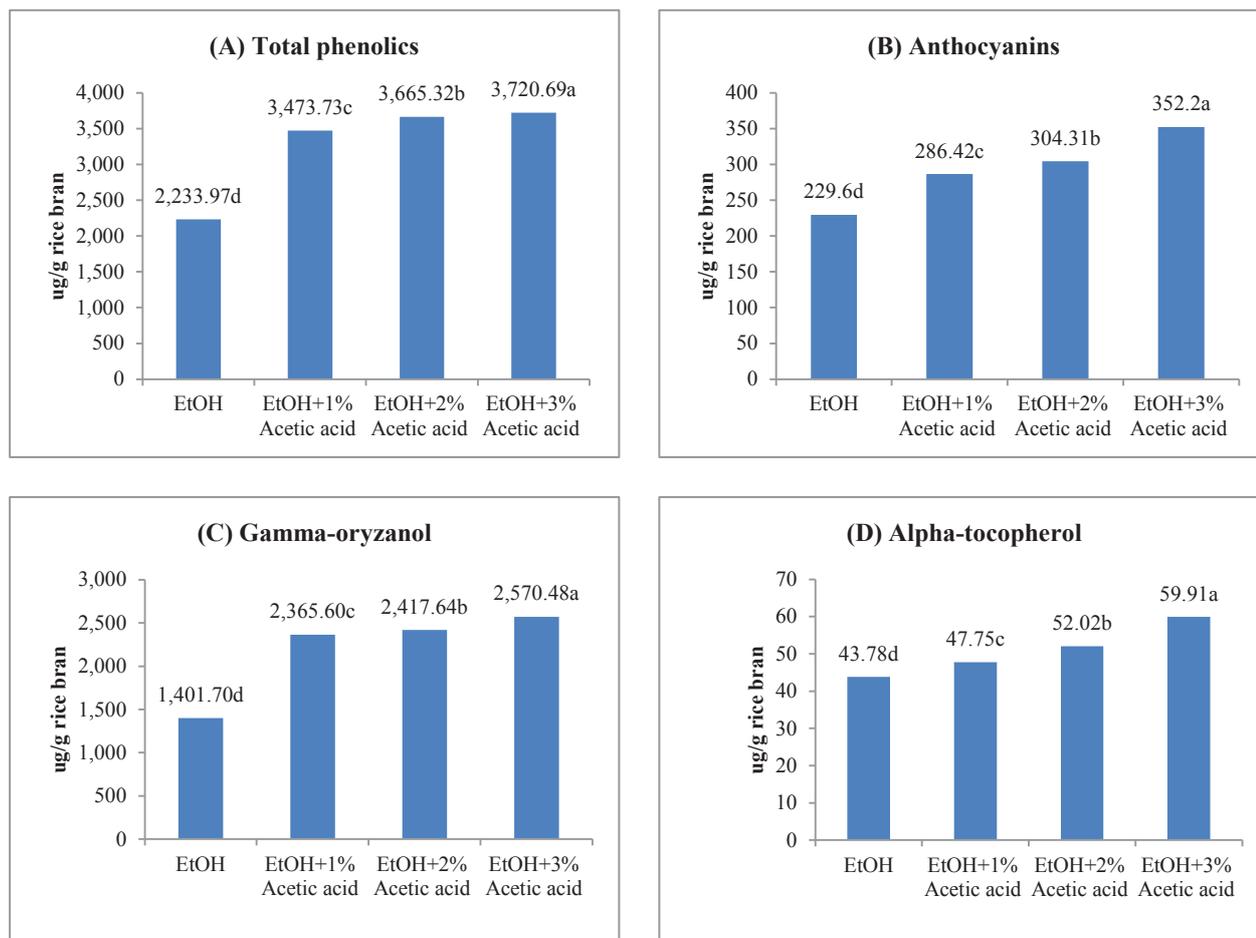


Figure 1 Antioxidant contents of ethanol and acidified ethanol extracts from Hom Nin rice bran.

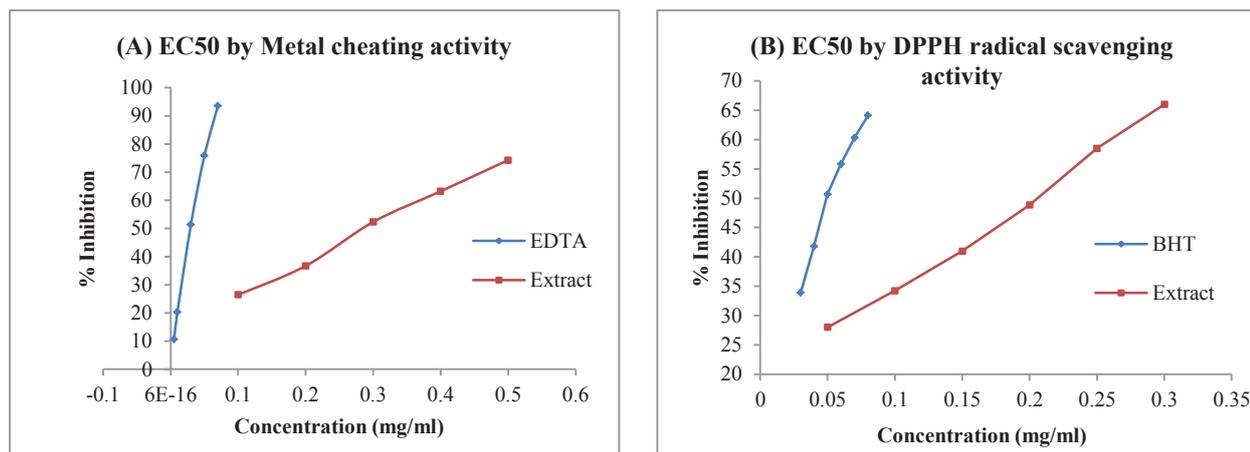


Figure 2 EC₅₀ values of ethanol + 3% acetic acid extract.

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Vulnerability to Climate Change of Threatened Forest Species in the Philippines

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Abstract: Climate change is projected to alter the geographic distribution of forest ecosystems. This study aimed to assess the vulnerability to climate change of selected threatened forest tree species in the Philippines. Based on the principle of maximum entropy, a machine algorithm called Maxent was used to estimate a target probability distribution and habitat suitability of the selected species. Threatened forest tree species occurrence records and sets of biophysical and bioclimatic variables were supplied to Maxent program to predict current and future distribution of the species. The Maxent models of the threatened species were evaluated using Receiver Operating Characteristics Area Under Curve (ROCAUC) and True Skill Statistics (TSS) tests which revealed that the models were better than random. The ROC AUC values of the 14 species ranged from 0.70 to 0.972 which was higher than 0.5 of a null model. Based on TSS criteria, Maxent models performed well in two species, very well in ten species, and excellent in two species. Seven species : *Azelia rhomboidea*, *Koordersiodendron pinnatum*, *Mangifera altissima*, *Shorea contorta*, *Shorea palosapis*, *Shorea polysperma* and *Vitex parviflora*, were found to be less vulnerable to climate change due to the potential increase in their suitable habitat. On the other hand, the other seven species : *Agathis philippinensis*, *Celtis luzonica*, *Dipterocarpus grandiflorus*, *Shorea aguiso*, *Shorea negrosensis*, *Toona calantas* and *Vatica mangachapoi*, were likely vulnerable to climate change due to the potential decline in their suitable habitat. The generated species distribution models and habitat suitability maps could be used as basis in formulating appropriate science-based adaptation policies, strategies and measures that could enhance the resilience of those threatened forest tree species and their natural ecosystems to current and future climate.

Keywords: Maxent, Geographic distribution, Threatened forest trees, Climate change, Biodiversity conservation

INTRODUCTION

The Philippines has very rich biodiversity in terms of number and percentage. It is regarded as one of 17 mega biodiversity countries accruing to its geographical isolation, diverse habitats and high rates of endemism [1, 2]. It ranks 5th globally in terms of the number of plant species and maintains 5% of the world's flora. However, due to anthropogenic activities as well as natural disturbances, it continues to lose its rich biodiversity resources [3]. The presence of large number of endangered and threatened species brings down the country into one of the global biodiversity hotspots in the world, thus making it one of the top global conservation priority areas [1, 4, 5]. The official country listing of threatened plant species [6]. lists 176 vulnerable species, 99 critically endangered species, 187 endangered species and 64 other threatened plant species in the Philippines.

In addition to anthropogenic habitat alteration, climate change has been identified as well as one of the major threats facing biodiversity worldwide [1, 7]. It has been estimated that 20–30% of plant and animal species, globally, will be at higher risk of extinction due to global warming and that a significant proportion of endemic species may become extinct by 2050 or 2100 as a consequence as global mean temperatures exceed 2 to 3⁰C above pre-industrial levels [8, 9].

In recent years, an aspect that scientists and researchers look into to evaluate the potential impacts and vulnerability to climate change of biodiversity is in the understanding of the likely shift in geographic distributions and habitat suitability of species due to future climate. Species-distribution models (SDMs) are based on the assumption that the relationship between a given pattern of interest (e.g. species abundance or presence/absence) and a set of factors (e.g. biophysical and bioclimatic variables) assumed to control it can be quantified [10, 11, 12, 13]. One popular SDM method involves maximum entropy modelling and has been used successfully to predict the distributions of different floral and faunal species [14, 15, 16]. For instance, in the study of Trisurat et al. (2011), results showed that from 26.6 °C 2008 to 28.7 °C in 2100, nine forest plant species have suitable distribution ranges in more than 15% of the region, 20 species have suitable ecological niches in less than 10% while the ecological niches of many Dipterocarpus species cover less than 1% of the region.

Threats to vulnerable forest tree species and their habitat in the Philippines caused by climate change could be exacerbated as well by modest research. Since 1997, only two studies on the potential impacts of climate change on forests ecosystems in the Philippines have been conducted: Cruz (1997) and Lasco et al. (2008). However, with regards to potential impacts of climate change on specific forest tree species, no research has been done yet in the country. Hence, this research was conducted also to fill the aforementioned research gap.

MATERIALS AND METHODS

Study Area

The Philippines is located between 116° 40', and 126° 34' E. longitude and 4° 40' and 21° 10' N. latitude and is bordered by the Philippine Sea to the east, the South China Sea to the west, and the Celebes Sea to the south. The Philippines has 7,107 islands covering a total of 30 million ha. Owing to its archipelagic nature, topographic variations characterize the Philippines. The mean annual temperature in the country is 26.6°C. The mean annual rainfall of the Philippines varies from 965 to 4,064 mm annually [17].

The Philippine government adopts the Food and Agriculture Organization definition of forest as “an area of more than 0.5 ha and tree crown cover (or equivalent stocking level) of more than 10% which includes natural and plantation and production forests” [18]. Due to deforestation and other factors, the most recent data on land cover of the Philippines revealed that there are only 23.9% (7.17 million ha) remaining forest cover in the country [19].

Biophysical and Bioclimatic Variables used

Species distribution is determined by temperature, rainfall, geographical barriers and other ecological factors such as underlying geological formations [20]. As such, biophysical and bioclimatic variables were selected as main predictors in this study. The assumption was that the biophysical variables are stable to indicate the vulnerability of threatened forest tree species distribution and habitat suitability to climate change.

Table 1 Group of highly correlated variables using Pearson's correlation coefficient, $r \geq 0.70$ and their corresponding contribution to Maxent pre-model 1.

GROUP	Layer/Climate scenario	Average % contribution in the distribution of <i>Afzelia rhomboida</i> and <i>Dipterocarpus grandiflorus</i>	Variable kept in the final Maxent final model
	Bio 1 = Annual Mean Temperature	0.54	
	Bio 5 = Max Temperature of Warmest Month	0.12	
	Bio 6 = Min Temperature of Coldest Month	4.36	
1	Bio 8 = Mean Temperature of Wettest Quarter	0.05	Bio 6
	Bio 9 = Mean Temperature of Driest Quarter	0.22	
	Bio 10 = Mean Temperature of Warmest Quarter	0.31	
	Bio 11 = Mean Temperature of Coldest Quarter	2.03	
	Bio 13 = Precipitation of Wettest Month	0.97	
2	Bio 16 = Precipitation of Wettest Quarter	0.27	Bio 13
	Bio 15 = Precipitation Seasonality (Coefficient of Variation)	0.89	
3	Bio 18 = Precipitation of Warmest Quarter	0.93	Bio 18
	Bio 14 = Precipitation of Driest Month	0.27	
4	Bio 17 = Precipitation of Driest Quarter	0.23	Bio 14
	Bio 19 = Precipitation of Coldest Quarter	0	
	river presence	0.14	river presence
	soil class	37.24	soil class
	aspect	1.64	aspect
5 ¹	elevation	1.97	elevation
	slope	1.23	slope
	land cover	8.31	landcover
	geology	22.87	geology
6	Bio 2 = Mean Diurnal Range (Mean of monthly (max temp - min temp))	7.83	Bio 2
	Bio 3 = Isothermality (BIO2/BIO7) (* 100)	3.7	
7	Bio 4 = Temperature Seasonality (standard deviation *100)	0.97	Bio 3
8	Bio 7 = Temperature Annual Range (Bio 5-Bio 6)	2.85	Bio 7
9	Bio 12 = Annual Precipitation	0.11	Bio 12

Note: ¹Though not highly correlated, for the purpose of categorization, all biophysical variables were put in the same group.

Twenty-six (26) variables which included seven biophysical variables (aspect, elevation, landcover, river presence, slope, soil classification, and soil geology) and nineteen (19) bioclimatic variables were used in this study. The biophysical variables were collected from relevant government agencies and data clearing house. Others were derived from digital elevation model Shuttle Radar Topographic Mission version 4 of CGIAR-CSI [21]. Bioclimatic variables are biologically more meaningful than just annual means for defining the ecological and physiological tolerances of a species [14, 22, 23,24]. In order to model the vulnerability of selected threatened forest tree species to future climate, two sets of bioclimatic variables, (i.e. base and projected for 2011-2040), were generated by the

International Research Institute (IRI) for Climate and Society at Columbia University. The values of the trends in projected precipitation and maximum and minimum temperature were determined as the median value of 13 global change projections reported in the IPCC AR4. For the Philippines as a whole, these trends were found to be +4% per 30 years for precipitation and +0.8 °C per 30 years for temperature. All bioclimatic and biophysical variables were converted into Raster ASCII grids (.asc) format as required by Maxent and re-sampled to 1km x 1km resolution using nearest neighbour algorithm in ArcGIS 10. The projection of all variables was set to WGS1984_UTM_Zone51N.

In order to avoid harmful collinearity of the variables, spatial autocorrelation was performed. Selecting the most appropriate variable for each group of highly correlated variables requires careful analysis. As discussed in Beaumont et al. (2005), different methods of combining bioclimatic parameters can influence predictions of the species distributions. So as to minimize error in choosing the final set of environmental variables or predictors, pre-model runs using two threatened forest tree species were done. Based on the results, only one variable from a set of highly cross-correlated variables was included in the final Maxent model. Thus, only eight out of 19 bioclimatic variables and all of the seven biophysical variables were kept for the final model (Table 1).

Collection of Threatened Forest Tree Species Presence Data

One of the principal components in Maxent modelling is the compilation of location of occurrence or presence of a species [14]. The presence data of the threatened forest tree species used in the study were from the georeferenced database developed by Ramos et al. 2012. The species were selected from the listing of the Department of Environment and Natural Resources Administrative Order (DAO) 2007-01 and 2003 International Union for Conservation of Nature (IUCN) Red List.

Selection of Species

Although, Maxent can generate good models with sample size as low as five [25], only threatened forest tree species with at least 39 occurrences were chosen for generating species distribution models. This quantity was chosen to have enough samples for testing the model accuracy. A total of 14 species representing seven families and seven forest formations were selected as final species to model their distribution (Table 2).

Species Distribution Modelling

The Maxent model used in this study was developed by Phillips et al. (2006). The idea of Maxent, is to estimate a target probability distribution by finding the probability distribution of maximum entropy (i.e., that is most spread out, or closest to uniform), subject to a set of constraints that represent our incomplete information about the target distribution. Maximum entropy principle “provides a means to obtain least-biased statistical inference when insufficient information is available” [24]. Maxent method was chosen among different SDMs as it ranked to have the best-performing model algorithm in a comparison of 16 different SDMs methods [26]. It also offers a number of advantages as cited by Kumar et al. (2009), Kumar and Stohlgren (2009) and Trisurat et al. (2011).

An approach to evaluate the Maxent model predictive performance is to have an independent test data [27, 28, 29]. This option allows to withhold a certain percentage of presence data that can be used to evaluate the prediction success or model’s performance [30, 31]. A heuristic approach developed by Huberty (1994) in determining the ratio of training to testing data suggests a ratio of $[1 + (p - 1)^{\frac{1}{2}}]^{-1}$, where p is the number of predictors. This approximates to a training data consisting of 75% and test data consisting of 25% of the point

Table 2 Final list of selected threatened forest tree species for Maxent modeling.

Species	Family	Forest formation found	Ecological status
1. <i>Afzelia rhomboidea</i>	Fabaceae	Tropical Semi-Evergreen/ Forest Over Limestone	indigenous
2. <i>Agathis philippinensis</i>	Araucariaceae	Tropical Lower Montane Rainforest	endemic (country)
3. <i>Celtis luzonica</i>	Cannabaceae	Forest Over Limestone	endemic (country)
4. <i>Koordersiodendron pinnatum</i>	Anacardiaceae	Tropical Semi-Evergreen	indigenous
5. <i>Mangifera altissima</i>	Anacardiaceae	Forest Over Limestone	indigenous
6. <i>Shorea contorta</i>	Dipterocarpaceae	Tropical Semi-Evergreen/ Forest Over Limestone	endemic (country)
7. <i>Shorea guiso</i>	Dipterocarpaceae	Tropical Semi-Evergreen/ Forest Over Limestone/Tropical Lowland Evergreen Rainforest	indigenous
8. <i>Shorea negrosensis</i>	Dipterocarpaceae	Tropical Lowland Evergreen Rainforest	endemic (country)
9. <i>Toona calantas</i>	Meliaceae	Tropical Moist Deciduous Forest	indigenous
10. <i>Vitex parviflora</i>	Lamiaceae	Tropical Moist Deciduous Forest/ Forest Over Limestone	indigenous
11. <i>Dipterocarpus grandiflorus</i>	Dipterocarpaceae	Tropical Semi-Evergreen/Tropical Lowland Evergreen Rainforest	indigenous
12. <i>Shorea palosapis</i>	Dipterocarpaceae	Forest Over Limestone/ Tropical Lower Montane Rainforest	endemic (country)
13. <i>Shorea polysperma</i>	Dipterocarpaceae	Tropical Lowland Evergreen Rainforest/ Tropical Lower Montane Rainforest	endemic (country)
14. <i>Vatica mangachapoi</i>	Dipterocarpaceae	Tropical Lowland Evergreen Rainforest/ Forest Over Limestone	indigenous

occurrences when $p > 10$. Following this, the study used 75% of the point occurrences to generate species distribution models, while the remaining 25% were kept as independent data to test the accuracy of each model (as also used by Kumar et al. 2006, Kumar et al. 2009, Kumar and Stohlgren 2009).

Furthermore, the study also utilized the Receiver Operating Characteristics Area Under Curve (ROC AUC), commonly called as AUC and true skill statistic (TSS) also known as the Hanssen–Kuipers discriminant to evaluate the Maxent models of the threatened species. The AUC provides a quantitative measure of model performance independent of any choice of threshold. TSS, on the other hand, compares the number of correct forecasts, minus those attributable to random guessing, to that of a hypothetical set of perfect forecasts [32].

RESULTS AND DISCUSSION

Assessing the Relative Predictive Power of Maximum Entropy in Modelling the Threatened Forest tree Species Potential Distributions

Following the criteria of Swets (1988) on AUC values, the Maxent models of 14 threatened forest tree species performed from fair to excellent. Individually, 27 Maxent models performed fair, 37 performed good, and six performed excellent. The deviation

among AUC values might be due to the fact that the parameters and variables were generalized in all species. As the selected threatened forest tree species are found in different forest formation types, they may have different sets of biophysical and bioclimatic parameters restricting their occurrence and distribution due to their different species-specific requirements or ecological niches. It might be that the values of the parameters in Maxent settings and variables used were not appropriate specifically for these species. As such, the use of general set of environmental variables and values of parameters when modelling distribution of multiple species should be avoided.

In the same way, using TSS as the criteria in evaluating the performance of Maxent for the 14 threatened forest tree species showed that Maxent model performed good in two species, very good in ten species, and excellent in two species. The TSS values computed for the 14 threatened forest tree species revealed that sample and background predictions generated by Maxent were generally in agreement. That is, the Maxent model performance in this study is better than random.

Table 3 Computed AUC and TSS values for each Maxent model of the 14 threatened tree species.

Species	AUC	TSS
<i>Azelia rhomboidea</i>	0.856	0.898
<i>Agathis philippinensis</i>	0.792	0.739
<i>Celtis luzonica</i>	0.815	0.76
<i>Dipterocarpus grandiflorus</i>	0.797	0.758
<i>Koordersiodendron pinnatum</i>	0.782	0.834
<i>Mangifera altissima</i>	0.878	0.903
<i>Shorea contorta</i>	0.814	0.756
<i>Shorea guiso</i>	0.798	0.752
<i>Shorea negrosensis</i>	0.834	0.786
<i>Shorea palosapis</i>	0.770	0.698
<i>Shorea polysperma</i>	0.873	0.781
<i>Toona calantas</i>	0.848	0.735
<i>Vatica mangachapoi</i>	0.819	0.633
<i>Vitex parviflora</i>	0.837	0.726

Shift in Geographic Distribution and Habitat Suitability between Potential Current Distribution and Potential Future Distribution

Maxent produces a continuous prediction map with values 0-1 representing habitat suitability. The continuous prediction maps using base and projected climate scenarios of the 14 threatened forest tree species were chosen from their Maxent model with highest AUC. The default probability of occurrence was divided into ten equal classes to illustrate both the suitable and unsuitable habitats where the species are likely to be present. A probability of occurrence between 0-50 represents unsuitable habitats, while a probability of occurrence 50-100 represents suitable habitats.

Our results show that seven species are likely to be less vulnerable to future climate while the other seven species are more vulnerable as demonstrated in the potential shift of ranges of their habitat (Figure 1). The seven species that are found to benefit from future climate due to the potential increase in their suitable habitat are *Azelia rhomboidea*, *Koordersiodendron pinnatum*, *Mangifera altissima*, *Shorea contorta*, *Shorea palosapis*, *Shorea polysperma*, *Vitex parviflora*. On the other hand, the seven species that will likely experience decline in their suitable habitat are *Agathis philippinensis*, *Celtis luzonica*,

Dipterocarpus grandiflorus, *Shorea guiso*, *Shorea negrosensis*, *Toona calantas*, and *Vatica mangachapoi*.

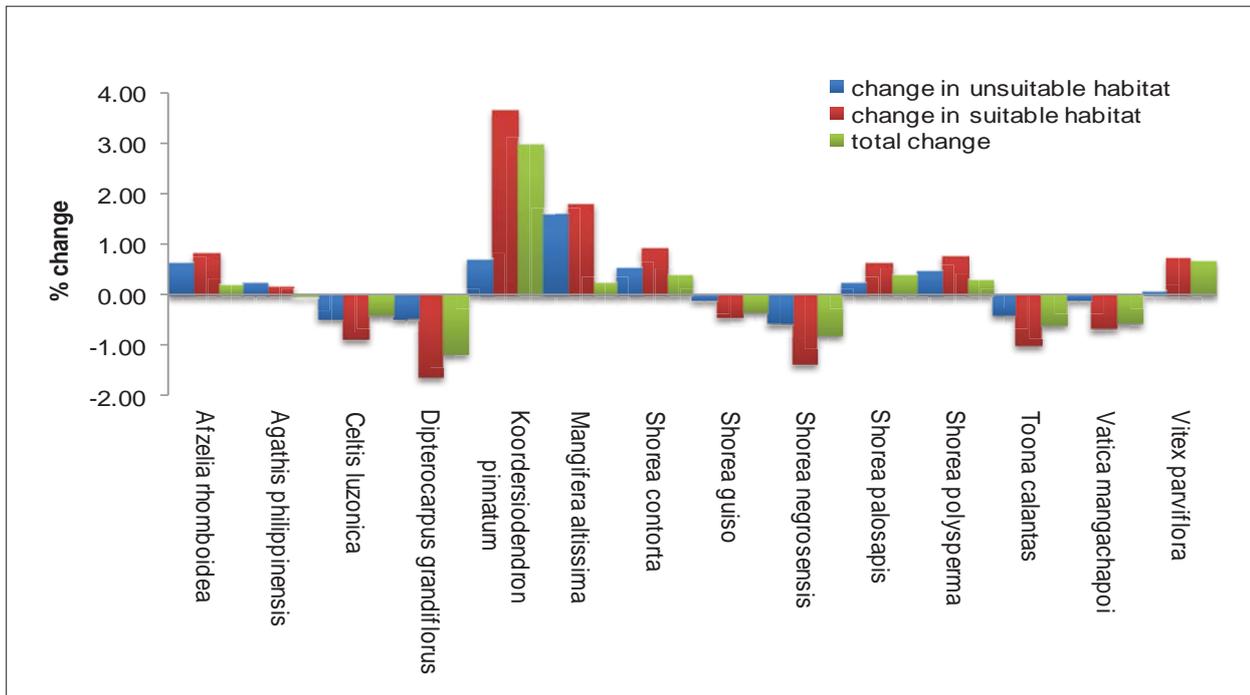


Figure 1 Percent change in habitat suitability of the 14 threatened forest tree species with base and projected climate scenarios.

Table 4 Changes in habitat class of *Afzelia rhomboidea* with base and projected climate scenarios.

Probability of occurrence (%)	Classes*	Habitat description	Area (km ²)		Area change (km ²)	% change
			Base	Projection		
0-10	1	Extremely unsuitable	215,483.48	207,279.00	-8,204.48	-0.04
10-20	2	Very unsuitable	24,008.40	27,149.60	3,141.20	0.13
20-30	3	Moderately unsuitable	11,531.16	13,032.90	1,501.74	0.13
30-40	4	Fairly unsuitable	6,758.64	7,793.81	1,035.17	0.15
40-50	5	Unsuitable	4,224.96	5,323.32	1,098.36	0.26
50-60	6	Fairly suitable	2,490.75	3,282.11	791.36	0.32
60-70	7	Moderately suitable	1,473.39	1,913.22	439.83	0.30
70-80	8	Suitable	883.71	1,023.03	139.32	0.16
80-90	9	Very suitable	538.65	654.48	115.83	0.22
90-100	10	Extremely suitable	332.91	274.58	-58.33	-0.18

For instance, as shown in Table 4, the extent of unsuitable habitat areas of *Afzelia rhomboidea* will slightly decrease by 0.64% while the extent of suitable habitat areas will slightly increase by 0.81% between using base and projected climate scenarios. Therefore, overall the distribution of *Afzelia rhomboidea* across the country is likely to increase with future climate. The assumption in this part was that the biophysical variables were treated as stable, to indicate the consequences of future climate on threatened forest tree species distribution.

As seen in Figure 2a, map using base climate scenario shows predicted high probability of occurrence in areas near Region 4, Bicol region, and Eastern Visayas region. For distribution using projected climate (Figure 2b), map shows increase in the probability of occurrence in some parts of Northern Luzon, Palawan, Mindoro, and Davao owing to the topographical characteristics of the areas and also likely to the projected increased in temperature. *Afzelia rhomboidea* thrives well in areas that are mainly composed of crystalline limestone covered by a shallow or very thin soil and where there is a yearly water stress of some duration. Figure 2c shows the shift in distribution of *Afzelia rhomboidea* with base and projected climate.

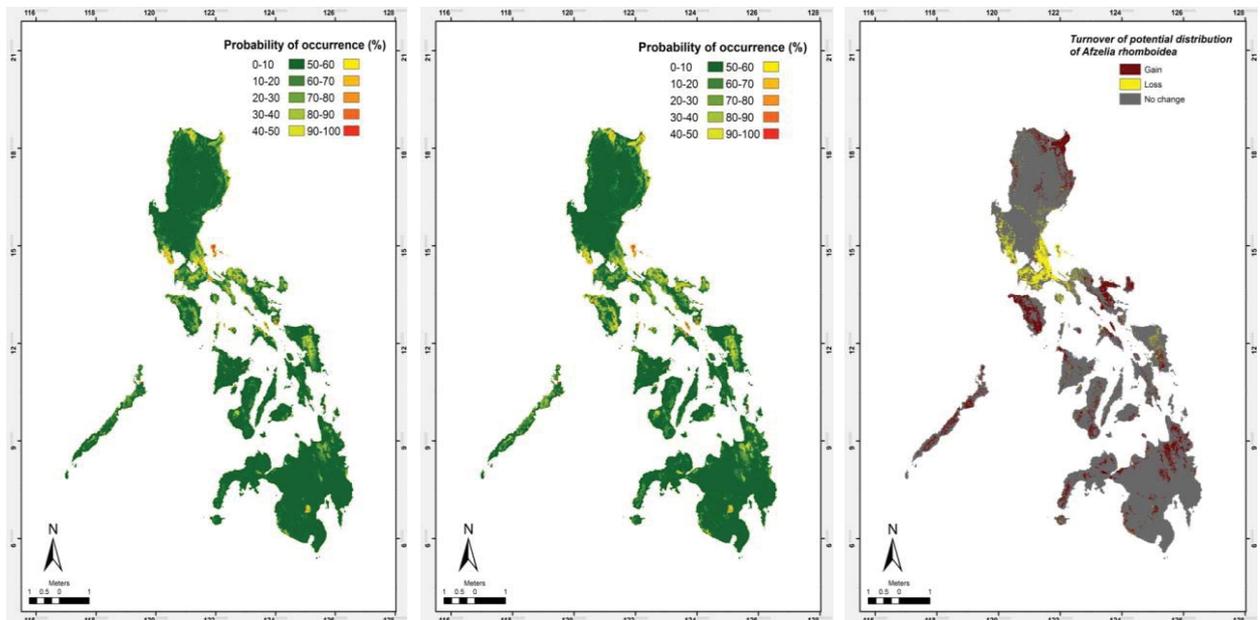


Figure 2 Predicted suitable and unsuitable habitat of *Afzelia rhomboidea* using (a-leftmost) base climate and (b-center) future climate scenarios. Warmer colors show areas with better predicted conditions. Map (c-rightmost) shows the turnover (loss or gain) of suitable and unsuitable area.

As opposed to *Afzelia rhomboidea*, there is a potential decrease in suitable habitat areas of *Celtis luzonica*. Though in some areas, there is an evident increase in suitable habitat of *Celtis luzonica* likely due to the projected increase in annual precipitation which favors its climate requirement, the loss of its habitat suitability is widely spread across the country (Figure 3c).

The shift in geographic distribution of suitable habitat was estimated to cover approximately 1312 km².

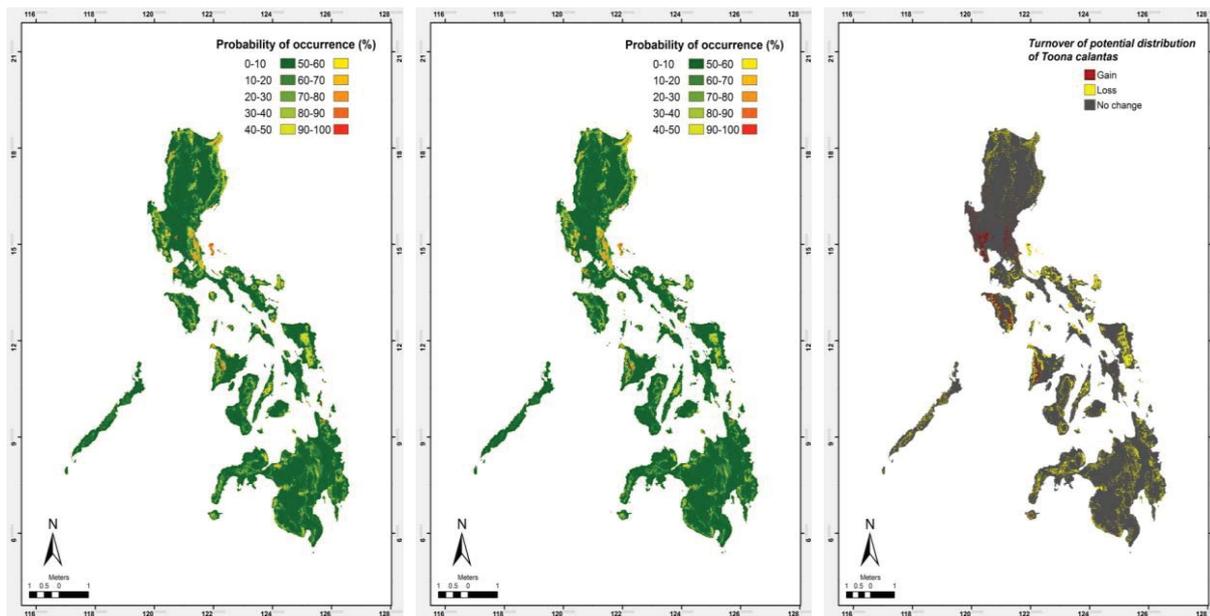


Figure 3 Predicted suitable and unsuitable habitat of *Celtis luzonica* using (a-leftmost) base climate and (b-center) future climate scenarios. Warmer colors show areas with better predicted conditions. Map (c-rightmost) shows the turnover (loss or gain) of suitable and unsuitable area.

CONCLUSIONS AND RECOMMENDATIONS

Our study aimed to assess the vulnerability of selected 14 threatened forest tree species in the Philippines by looking at their geographical distributions and habitat suitability due to climate change. The study made use of the Maxent algorithm. While the Maxent models generated performed better than random, they could still be improved by avoiding the generalization of the parameters and variables to be used in modelling multiple species. As the selected threatened forest tree species are found in different forest formation types, they have different sets of biophysical and bioclimatic parameters restricting their occurrence and distribution due to their different species-specific requirements or ecological niches. This also suggests that in future studies, knowledge of the edaphic requirements of the species is needed.

To test if climate change will result to shift in geographic distribution of suitable and unsuitable habitat of the 14 threatened forest tree species, the Maxent logistic predictions for present and future distributions of the threatened species were analyzed. This was done also to evaluate the vulnerability of the selected species to climate change based on the changes in their habitat suitability and unsuitability. Seven species (*Azelia rhomboidea*; *Koordersiodendron pinnatum*; *Mangifera altissima*; *Shorea contorta*; *Shorea palosapis*; *Shorea polysperma*; *Vitex parviflora*) were found to benefit from future climate while the other seven species (*Agathis philippinensis*; *Celtis luzonica*; *Dipterocarpus grandiflorus*; *Shorea guiso*; *Shorea negrosensis*; *Toona calantas*; *Vatica mangachapoi*) will experience decline in their suitable habitat.

Policy Implications

The possible habitat alterations of the threatened species due to climate change call for appropriate adaptation strategies particularly in conserving those areas where the species are likely to be found. For instance, the potential increase in suitable habitat of some species will help them endure the manifold pressures arising from climate change. As such, existing and predicted habitat areas of the threatened species should be protected from clearing,

encroachment, and further degradation. Another option is by providing functional connectivity between smaller patches through restoration and maintenance of links between habitat patches. There is a need to incorporate the relative importance of habitat area in terms of environmental diversity, connectivity and isolation.

While there are still major gaps in knowledge about the impacts of climate change on forests, associated wildlife and people and how adaptation measures can best be tailored to local conditions [20], the advancement of our understanding to model species distributions in the face of future climate and the improvement of spatial databases could lead to development of science-based conservation strategies that would benefit both the species and their ecosystem. Due to the inherent connectivity between different ecosystems in a landscape, it is imperative that the biodiversity species, particularly forest tree species, are protected so they can sustainably provide the services people need. Furthermore, the local and global significance of conserving Philippines' biodiversity demands us to double our efforts in protecting those species that are exposed to different threats including climate change.

This study provided an initial understanding on how species distribution will be affected by future climate which is a prerequisite in formulation of necessary conservation strategies. There are still critiques in the use of bioclimatic models, such as Maxent, due to their exclusion of biotic interactions and dispersals scenarios [33]. However, we need to keep in mind that these models produces spatially explicit and comprehensive maps that are particularly useful for identifying areas where conservation efforts are most needed or effective [34]. Similar to other species distribution researches, this study provided an initial understanding on how species distribution will be affected by future climate which is a prerequisite in formulation of necessary conservation strategies.

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SOCIAL SCIENCE

Determinants of International Alliance Stability

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Abstract: Alliance stability is viewed as a vital factor for alliance survival, development, and evolution. It creates the conditions for performance enhancement and alliance success. The clear understanding of alliance stability is still needed. Therefore, the objective of this paper is to explore the relationships among goal interdependence, resource complementarity, inter-organizational learning, relational capability, and international alliance stability. It is proposed that cooperative goal interdependence, high resource complementarity, cooperative inter-organizational learning, and high relational capability are associated with the stability of international alliance. Along with the conceptual model, a number of propositions are developed to facilitate future empirical testing. Moreover, some key managerial implications are also suggested.

Keywords: Goal interdependence, Resource complementarity, Inter-organizational learning, Relational capability, International alliance stability

INTRODUCTION

In a globalized and networked economy, instantaneously available resources through alliances are critical determinants of competitive advantage which leads to business success [1]. As a result, strategic alliances received great attention from both academicians and practitioners [2]. For example, Cigna Thailand and Thai Life Insurance launched their business partnership for leveraging the strengths and supporting each other in order to gain market opportunities by providing rapid response to what customers need [3]. Similarly, Thai Airway International and JBC, Japan's largest credit card company, made an agreement to enhance co-brand card value proposition to better serve mutual customers and strengthen customer loyalty [4]. However, firms have encountered the complexity of management in international collaborative arrangement, resulting in a high degree of instability and undesirable outcomes [5]. It is also stated that a clear understanding of strategic alliance stability is still limited [2]. An attempt to review past literature and incorporate relevant theoretical perspectives to propose a conceptual model of the determinants of international alliance stability was done. The next section discusses theoretical foundation of this paper, followed by a literature review and the proposed relationships and the conceptual model. The last section concludes with theoretical contributions and expected managerial implications.

Theoretical foundation

Four theoretical perspectives are used to build a conceptual model and develop a set of propositions. Firstly, the theory of cooperation and competition [6], which describes that the goal of an organization determines the interaction between individuals, groups, and organizations and the interaction patterns, which subsequently yield certain outcomes. This study employed a premise of this theory to explain the relationship between goal interdependence and international alliance stability. Goal interdependence is likely to frame the actions of alliance partners in promoting, obstructing, or doing nothing to affect the success of each partner. For example, when partners perceive that their own goals will be

achieved only when the achievement of others' goal is also reached, partners, thereby, tends to interact with each other in a supportive way, which will subsequently yield higher level of stability of the international alliance [7, 8].

Secondly, resource dependence theory [9] seeks to explain the existence and continuation of inter-organizational ties in particular, emphasizing the need to access the critical resources controlled by other firms (external environment). Its argument indicates that firms are social actors that are likely to be dependent on other firms. Their interdependences affect uncertainty of survival and a continued success. As such, firms tend to take action to manage external dependence and subsequently create a new pattern of interdependence that fosters a more stable relationship [10,11]. The nature of resource complementarity implies the sense of interdependence among partners [12] because firms that are not self-sufficient in certain type of resources attempt to make a collaboration with partner(s) who possess those resources. This resulted in situations where one firm's resources strengthen the other's, which may create opportunistic behaviors by which one firm may try to take more benefits at the expense of the other. All of these results in unstable relationships [13].

Thirdly, organizational learning perspective, which indicates that an organization learns and acquires resources from partners in a form of knowledge, skills, and competence--all of which are recognized as useful drivers that enable firms to achieve desirable outcomes [14]. It is argued that imitating and accepting others' behaviors is a key source of organizational learning [15]. Organizational learning perspective implies that alliance members will learn from each other to create, exchange and/or obtain knowledge if they are in a 'cooperative relationship', which emphasizes the cooperation and common perception of the partnership, leading to the enhancement of long-term relationship. In contrast, a competitive relationship entails that one partner becomes opportunistic while another is likely to imitate the partner's behavior so they subsequently become rivals who try to outcompete one another. This action results in an unstable alliance relationship.

Fourthly, a resource based view of the firm (RBV), which postulates that firms are able to attain and sustain competitive advantage over time by utilizing the strategic resources which are characterized as rare, valuable, imperfectly imitable, and non-substitutable [16,17,18]. Based on RBV, the linkages between relational capability and international alliance stability is demonstrated. The argument of RBV implies that firms tend to enter the cooperative relationship with others in order to pursue preserved resource, risk sharing, innovative value creation, knowledge transfer, and the attainment of competitive advantage [19, 20, 21]. However, uncertainty in alliance relationships caused by an opportunistic behavior, conflict, and/or broad alliance scope may hinder the effectiveness of cooperative relationship, which may eventually lead to a termination of the relationships among partners [2, 22]. Therefore, relational capability is required to enable partners to perform cooperatively through uncertainty and lead to a stable alliance relationship.

LITERATURE REVIEW AND THE DEVELOPMENT OF PROPOSITIONS

According to Teng and Das [23], there are three types of alliance; joint venture, minority equity alliance, and non-equity alliance (contractual alliance). An alliance can be defined as a partnership between firms that aim to develop, manufacture, and distribute goods and/or services by combining valuable resources and capabilities so as to pursue a mutual goal [24]. A joint venture refers to a joint ownership in a newly incorporated entity. Minority equity alliances involve equity acquisition by one or more partners. Contractual alliances involve no equity or no new entities so this type of alliance provides greater flexibility, less commitment and more tendencies for opportunistic behavior. These alliances are obviously different in terms of the equity involvement. Nevertheless, an international joint venture

seems to be the most committed option since its relationship is based on trust and confidence among partners, which is a crucial driver behind our proposed relationships. Therefore, this study focuses on international joint venture. The following section discusses the authors' proposed relationships.

Goal Interdependence and International Alliance Stability

Partners from different nations might have different objectives when forming international alliances. These goals include, for example, profit, competitive benefits, and strategic benefits [25]. With reference to the theory of cooperation and competition [6], how a goal is determined will likely influence the interactive behavior among partners. Goal interdependence can be characterized into three types; cooperation, competition, and independence [26]. When the goal is set as cooperative, each partner understands that their goals will be achieved only through the success of the other's. In the case of a cooperative goal, local and foreign partners perceive the importance of one another's goal attainment so they will help each other perform tasks more effectively and attempt to enhance the mutual goal achievements [8]. This cooperative-based relationship creates resources through reciprocal contributions [27]. Moreover, partners with cooperative goals seem to openly and constructively assist their counterparts so it can be argued that if a local and foreign partner has cooperative goal interdependence, alliance stability is likely to be maintained.

On the other hand, the partners with competitive goal are more associated with alliance instability than ones with cooperative goal. This is because the partners perceive that they are encountered with win-lose relationship. Specifically, the more one partner succeeds, the less likely all partners are able to get what they want. In general, conflicting behaviors between partners vary based on the differences between the partners' goals. This can bring about misunderstanding and interaction problems [28]. Therefore, competitive goal interdependence is hypothesized to obstruct alliance stability because it reduces a discussion on conflicting issues. In this case, partners attempt to achieve their own goals while leaving the others' behind. Overall, this is consistent with the study of Chen, Tang and Wang [29], who found that goal interdependence plays substantial roles in the development of group cohesion among members. Moreover, cooperative goal, compared with competitive goal can improve team relationship, productivity, and budget quality [7]. The governance between focal firm and its suppliers is likely to be ineffective when their relationship is based on unbalanced bargaining power caused by competitive interdependence [27]. From the aforementioned literature on goal interdependence, the first proposition can be stated as:

Proposition 1: International alliances with cooperative goal interdependence are more likely to achieve alliance stability than those with competitive goal interdependence.

Resource Complementarity and International Alliance Stability

Firms tend to engage in alliance whose resources are complementary in an area that they lack a relative competitive advantage [22, 23, 30, 32]. This indicates that the valuable resources necessitating alliance formation and the way those resources are integrated, which eventually affects alliance performance should be considered [33]. Though resource complementarity has been the most common type of resource alignment affecting alliances success in prior research via resource based rationale [5, 32], the results are still unclear [5, 33]. This study adopts the concept of complementarity introduced by Das and Teng [33], who proposed a typology of inter-partner resource alignment, built on resource similarity and resource utilization, which can distinguish supplementary from complementary resources. They suggest that complementary resources have to be different resources contributed by

each partner, yet compatible, and these resources need to be fully utilized. Therefore, resource complementarity refers to the degree to which partner firms are able to bring needed and non-redundant unique resources into the collaboration in order to eliminate each other's weaknesses and subsequently create distinctive and valuable synergy [33, 34].

This indicates that complementary resources enhance the sense of dependence among firms in terms of resource endowment, which can be either high resource complementarity or low resource complementarity. This study believes that each type of complementarity may affect the alliance stability in a different way. When alliance partners complement their own resources with each other, inequality among them normally appears [11]. Applying resource dependence perspective, low resource complementarity is vulnerable to opportunistic behavior from the partner. This may destabilize the alliance relationship [11, 35, 36]. The partner who provides more critical resources becomes more dominant member in a dyadic relationship and these partners tend to minimize their resource contribution while attempting to take benefits from resources possessed by the weaker partner and maximize the advantage received from collaboration. Consequently, the level of perceived fairness and partner trust are diminished [37]. Similarly, in the case of the availability of alternative sources of resources, partners may try to reduce their dependence with a particular partner through making additional ties with alternative partners or trying to obtain more rights to control over critical resources with the existing ones. Consequently, their existing relationship becomes divisive [35]. Partners are, however, expected to exchange their resources in a way that require inimitability and symmetry of resource contribution for earning trust-based relationship [22]. It is congruent with Jiang, Li, and Gao [2] and Jap [38] who allude that the symmetry in resource complementarity is an important condition for the enhancement of alliance stability. From the aforementioned literature on resource complementarity, the second proposition can be stated as:

Proposition 2: The higher the resource complementarity, the higher the likelihood of international alliance stability.

Inter-organizational Learning and International Alliance Stability

While organizational learning has been studied at different levels--individual, group, organization, and industry, the inter-organizational level is a focal part of this study. Organizational learning is defined as a continuous, dynamic, and interactive process by which firms are seen as collective learners through interaction among individuals, groups, and organizations [39, 40]. Therefore, inter-organizational learning can be defined as the activities of partners (both local and foreign alliance member) to obtain the information, knowledge, and understanding from their counterparts within their alliance relationships [41]. In international alliance, inter-organizational learning can be cooperative learning and competitive learning that may influence the alliance relationship [20]. In this paper, we postulate that each type of learning is associated with the different propensities of international alliance stability.

Inter-firm collaboration is viewed as a means of learning by which the alliance partners want to learn certain knowledge/know-how from one another [41]. In turn, inter-organizational learning facilitates inter-firm knowledge sharing between local and foreign alliances, which eventually can improve the relationship and lead to stable relationship maintenance between alliance members [2]. It can be argued that cooperative learning occurs when partners work together and both are likely to contribute their resources, knowledge, skills, and competencies in order to increase the stock of new knowledge [20]. Cooperative learning creates trust and commitment-based environment that promotes collective learning between alliance members, and subsequently contributes to the enhancement of stable

alliance relationship [41, 42]. Empirically, Deitz, Tokman, Richey and Morgan [22] found that trust and cooperative intent have a positive relationship with intention to remain in an international joint venture relationship. On the other hand, when partners are going to be a competitive learning alliance, they will see their partners as rivals. One partner may acquire a certain knowledge/information while sacrificing the benefits of the others. When alliance relationship is based on individual benefit rather than partners' mutual benefits, partners tend to engage in a learning race that undermines the alliance relationship, which eventually results in alliance instability. As such, the proposed third relationship is:

Proposition 3: International alliances with cooperative inter-organizational learning are more likely to attain stability than those with competitive inter-organizational learning

Relational Capability and International Alliance Stability

Managing international alliance is a difficult activity because of its complex nature that crosses both organizational and national boundaries so most alliances fail or are not as successful as expected [17]. Therefore, the ability to manage alliance effectively becomes a vital capability to maintain alliance relationship. Relational capability in this paper refers to an inter-organizational capability needed for allied firms to jointly manage inter-organizational resources, capabilities, and processes which allow partners to generate relational performance as well as stabilize alliance relationship through trust, effective communication, and coordination [21]. Coordination and relational skills are critical aspects of this kind of capability. Coordination is seen as boundary-spanning activity which connect the firms with one another and create a mutual supportive relationship. Relational skill is viewed as social competence, emotional stability, conflict management skill, that is essential in inter-personal interaction [43]. With our focus on the determinants of international alliance stability, it is hypothesized that international alliances with high relational capability are more likely to attain alliance stability than alliances with low relational capability. Relational capability enables alliance members to engage in collaborative relationship and to create an effective relationship that eventually yields quality improvement, reliability, and speedy knowledge sharing [29]. Rodríguez-Díaz and Espino-Rodríguez [44] also found that associative advantage is created through interactions with alliance partners and it will be achieved and sustained if alliance members develop capabilities that can maintain business relationships when facing environmental changes. Therefore, the fourth proposition can be formulated as:

Proposition 4: The higher the relational capability, the higher the likelihood of international alliance stability.

CONCLUSION AND SUGGESTIONS FOR FUTURE RESEARCH

The primary objective of this paper is to propose a conceptual model exploring the determinants of international alliance stability. Specifically, it is drawn on four theoretical perspectives: 1) the theory of cooperation and competition [6], 2) resource dependence theory [9], 3) organizational learning [45], and 4) the resource-based view of the firm [16] to propose a model of international alliance stability. It is argued that international alliance stability depends on cooperative goal interdependence, cooperative inter-organizational learning, higher relational capabilities, and resource complementarity. It is some issues were clarified regarding how international alliances can attain alliance stability. Furthermore, it is suggested for future research to empirically test the proposed relationships on the

international joint venture. In alliance literature, joint venture provides a situation called mutual hostage that enables partners to align the strategic goals so that opportunistic behaviors can be discouraged [23, 24]. Furthermore, joint venture is expected to be more suitable for inter-firm learning, it allows partners to better acquire, transfer and integrate tacit knowledge and know-how embedded in other partners because of closer collaboration, communication, trust, and interconnection [40]. Much of the failure in joint venture arrangement stems from management problem such as incompatible culture and control system so partners are likely to gain relational capability to resolve the problems [24].

To practitioners, this paper helps managers identify key factors that contribute to international alliance stability. First, managers of international alliances should pay special attention to ensure that appropriate goals are set among alliance partners by encouraging open and regular discussions and communication about each partner's goals. Second, alliance managers are expected to blend the related distinctive resources contributed from different partners in a way that they complement each other's weaknesses, lead to mutual gain. Therefore, magnitude and value of resources should be considered. Moreover, relational risks should be diminished by fostering high symmetric interdependent relationship. Third, managers should be aware of every partner's learning objectives from the inception of the alliance and work cooperatively to help each other enhance learning and achieve the goals by establishing appropriate learning activities. Lastly, firm may create a unit within an organization to take charge of handling every facet of alliance management from formation to termination phases. This unit can develop guidelines for decision making in specific alliance situations, which help managers respond to alliance partners effectively [43].

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Development of Decision Support System for Medical Instrument Management in Hospitals

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Abstract: The objectives of this research were to study and develop the characteristics of a decision support system (DSS) in accordance with hospital accreditation standard, and to evaluate satisfaction of its use in a hospital. This study consisted of 3 steps as follows: 1) The characteristics of the DSS was studied by the qualitative method and quantitative method at Rajvithi Hospital, Police Hospital, Ramathibodi Hospital, Queen Sirikit National Institute of Child Health, Taksin hospital, and King Chulalongkorn memorial hospital. 2) Development of the DSS used the prototype-based methodology and it was evaluated to determine the errors by the experts. 3) Evaluation of the satisfaction of usage was performed from the Queen Sirikit National Institute of Child Health. It was showed that the first 3 highest score were the medical equipment database system (70.06%), the maintenance plan (66.88%), and the record of medical equipment repair (64.97%), respectively. The results of development of the DSS included 1) the spare parts inventory and alert, 2) the automatic repairing distribution, 3) classification of the equipment age by color, 4) the decision model for the time to repair by color and 5) the decision model for calibration planning. User satisfaction evaluation consisted of 1) working processes, 2) these design of the display, 3) operation and 4) security. All of topics were higher than the average (3.51-4.50).

Keywords: The decision support system, Medical equipment management

INTRODUCTION

The hospital accreditation system has been developed to examine and confirm that a hospital has met quality and standards. This concept was first developed in the United States, and it has become a collaboration of different organizations related to standards of health. At present, this system is in existence in more than 70 countries worldwide (The Institute of Hospital Quality Improvement & Accreditation, 2009). In Thailand, the system has been implemented by applying the strengths and distinguishing characteristics of the hospital accreditation system of the United States and linking them to related universal standards. One of the requirements of the system is the evaluation of the quality of the medical equipment management system of the hospital, with an emphasis placed on management planning, readiness for use, and improvement of the process (The Joint Commission, 2011) so as to make sure that all medical equipment is ready to be used effectively.

The present paper presents an architectural structure of Decision Support system for Medical Equipment Management (DSMEM) which portrays the relationships among the

subsystems, examples of implementation, and implementers' satisfaction with outcomes. Data were collected after actual implementation at Queen Sirikit National Institute of Child Health with more than 1,800 pieces of medical equipment under its care.

MATERIALS AND METHODS

DSMEM has been designed with subsystems that are efficiently integrated and interrelated. It is also equipped with the capability to construct databases from client computers with the installed program.

Design and development of the system

The networking architecture system of DSMEM has been designed with data safety and work performance taken into account using the data derived from in-depth interviews of three heads of the medical equipment unit (Siriraj Hospital, Rajavithi Hospital, and Queen Sirikit National Institute of Child Health) as well as the data obtained from the questionnaire on information and appropriate characteristics of the decision support system distributed to hospital administrators, ICU nurses, and medical equipment technicians at seven hospitals (Siriraj Hospital, Police Hospital, Ramathibodi Hospital, King Chulalongkorn Memorial Hospital, Queen Sirikit National Institution of Child Health, Taksin Hospital, and Rajavithi Hospital). The sample consisted of 69 hospital administrators, 89 ICU nurses, and 52 medical equipment technicians. The collected data were analyzed to develop the program using the prototype-based methodology by constructing a prototype to test the performance and correct each part of the errors until the complete program has been achieved. The scope of the DSMEM development can be divided as follows:

1. User interface: The user interface works by importing the information from the management process and showing information outcomes. Various user levels can be determined based on users (e.g. hospital administrators, nurses, or medical equipment technicians), coordinating with the database system via firewall of the computer network within the hospitals to provide services to members. There are five subsystems of the user interface:

1.1 The medical equipment and spare parts registration subsystem stores basic data of medical equipment and spare parts, working with the decision model to portray the relationship between the instruments and their lifetime.

1.2 The repair subsystem stores data regarding repair lists and examines and follows up the repair progress.

1.3 The maintenance and calibrating subsystem works with the decision support model to devise the maintenance and calibrating plans in accordance with the guideline of the Emergency Care Research Institute.

1.4 The summary and reporting subsystem works with the decision support model and knowledge management to process data and create information technology necessary for improvement of management processes.

1.5 The back office subsystem manages different DSMEM subsystems to ensure suitability and to correct, add, or cross out some data in the program to suit specific contexts of hospital's management processes.

2. Database: The database has been developed with the relative database technique to create the databank to retrieve, categorize, and store important data of the management processes so as to share the data among the DSMEM members through the hospital networks.

3. Decision support model management: This work is to control functioning of various models developed in the present study, which includes the following:

3.1 The automatic repair job assignment model

- 3.2 The spare parts inventory management and reminder model
- 3.3 The color-coding of the medical equipment lifetime
- 3.4 The color-coding of repair duration model
- 3.5 The calibration model

4. Knowledge management: The databank technique is used in the search and display of the relationship among data significant for the planning of management of medical equipment, which possibly leads to a new body of knowledge derived from such relationships of data.

Development tools

The instrument used in the construction of DSMEM and the database was the Visual Foxpro program for graphic user interface (GUI) and for processing of operational outcomes because this program can effectively manage relative database systems and it is an object-oriented programming. The advantages of the program include its ability to contact remote databases which is not Visual Foxpro (e.g. Oracle, SQL server, etc.) by merely creating a connection with the databases. The database system employs the Microsoft SQL server installed in the main server to test the operations.

Evaluation of satisfaction

After DSMEM was completely developed, it was tried out at Queen Sirikit National Institution of Child Health for one month. Satisfaction with the operation of DSMEM was assessed in terms of 1) operation formats, 2) design of output unit, 3) operation, and 4) data security. The assessors consisted of seven administrators in the intensive care unit, 36 ICU nurses, and 21 medical equipment technicians. Data were analyzed by means of mean and standard deviation (SD). The evaluation criteria of mean scores were as follows (Srisa-ard, 2011) 4.51-5.00 (highest), 3.51-4.50 (high), 2.51-3.50 (moderate), 1.51-2.50 (low), and 1.00-1.50 (lowest).

RESULTS AND DISCUSSION

Figure 1 shows a systems network architecture of DSMEM which operates through the computer network system in the hospital under the supervision of the biomedical equipment staffs who input necessary baseline data. Figure 2 illustrates the structure of DSMEM, with the database being installed onto the server, ready to display the function menu once members have logged in, depending on member users' rights (as specified by system administrators). Figure 3 portrays the main menu of DSMEM, with the main menu being displayed above the icons for different parts of the program to be selected for use. Figure 4 presents the list of medical equipment, with the red strips signifying the chronological age of the equipment older than the number of years of value depreciation and the yellow strips indicating the one remaining year of value depreciation, to support decision to timely acquire replacement. Figure 5 exhibits the graphs of the amount of medical equipment being repaired, with the top three being incubators, infusion pumps, and ventilators. Figure 6 is the screen displaying the repair record of medical equipment including important data such as causes, types of repair, and malfunctions, which can be adjusted according to the contexts of the hospital, with all the data being shown on the summary report of repaired medical equipment, indicating the relationship among the machines, brands, models, malfunctions, causes, and frequency of repair. The analyzed information may reflect the capacity of the equipment, frequency of malfunctions, or the durability of the equipment, which can be used when making a decision to buy each model of medical equipment. Figure 7 shows parts of calibration outcomes with reference to the ECRI

standard, with DSMEM calculating error values and automatically displaying the outcomes. Figure 8 show the summary and report of spare parts inventory, total amount of monthly use, and stock turnover ratio, thus reflecting the appropriate quantity of each type of spare parts inventory, which in turn can be used in decision support to appropriately manage spare parts inventory and reduce storage space.

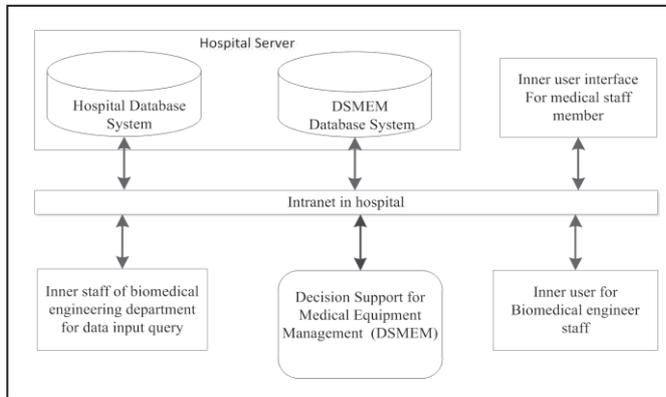


Figure 1 The network architecture system of DSMEM.

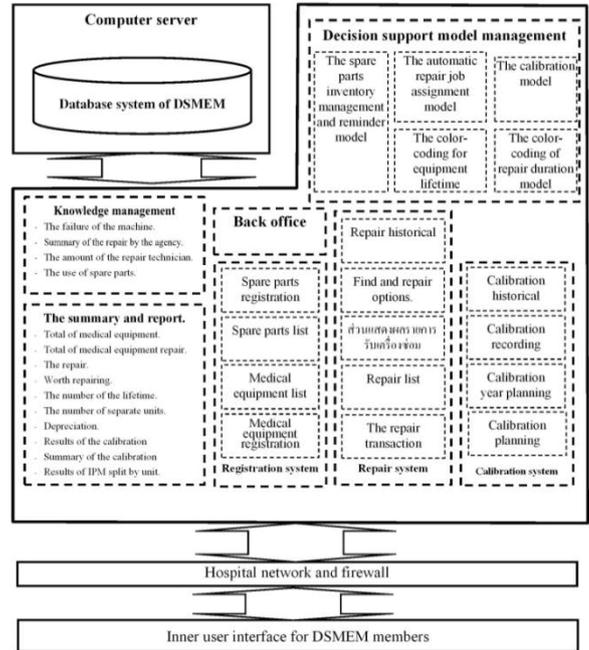


Figure 2 The structure of DSMEM.

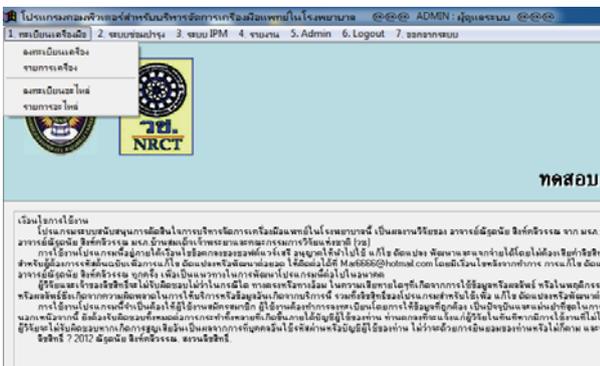


Figure 3 The user interface of DSMEM.

รหัส	ชื่อแพทย์	ชนิดของเครื่องมือ	ชนิดของเครื่องมือ	หมายเลข	ชนิดของเครื่องมือ	วันที่	อายุการใช้งาน
1	BPM01	เครื่องวัดความดันโลหิตอัตโนมัติ	Blood Pressure		อัตโนมัติ	0001	1 ปี 6 เดือน 5 วัน
2	BPM02	เครื่องวัดความดันโลหิตอัตโนมัติ	Blood Pressure	001-999-0000/17144	อัตโนมัติ	0001	1 ปี 6 เดือน 16 วัน
3	BPM0PK-001	เครื่องวัดความดันโลหิตอัตโนมัติ	Automatic Blood Pressure	001-999-0000/22001	อัตโนมัติ	1M-2009P	1 ปี 6 เดือน 7 วัน
4	BPM0PK-002	เครื่องวัดความดันโลหิตอัตโนมัติ	Automatic Blood Pressure	001-999-0000/22002	อัตโนมัติ	1M-2009P	1 ปี 6 เดือน 7 วัน
5	BPM0-000	เครื่องวัดความดันโลหิตอัตโนมัติ	Automatic Blood Pressure		อัตโนมัติ	1M-2009P	1 ปี 6 เดือน 14 วัน
6	BPM0-001	เครื่องวัดความดันโลหิตอัตโนมัติ	Automatic Blood Pressure	001-999-0000/9849	อัตโนมัติ	1M-2009P	1 ปี 6 เดือน 14 วัน
7	BPM0-002	เครื่องวัดความดันโลหิตอัตโนมัติ	Automatic Blood Pressure	001-999-0000/9849	อัตโนมัติ	1M-2009P	1 ปี 6 เดือน 14 วัน
8	BPM0V14-001	เครื่องวัดความดันโลหิตอัตโนมัติ	Automatic Blood Pressure	676	อัตโนมัติ	1M-2009P	1 ปี 6 เดือน 14 วัน
9	BPM0V14-002	เครื่องวัดความดันโลหิตอัตโนมัติ	Automatic Blood Pressure	001-999-0000/17150	อัตโนมัติ	1M-2009P	1 ปี 6 เดือน 14 วัน
10	BPM0V14-003	เครื่องวัดความดันโลหิตอัตโนมัติ	Automatic Blood Pressure	001-999-0000/17150	อัตโนมัติ	1M-2009P	1 ปี 6 เดือน 14 วัน
11	BPM0V14-004	เครื่องวัดความดันโลหิตอัตโนมัติ	Automatic Blood Pressure	001-999-0000/22000	อัตโนมัติ	1M-2009P	1 ปี 6 เดือน 14 วัน
12	BPM0V14-005	เครื่องวัดความดันโลหิตอัตโนมัติ	Automatic Blood Pressure	001-999-0000/22000	อัตโนมัติ	1M-2009P	1 ปี 6 เดือน 14 วัน
13	BPM0V14-006	เครื่องวัดความดันโลหิตอัตโนมัติ	Automatic Blood Pressure	10049	อัตโนมัติ	1M-2009P	1 ปี 6 เดือน 14 วัน
14	BPM0V14-007	เครื่องวัดความดันโลหิตอัตโนมัติ	Automatic Blood Pressure	10049	อัตโนมัติ	1M-2009P	1 ปี 6 เดือน 14 วัน
15	BPM0V14-008	เครื่องวัดความดันโลหิตอัตโนมัติ	Automatic Blood Pressure	001-999-0000/9849	อัตโนมัติ	1M-2009P	1 ปี 6 เดือน 14 วัน

Figure 4 The medical equipment registration.

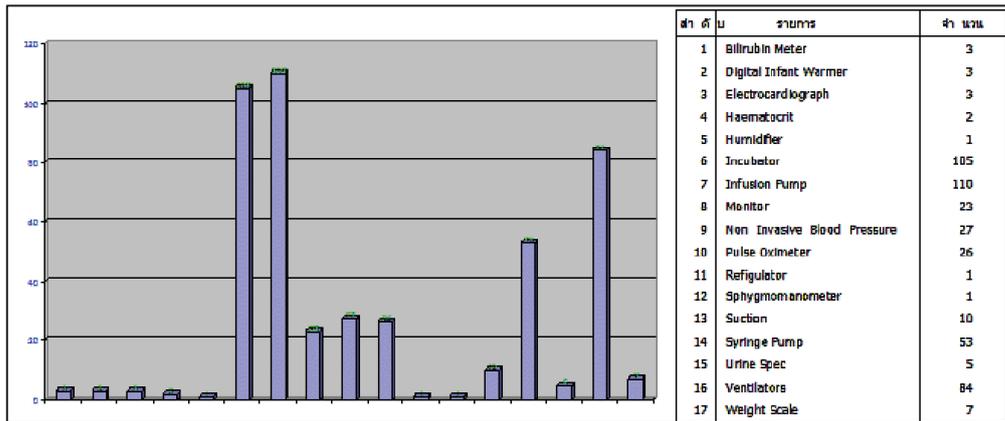


Figure 5 The graphs of the amount of medical equipment being repaired.

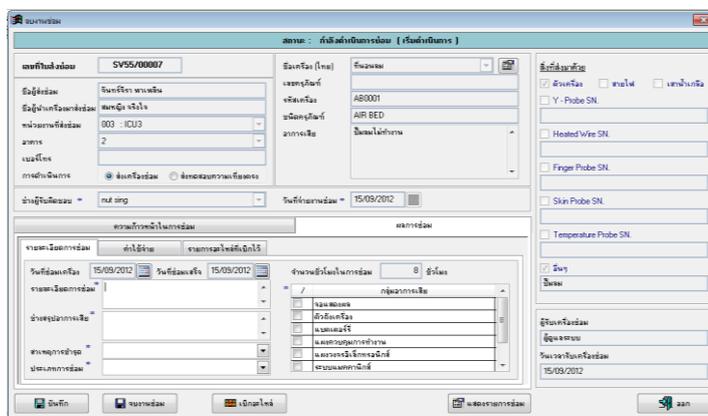


Figure 6 The user interface for repair record results.

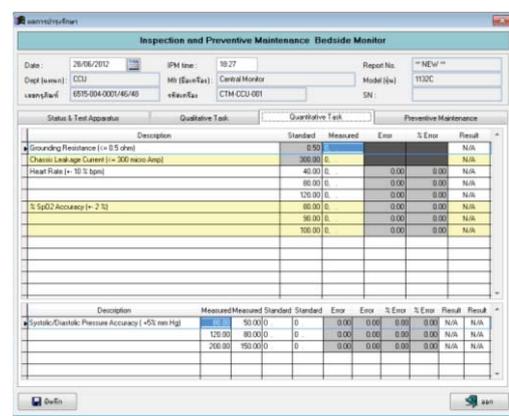


Figure 7 The calibration record with ECRI standard.

ลำดับ	ชื่ออะไหล่	จำนวน	ราคา	มูลค่ารวม	Stock Turnover
1	001 MOTOR	402	100.00	40,200.00	138
2	XXXX	4	100.00	400.00	14
TOTAL		406	0.00	40,600.00	152

Figure 8 The summary and report of spare parts inventory.

After implementing DSMEM for a period of one month, the satisfaction with four aspects of functioning of DSMEM was evaluated with 22 items (Figure 9). The findings revealed that overall satisfaction of three groups of assessors (administrators of the ICU, ICU nurses, and medical equipment technicians) was at a high level (3.51-4.50) in all items. The five items which received the highest level of satisfaction were comprehensiveness of medical equipment registration record ($\bar{x} = 3.86$), display of beneficial information ($\bar{x} = 3.85$), ease of work follow-ups ($\bar{x} = 3.84$), convenient and fast operation ($\bar{x} = 3.83$), and user-friendly ($\bar{x} = 3.80$).

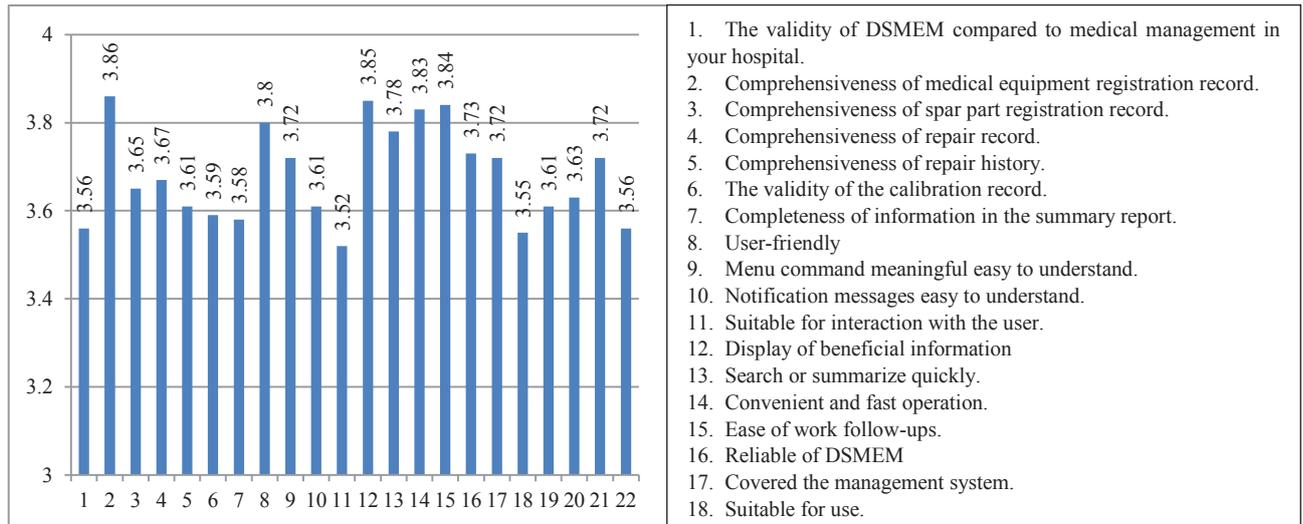


Figure 9 The satisfaction graph of DSMEM.

CONCLUSION

The developed DSMEM can be accessed for use from a computer in the network. It displays the work menus to users (e.g. nurses, medical equipment technicians) in accordance with the users’ rights granted by the system administrators. The test of its operation on the computer network at the Queen Sirikit National Institute of Child Health has led to the following conclusions: 1) it can be installed in more than one database in the server without having to install the program in the server, 2) assignment of repair works can be done automatically or by a staff in charge, 3) while making a list of repair, the summary of repair data (e.g. costs, frequency) is displayed for decision support before sending the equipment for repair, 4) progresses of the repair can be monitored, 5) a color strip on the repair waiting list facilitates examination of undone repair work, 6) types, brands, and models of spare parts to be used by the doctor can be specified, 7) algorithm of planning for validation has been developed based on professional experience of specialists, hence smooth operations, 8) important data of internal management of the program can be adjusted to suit own administrative contexts, and 9) users are able to adjust the range of data during validation, while the program automatically continues to run its calculations of values used in the test.

The evaluation of satisfaction has indicated that satisfaction with all aspects of DSMEM was at a high level, hence indicating that DSMEM is appropriate for the hospital accreditation standard($\bar{x} = 3.61$), it is effective and appropriate for use ($\bar{x} = 3.55$), it is comprehensive for actual work systems ($\bar{x}= 3.72$), it is reliable ($\bar{x}= 3.73$), it is accurate when being compared to the medical equipment management system ($\bar{x} = 3.56$), the data on display are beneficial ($\bar{x} = 3.85$), the data are complete for medical equipment registration records($\bar{x}= 3.86$), and makes operations more convenient and faster($\bar{x} = 3.83$).

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Development of Knowledge Management of Organic Agriculture Business for Sustainable Strength of Community Entrepreneurs

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Abstract: The objectives of this research are to (1) develop a knowledge management system concerning organic agriculture business among organic agriculture producers; (2) strengthen the working ability of organic agriculture businesses based on a knowledge management system and (3) create information technology involving the development of a knowledge management system. The data were collected by sample-group interviews and analyzed to develop key knowledge for the working administration of organic agriculture business as well as for use in the knowledge management system. It was revealed that the model of organic agriculture group had variation in the administration of the same business. Knowledge concerning management, production, marketing, financing and accounting could be spread out via such a knowledge management system. Based on the study, the model of a knowledge management system of organic agriculture business could be shown in the form of a web application via a PHP program and a MySQL database and is named as “organic agriculture community” at www.maejoorganic.com.

Keywords: Information technology, Knowledge management, Organic agriculture business.

INTRODUCTION

Organic market in Thailand started in since around 2546. When the International Conference on Organic Agriculture was held in Thailand by the International Federation of Organic Agriculture Movements (IFOAM), the Food and Agriculture Organization (FAO) and the Earth Net Foundation and Greennet, the activity stimulate the interest of Thai agriculture business to engage in. In production, consumption and pushed for policies for organic agriculture. Moreover, the organic market in Thailand increased as evidenced by 1) the use of certified organic seal of the Organic Agriculture Certification (ACT) of the Department of Agriculture which allows consumers to distinguish organic products more conveniently 2) the organic market policies identified specialized retailers areas especially in areas such as Lemon Farm Shop. 3) The large retailers started to see the trend and direction of the organic market and started selling organic products in supermarkets such as Villa, Carrefour, Top, Emporium and Siam Paragon (<http://www.greennet.or.th> 2550).

Organic cultivation across the country in the year 2549 had an area of 140.96 acres, representing 0.103% of the total agricultural area. Organic farms totaled 7,564 or 0.148% of all farms in Thailand. Organic produce amounted to 30,381 tons, worth 948 million baht. 520 million worth was sold in the domestic market and exported 428 million worth was exported. There are several requirements of organic standards including how How to deal with complex manufacturing processes. There is an Attractive market for organic products. In Europe governments provide funding to farmers to convert to organic farming in order to preserve the environment. Market segment in the U.S. has adopted the same standards and consumer

attention is on organic products. Organic products consumption growth is almost 10% (<http://www.healthsquare.org>, 2550).

The organic market in Thailand has grown to become the market trend consumers want more organic products for health care reasons. Though manufacturers are limited, the production of organic products in the farmer's market is way brighter in Thailand. The modifications in the production of organic products in Thailand will inevitably result in increased export opportunities. Thailand is an agricultural country with an advantage in terms of geography and climate. The country is also a major food manufacturer and exporter. It has the opportunity to develop into a major manufacturer of organic products in the world. To be successful in that are it is essential that the government support the needs for such a serious understanding and knowledge of farmers. Certification standards recognized by the international community as it is a new option to organic farmers of Thailand to add value to agricultural and food products safety in the country. Meanwhile, the project will support the government's food safety to succeed even more. The positive effect on the quality of life of farmers is the increase in revenue. (วิทยาลัยมหาจุฬาลงกรณราชวิทยาลัย, 2550).

In addition, the majority of consumers believe that organic foods are safe, healthy and help mitigate global warming. The popularity of consumption of organic products is growing rapidly. The top 5 countries which consume organic products are U.S., Germany, Italy, United Kingdom and France. The new markets to watch in the future is China, India and the Middle East because of the demand for organic products in these countries increased. Popularity of consumption of organic products is growing. The consumption of organic products from a niche market is because people around the world are thinking about the future before making a purchase. The country's weakness in the market is a the low operating working capital to organic farmers and agricultural cooperatives. A database should be developed for a sustainable organic market. This will expand domestic consumption and promote organic products of Thailand in the international market. (<http://www.healthsquare.org>, 2550).

Studies related to User-Centered Knowledge Management System implemented on a Community-Based Web Service Framework (Thawatchai Piyawat, online) has developed software that is widely used on the site GotoKnow.org is KnowledgeVolution. This is an open-source software aimed at supporting knowledge management that can be applied to business continuity and development inside and outside Thailand. This provide services to used around the country. By various organizations both public and private as well as many universities. Two softwares, FeedSpring and PlanetMatter are used in the management of organizational knowledge. Both pieces of software which has been used widely, especially in foreign countries. During the development of the software, it was found that infrastructure software, and application software is necessary for knowledge management especially for distributed and enterprise social management.

A case study on the sustainability of the use of information systems in the planning and management of Tambon Administration Organization (Krirksak Boonyanupong, 2547) found that the district administration is using data and information. But is not used effectively because information is incomplete and scattered along an unorganized system. Information that can not help to increase the knowledge in district development plan. The lack of information is one of the main obstacles in the development of corporate information technology. Assessment of the availability of the administrative district in the development of information technology found that most subdistricts are not ready to use of information technology. It was found that personnel at all levels, have not knowledge of the preparation of development plans and lack of knowledge about information technology. And agency may not grant ongoing information system development to an outside agency because they are

Unable to continue sustainability. Consulting agency are used to transfer the work load of the process. For information technology infrastructure, it is not an issue because the prices of the devices decreased with higher performance machines. There is no problem in procurement. But the problem lies in the focus of agencies on investment in infrastructure which ignore the content and lacks knowledge to use the tool and various computer equipment.

Since fiscal year 2551, researchers conducted a study on “The Development of Organic Agriculture Business Management Model for Sustainable Strength of Community Entrepreneurs”. The results of the study is the business model for organic producers adapted to the management group in order to be competitive. However, the model needs to be updated and improved to keep pace with the environmental change. In fiscal year 2552, the research team evaluated and monitor the implementation of the administration of the organic business model applied to the business operations to know the issues or barriers arising from the application. This was done in order to find ways to strengthen the model suitable for the implementation of the organic business sector. In addition, the research team also aimed to study the formation and development of collaborative networks and knowledge management systems in organic farming business in Chiang Mai. The link exchange information or knowledge to assist organic famers in various aspects both within and outside the network. This result in the organic business competitiveness in industrial and commercial growth and can run a sustainable business.

MATERIALS AND METHODS

This research aims on (1) to develop knowledge management systems, which include business administration, knowledge finance, accounting, marketing, production and human resource management of organic production in Chiang Mai.(2) to strengthen the technology system used in the development of knowledge management systems comprising hardware, software, network communications and information technology personnel. Research design used the survey research and exploratory research. The research was conducted in the location and production of organic produce farmers in Chiang Mai. The population of this research are 18 groups. Because the research budget has been reduced the sample size was reduces fit the budget. Selected farmers using organic production methods only selected nine groups. There are organic agriculture group in Ban Nong Ma Jab, bio-organic fertilizer producers in Ban Dorg Daeng, community learning centers in Ban Dorg Daeng, organic agriculture group in Ban Dorg Daeng (Fish), vegetative safety production in Saraphi District, Kitchen garden organic agriculture in Doi Sa Ket Group, agricultural group of vegetative safety production, of Monkolvaram (Agriculturalsafety) and community enterprise group of Aerated Static Pile Composting System. The research tools include questionnaires and interviews which will further the knowledge of marketing, production, human resources, accounting and finance group of organic production, including how to manage the knowledge. Data collected were two types. 1) Primary data will be collected using in-depth interviews and a structured interview. 2) Secondary data will be collected from research report and various related articles. The data and information collected were analyzed to design and develop a body of knowledge that is important in the management of the business of organic farming. Then be taken as a model of the knowledge management systems of organic farming business.

RESULTS AND DISCUSSION

From the collection of the samples from the 9 groups the research teams analyzed the design and development of organic agriculture business management knowledge. By the

knowledge presented in the form of a Web Application using the programming language PHP and database system MySQL, which is software and open source development presented in this study. Possible to use the site name as "organic agriculture community" under URL: www.maejoorganic.com. The information presented on the site.



Figure 1 The homepage of knowledge management of organic agriculture business.



Figure 2 The page of information knowledge management of organic agriculture business.

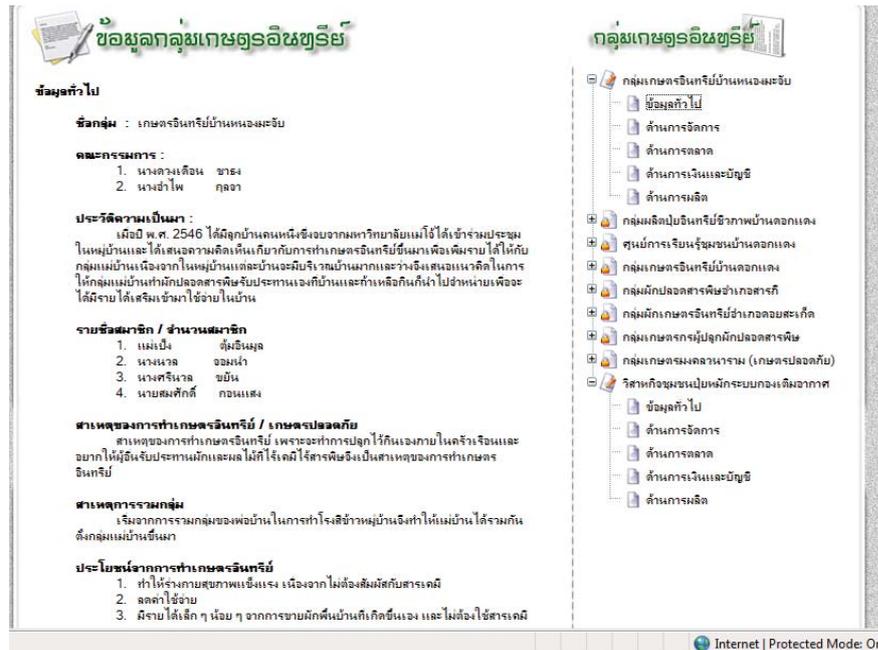


Figure 3 The page information, knowledge, business groups, organic production, management, marketing, finance and accounting.

The results showed that examples of organic groups form a variety of organic management. Knowledge of organic agriculture in the production management, marketing, finance and accounting. Able to be distributed through the knowledge management system of the business of organic farming research to get a master of business management systems, knowledge of organic farming by bringing knowledge expressed in the form of the Web. The site name as “organic community” under which www.maejoorganic.com of data collection: interviews with all 9 groups of organic production, organic agriculture group in Ban Nong Ma Jab, Group Producing Bio-organic Fertilizer in Ban Dorg Daeng, Community Learning Centers in Ban Dorg Daeng, Organic agriculture group in Ban Dorg Daeng (Fish), Vegetative Safety Production in Saraphi District, Kitchen garden organic agricultural in Doi Sa Ket Group, Agricultural group of Vegetative Safety Production, Agricultural group of Monkolvanaram (Agriculturalsafety) and Community Enterprise Group of Aerated Static Pile Composting System.

Which were used to sample experimental results show that this system with user satisfaction as well. But there are still obstacles to the knowledge of the technology and a few individuals in each group, it has limitations in terms of technology and the age of the group was also a middle-aged. In addition, each group of organic no technological equipment with sufficient capability to communicate as a barrier to access to and use of this system fully and continuously.

CONCLUSION

This study focused data collection system for organic agricultural business management knowledge in a systematic and complete technical studies are summarized below. The model structure of the knowledge management systems of organic farming by bringing business knowledge expressed in the form of a Web Application is developed for the analysis and design of work areas. Using the programming language PHP and the database MySQL. The site name as “organic agriculture community” under www.maejoorganic.com.

RECOMMENDATIONS

The development of knowledge management of organic agriculture business for sustainable strength of community entrepreneurs. Researchers have suggested in the literature as follows.

1. Should make improvements to the site have continuous.
2. Should have pushed youth groups took part in the development of knowledge and to assist the leadership in the use of technology to achieve the benefits.
3. Should study in the wider business, not just the knowledge of organic farming but the cognitive aspects of the business, profession or other community enterprise.

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Development E-Learning for Self-Study to Solve the Reading Skills of Primary School Students

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Abstract: This research aimed to solve the reading skills of primary school students with developing e-Learning system. This system uses Machine Learning technique, which could memorize behavior of students, while they are doing their exercises. For example, they read Thai words in their exercises and they cannot read some words, e-Learning system records those words and gives an opportunity to redo those exercises. Furthermore, Machine Learning technique can adjust the lessons, which are within this e-Learning system to suit the potential of each individual. The outcome of this research is used by the primary school students, who belong to education department in Bangkok. It was found that the students spent more time for reading with e-Learning than for reading the actual Thai books. In addition, this research can increase the reading skills of primary school students, by approximately ten percent.

Keywords: Machine learning, E-Learning, Primary school students

INTRODUCTION

The reading skills of Thai primary school students is one of the major problems of Thailand for ten years. Mr. Chinaworn Boonyakeit, who was Minister of Education in 2011, proposed a solution to solved this problem changing the lesson development strategy about reading skills of primary school students. This strategy sought the help of many experts on reading to develop teaching and learning strategies revision of Thai books to improve the students, reading skills.

In addition, the Ministry of Education tested students in grade two and grade five of all primary schools of Thailand in 2009. The results of this test are 15.35% in good level, 70.55% in normal level and 14.10% in repairable level of students of sullies of students in grade 2. In grade 5, 17.20% of students were in good reading level, 61.91% in normal level and 20.81% in repairable level. From this test results, the staff of the Educational Testing Bureau of the Office of Basic Education found that most primary school students have problems in reading of orthographies in Thai language. Furthermore, the staff of the Organization for Economic Cooperation and Development (OECD) have reported that 37% of Thai students, who are not over 15 years old, have very low reading skills. In 1996, OECD found that, more than seventy-five thousand person or thirteen percent from all students primary school's students in grade two not can read Thai text.

Nevertheless, other subjects are affected by this problem. This research developed an e-Learning system using Machine Learning to learn behavior of students when they take the test with this system. The benefits from this system are improvement of reading skill of students in the primary schools and save time of teachers when they teach their students.

MATERIALS AND METHODS

This research developed an e-Learning system for self-study to solve the reading skills of primary school students. In addition, this system is designed to help learners by lesson

adjusting the based on the abilities of each student. Students have attention span in the classroom is not over thirty minutes so they may ignore the lesson after. However, they can endure and spend much time on games, cartoons and the like. So, this e-Learning was created based on students' learning interests.

Machine Learning is applied with e-Learning system in this research. It can help analyze or decide on lesson selection after the students accomplished the tests.

e-Learning with Machine Learning (eLML) Architecture

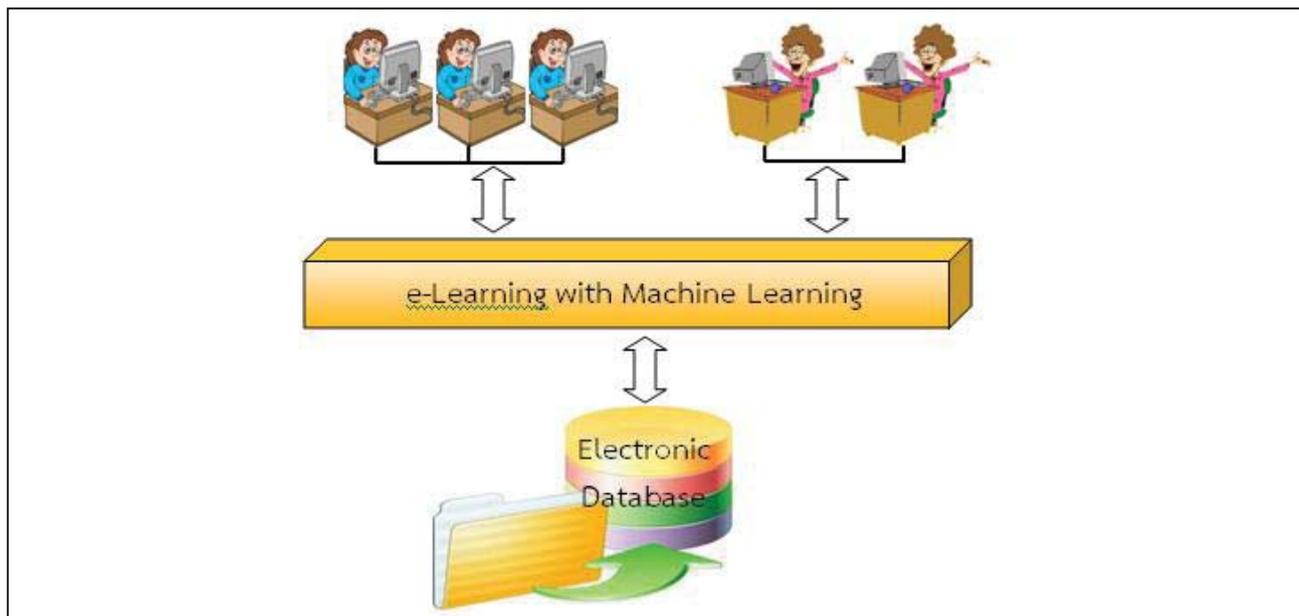


Figure 1 e-Learning with Machine Learning (eLML) Architecture

Figure 1 shows that the e-Learning with Machine Learning (eLML) Architecture has three elements Electronic Database, eLML and user interface. Electronic Database is where the data is store, do records lessons, tests and reports. eLML is an e-Learning application, controlled by Machine Learning. There is flexible performance because it can automatically adapt lessons for students all the time. User interface is a part of the system that is used for connecting the users and the eLML.

Figure 2 Introduces the working system flow chart which has two modules, The student the module and Teacher module. Users can use e-Learning by registration. Basically, this e-Learning wants to store data about their users. If users are students, they are tested using the electronic system before they more further into the lessons. Machine Learning is used to analyze their test scores so that the e-Learning system can arrange the best lesson sequence for each learner. Each level of lesson is adapted based on the ability of the learners. Some teachers may not fully know the ability of each student because they not can check and analyze all of the students' tests.

Teacher module part of this system can show reports such as scores, studying and the like. It is very useful and saves time for teacher's lesson, grade and report preparation.

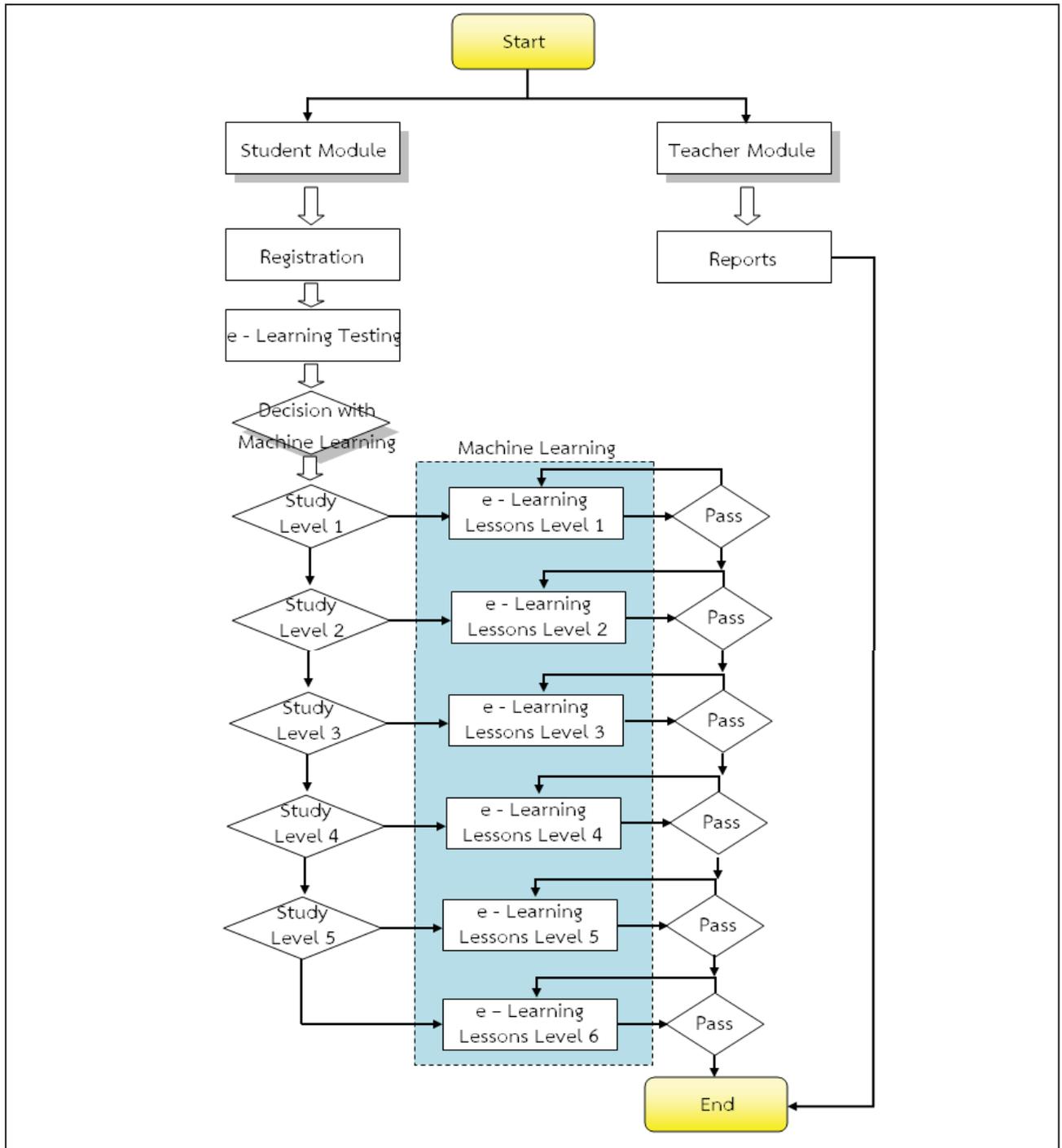


Figure 2 System Flow Chart

RESULTS AND DISCUSSION

This research developed an e-Learning for self-study to solve low reading skills of primary school students by adjusting to suit the potential of each individual. It was used by students of Chatchalerm School, a primary school at Laksi District in Bangkok. This study has a sample size of 122 students. The students were divided into two groups, regular studies and studying with e-Learning. The results of this research are described by Figure 3. to 8.

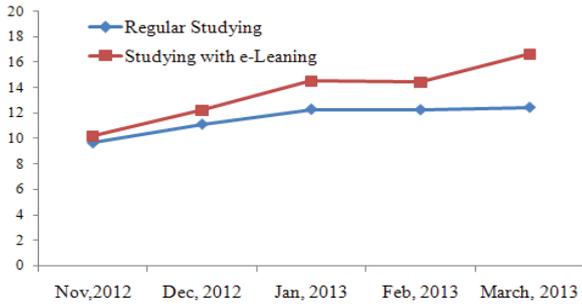


Figure 3 Average scores between regular and studying with e-Learning in grade 1 graph

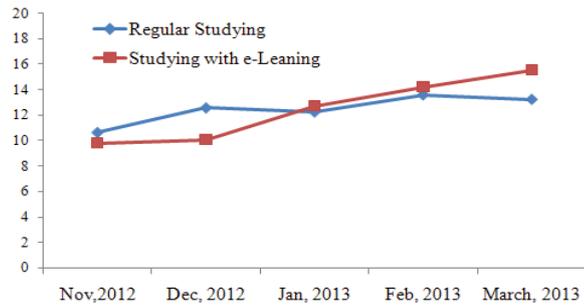


Figure 4 Average scores between regular and studying with e-Learning in grade 2 graph

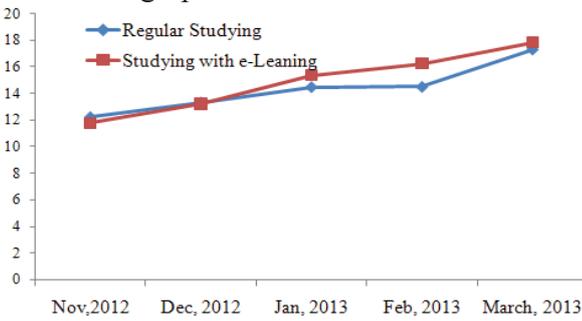


Figure 5 Average scores between regular and studying with e-Learning in grade 3 graph

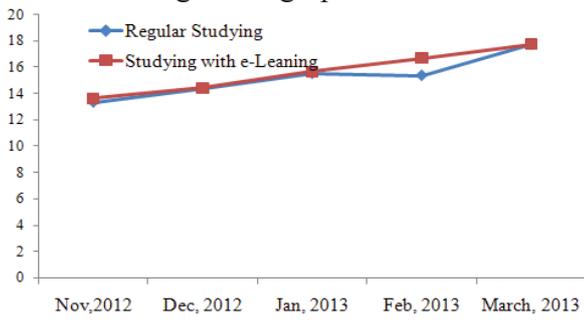


Figure 6 Average scores between regular and studying with e-Learning in grade 4 graph

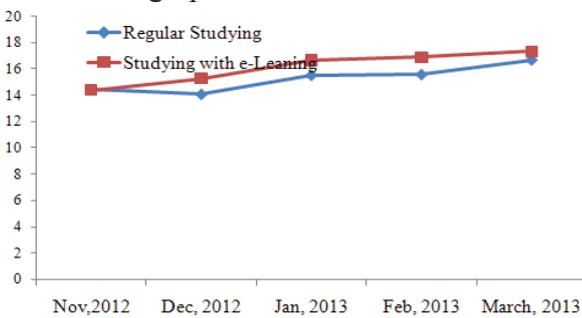


Figure 7 Average scores between regular and studying with e-Learning in grade 5 graph

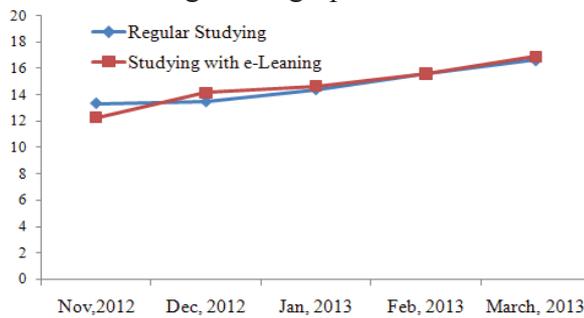


Figure 8 Average scores between regular and studying with e-Learning in grade 6 graph

Figure 3 to 8 show graphs of average scores of student from grades 1 to 6. It compared two samples, regular and studying with e-Learning. All graphs show increase from November, 2012 to March, 2013. All average scores of studying with e-Learning were higher than those in the regular studies from January 2013 and March 2013.

It can be seen that learning with eLML can be used to improve learning in primary schools. Furthermore, students can learn better with eLML with less supervision and control from the teacher.

CONCLUSION

Many teachers in primary schools have many work and activities so they have lesser time to prepare their teaching documents. Teaching reading skills in Thai language is impacted by this. The eLML is used to solve the reading skills of primary school students. Moreover with eLML, the teachers have more time for preparation about their subjects.

English language is another problem of Thai students research to study about tools development for learning the English language using eLML can be done in the future.

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Plagiarism and ASEAN Culture: A Study on How Postgraduate Students Use Electronic and Internet Resources in Their Writing

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Abstract: As ASEAN will integrate and become one, it is necessary to raise the academic standard especially in the postgraduate level to compete with the rest of the globe. Electronic and Internet resources are keys to research production that postgraduate students use as tools in studying and in producing their theses. This paper examines postgraduate students' views on the role of the electronic and Internet resources in facilitating their research. Data were collected from postgraduate students from three universities (Khon Kaen University, Suranaree University of Technology and Mahasarakham University) in Thailand. The findings showed that ASEAN teaching culture has been influenced by the learning culture where information technology is changing the delivery of education. Issues related to use of electronic resources including plagiarism, obstacles, patterns of use, and factors that play a role in deciding to use the electronic resources to seek information were also found. Of these issues, this paper particularly highlights plagiarism as it has been noticed to be committed relatively more often by Asian students. The findings will be useful to thesis advisors, teachers and librarians in providing proper electronic resources and training postgraduate students for their research.

Keywords: Plagiarism, Postgraduate students, Electronic resource, ASEAN culture

INTRODUCTION

During these years, there is an incredible revolution in the research community as a result of technology-driven applications. The use of electronic resources via computers and the Internet has led to a huge and high quality research production. Consequently, this new dimension of writing research has become a powerful service contributing to numerous intellectual products produced by higher education institutions. Electronic resources refer to databases, CD – ROM, electronic mails, Online Public Access Catalogues (OPAC) and internet browsing. Access to electronic books and journals; various databases and search engines depends on the Internet.

Khampusaen [1] informed that electronic resources have greatly affected the academic community especially in the universities. They changed the way teaching and learning is carried out and the ways research is conducted. Using computer network enhances a researcher's access to various types of useful and relevant information (e.g., full text, digital contents of local and distant libraries). It has been accepted and is equally recognized as retrieving information from printed materials. There are in fact a great number of differences between electronic and printed resources. However, the most stunning fact falls into how electronic information is used.

Ease of use of this powerful resource and its benefits to postgraduate programs in many universities, little is known about, firstly how effectively students use it. Secondly, there could be varying factors affecting the effectiveness of use including poor Internet signal of universities, high expenses of ICT equipment, and limited knowledge due to lack of proper

training [2]. These factors could lead to positive or negative attitudes toward use of electronic resources. Thirdly, positive attitude is a significant feature for successful use and integration of information technology in learning [3]. In addition, motivation that enhances use of electronic resources has to be studied so that the service can be adjusted to suit their needs [4]. Thus, this study focuses on factors affecting use of electronic resources of postgraduate students as the main objective. The researcher also aims at discussing other related issues regarding the topic.

Literature Review

The electronic resources have become an important tool for postgraduate students to have a better participation and engagement in the current information society. Use of electronic resources enable students to find, build, expand, analyze and present information. Students have exploited electronic resources to model situations as well as to solve problems. High speed Internet allows access to enormous source of information where students can justify their ideas and gain experiences from a wide range of people, communities and cultures. Furthermore, they can work in partnership and exchange information on a wider scale.

Electronic information sources are products of information and communication technologies and they have been found relevant to the learning and research process in universities. It is admired as a key tool to provide alternative possibilities for education [5]. White [6] stated that the availability of electronic resources has changed traditional context of postgraduate education to be more interactive. By using electronic resources, students can manage time better. This advantage is an attractive feature that transforms the teaching-learning and the research process [7]. Moreover, wireless networks, internet, search engines, databases, websites and web 2.0 technologies enable students to access and distribute electronic information like e-books and e-journals [8].

On the other hand, effective uses of electronic resources in general are being hampered by varying factors including, technical problems, and demographics of users.

It was found that age is a factor correlated with computers and use of electronic resources [9]. Simply put, younger students are more familiar with computers and tend to work better on the computer tasks. They added that younger generations can make faster and more accurate decision on computer tasks. The finding is useful particularly to the current study as there is a variety of age range among postgraduate students.

Gender was found by Ford and others [10] that females have more difficulty finding information online. They have to put more effort than male students to feel competent and comfortable using the internet. Several researchers [2, 11] revealed that factors including poor telecommunication infrastructures are significant barriers in using electronic resources. Regarding user demographics data, Bassi and Camble [12] found that female students use the internet less frequently than males and to make use of a less varied set of internet application. So it is feasible to indicate that gender is also an important factor in establishing computers skills and makes a difference in using electronic resources. As a result, Waldman [13] concluded that males seem to enjoy browsing the internet better. However, this researcher reminded that when exploring in great depth, use of the Internet among males seems to involve with enjoyment while female tend to only use it for work - related purposes.

Besides gender, there is another data set that affects their use of electronic resources including attitude. Christensen [3] submitted that use of electronic resources can be promoted or spoiled by attitude towards the tool and users. Naturally, positive attitude leads to successful use and integration of information technology in learning. Moreover, this factor has also been found a key to better perceptions and rates of adoption and extent of utilization of information technology [4].

In addition, there are other related variables in use of electronic resources of postgraduate students. Of these, the educational institutions and their libraries are the significant ones. The electronic resources service has created pressure on the university and its library due to the ability to provide reliable and effective learning environment. The libraries particularly concern about the provision of necessary guidance to end users. As suggested by Fatoki [2], libraries should collaborate with faculties to support the use of information technology. This infers that it is essential to provide core competencies of information literacy to improve abilities involved in identifying needs, accessing needed information, evaluating, managing and applying information, and understanding the legal, social, and ethical aspects of information use.

Scope of the Study

This study examined the factors that influence the use of electronic information sources and other related issues among postgraduate students. The study covered three universities in Northeast Thailand, namely, Khon Kaen University, Mahasarakham University and Suranaree University of Technology.

Objectives of the Study

The objectives of the study were to

- analyze the current situation on the use of electronic resources for thesis writing of postgraduate students
- examine the factors affecting use of electronic resources of postgraduate students
- evaluate postgraduate student's knowledge and awareness on plagiarism in relation to use of electronic resources.

RESEARCH METHODOLOGY

This research project adopted a survey method, collecting qualitative data sets. An online survey was used to identify issues that were important to postgraduate students in relation to information searching, information management and the support and advice that is available to assist with these research skills. Furthermore, particular attention was placed on the level of awareness regarding plagiarism. The web-based survey is self-built employing Google App.

RESULTS AND DISCUSSION

This study found that there is no strong differences among universities in terms of general information, general use and specific use of electronic resources and other related issues. Responses obtained from each respondent from different universities were in the same trend. There is no need to show the results of each university separately.

In total, the online survey gathered data from 61 postgraduate students (15 males, 46 females) from the three universities. The first section presents their demographic data. 42.6% of the respondents aged between 25-29 years old. Most of the students reported that they had a computer or a laptop at home and has access to the electronic resources from home. Those who use the electronic resources in the campuses had wifi connection, so they primarily access the Internet from almost everywhere within the campuses.

The second section surveyed their behavior in using the electronic resources. It was found that over half of these students spent between 1-5 hours every day in using electronic resources from their accommodation. The Internet came up as the most popular tool (96%) used for postgraduate study. Only 1.6% used e-journal for the same purpose. The electronic resource was mainly used for assignment rather than for thesis writing.

When asked to choose the three most relevant choices regarding knowledge and strategies in using electronic learning resources, it is observed from Figure 1 that about 98.4 % of students learned this from self-study while 78.7% and 59% of them learns how to use electronic learning resources from colleagues and teachers/research advisor respectively. The pie chart shows that the option ‘Formal training’ was chosen by only 8 students while option ‘Others’ came up the last with only 1 student. This indicates that the options were common methods frequently used by the students.

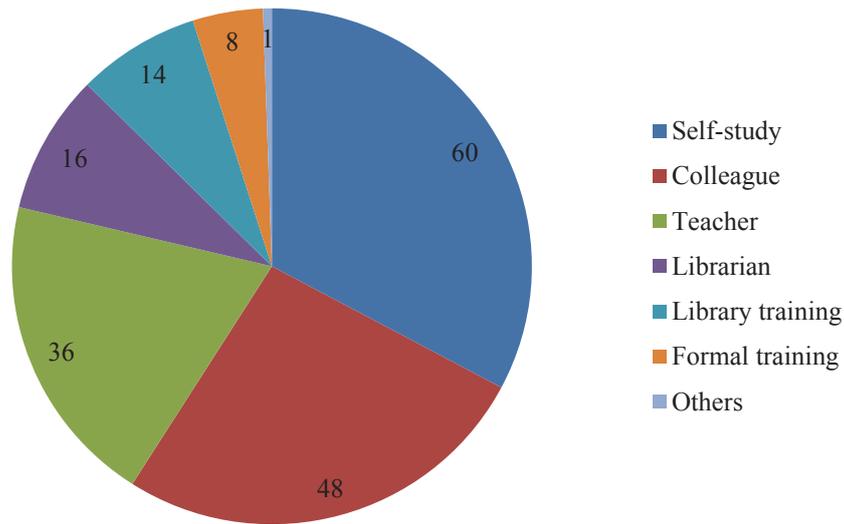


Figure 1 The top-three options how students learned to use electronic resources

Post graduate students seemed to have more confidence in computer literacy skills than their English skills. Findings revealed that the majority of the students had difficulty in using electronic resources due to access to database, source selection and poor internet connection. The early finding section has presented that over half of the students accessed to electronic resources from home, it is therefore assumed that they had problem in connecting to the university database or commercial database such as Springerlink when accessing it from home. It was suggested that all the three universities should also provide training in selecting relevant sources that fit well with students’ work.

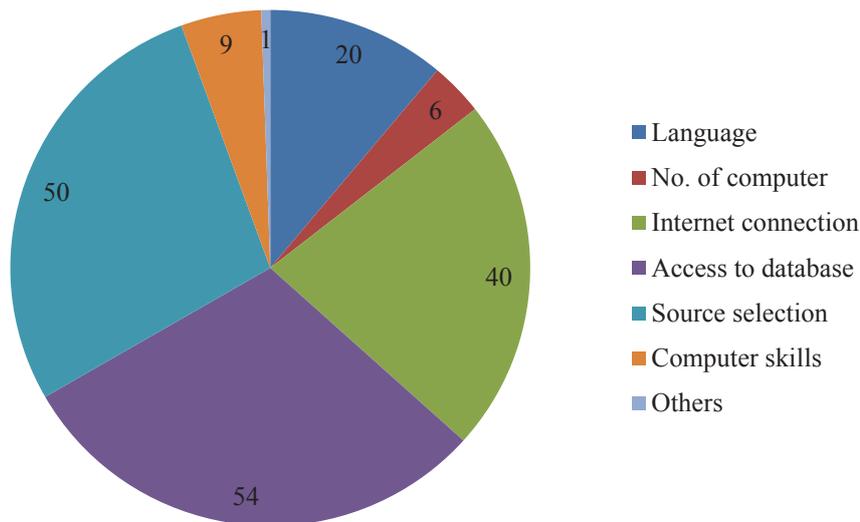


Figure 2 The top-three problems related to use of electronic resources

In the third section of the survey, specific use of electronic resources was examined. The findings revealed that two third of the respondents used electronic resources to complete assignment. Similar portions of these users (40% and 40%) used the resources because of their freshness and excitement features.

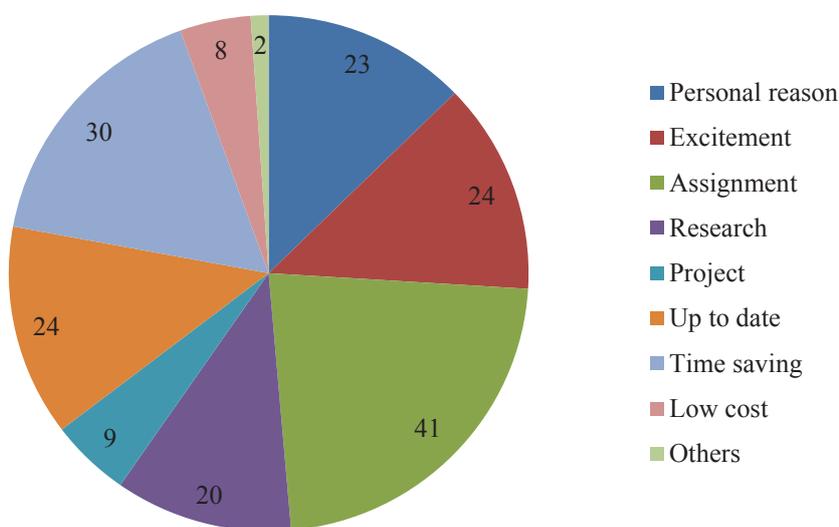


Figure 3 The top-three motivation in using electronic resources

The last section of the survey revealed issues of plagiarism from using of electronic resources. It was found that most students (85.20%) were aware of plagiarism by always trying to search for the original texts and sources rather than to use the secondary sources. Over half of the respondents claimed that they made citation and references for all texts or ideas taken from outside sources.

However, about half of the students tend to conduct plagiarism by avoiding citing and referencing to the original when they were in a rush. Moreover they fabricated the source to

fit their work and failed to give proper reference. Three quarter of students admitted that they had limitation in English. Still only half of the respondents perceived the importance of honesty in academic writing and tried to keep the meaning of the original texts in their work.

Table 1 Understanding and perception towards plagiarism

Statement	Yes	No
1. I make citation and references for all texts or ideas of outside sources.	68.90%	31.10%
2. Sometimes I make changes to some part of the selection to avoid citing the source.	55.00%	45.00%
3. My teachers/supervisors may not notice a small selection I have copied into my work.	13.10%	86.90%
4. I often have problems trying to relate the cited selection to fit my work.	73.80%	26.20%
5. My English writing skill is not as good as the original.	77.00%	23.00%
6. I want to cite the source; however, I don't know how to.	78.70%	21.30%
7. I have learned about citing and referencing from my teachers/advisor.	59.00%	41.00%
8. When citing, the closet to the original is the best.	50.80%	49.20%
9. I often cite and reference sources if I am not in rush.	73.80%	26.20%
10. I always search for the original rather than use the secondary source.	85.20%	14.80%

DISCUSSION

The data from the survey revealed that nearly all participants reported that they use the Internet for personal, work, and school related reasons. Most participants have computing facilities as well as an Internet connection available to them at home. This could be a relief for universities that there is not much need for them to provide a large number of computers with Internet connection for postgraduate students. The universities should, on the other hand, allocate funds to help improve library resources and services. The library should prepare high quality resources that relevant to the areas of interest of users. For example, the most common types of sites visited for research are databases with journal articles or books. Using electronic resources is a great necessity to postgraduates in several ways. For example, it provides 24/7 services. Users can enjoy the one-stop service, all in one place and from any location. Electronic resources offer the diversity of resources.

It is obvious that library resources are an essential part of the research procedure for these students because they can access knowledge resources almost in all the steps of their postgraduate study.

It appeared that enormous amounts of information that the search comes up with are sometimes overwhelming, and students had difficulty in sorting through all this information and discriminate what is relevant and what is not relevant to their needs. Specific training should be designed to help students to use the electronic resources more effectively.

The most important issue came up with the use of electronic resources in postgraduate students is plagiarism [14]. It was observed that some students have incorrect attitudes and perception towards plagiarism. Unfortunately, issues on student attitudes towards plagiarism

and towards copyright violations, knowledge and understanding about plagiarism, and time concerns are strong reasons making students plagiarize. It has also been agreed [15, 16] that lack of understanding of what constitutes plagiarism is a significant motivation to plagiarize. It is also reasonable to put that advanced internet technology has contributed to the increasing act of plagiarism. The same problem was found less in the past as people needed to go the libraries and read books as part of their written work production. Currently, many students plagiarize by using the internet as a tool. From this scenario, it is an obligation for the university, teachers, and the libraries to collaboratively assist these students to deal with their academic literacy. Teachers need to help them gain appropriate skills in academic writing to address plagiarism and that they can develop their own writing identities. It is considered necessary to discuss academic integrity in the classroom. Teachers should be encouraged to create a climate of involvement and interest rather than of detection and punishment. Teachers also need to teach the skills of summarising and paraphrasing in relation to using texts and ideas from outside sources to their postgraduate students to avoid plagiarism.

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CRRU Model for ASEAN Collaboration using Interdisciplinary Approach between University Faculties: Chiang Rai Rajabhat University, Thailand and Luang Namtha Teachers College, Lao PDR

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Abstract: As the deadline for ASEAN 2015 approaches, it appears that many educational institutions in Thailand may not be ready and many have no clear strategies for getting ready. Establishing Mou between participating members is not easy and attempts to sustain the Mou are not always certain. With this uncertainty there appears to be a strong need for a model to follow in order to begin, have and nurture short term and long term collaboration between different educational institutions in ASEAN. After the change in administrative staff at Chiang Rai Rajabhat University, the new team of administrators is exploring ways to develop an effective model for ASEAN academic collaboration across Thai borders. There are many important priorities that top administrators want to develop including; better networking, human resource development, joint research projects, expertise sharing and others. The best way to achieve these priorities are to base decisions from past and on-going projects. This paper investigates and analyzes a collaboration model of to determine its effectiveness in networking, managing and using appropriate learning resources with Luang Namtha Teachers College in Lao PDR. Based on the data outlined in this paper, there is strong and compelling evidence to support the establishment of an ASEAN collaboration model using an interdisciplinary approach in cooperation with different faculties, centers, units, etc. The data show that this model using PAR and multilingualism is both effective and sustainable. The project has led to further discussions in student-student exchange projects, teacher-teacher exchange projects, and joint research projects between Luang Namtha Teachers College and Chiang Rai Rajabhat University.

Keywords: ASEAN collaboration, Interdisciplinary approach, Mou

INTRODUCTION

The question has frequently been asked about CRRU's readiness for ASEAN 2015. Many inside the university system say no and many outside the system are unable to answer this question because there are no examples of successful projects completed or "on the drawing board" between CRRU and ASEAN educational institutions. Furthermore, there is no existing CRRU master plan for getting ready for ASEAN 2015. In the past both administrators and teachers were focused on attending ASEAN conferences and seminars as passive listeners and rarely contributed in the debate for turning passive participation into proactive projects. No one has presented a plan of action or master plan to implement at CRRU. Time is running out and there is a need to step forward with a master plan of action for ASEAN 2015. It is with this motivation that this research project was initiated. The research focuses on the following;

- Networking strategies and sustainable bonding
- Teacher/student intercultural communication competency
- Appropriate learning resource development
- Management and assessment of interdisciplinary collaborative ASEAN projects

Since the change in administrative staff at Chiang Rai Rajabhat University, the new team of administrators is exploring ways to develop an effective model for ASEAN academic collaboration across Thai borders. Newly appointed Vice President of Academic Affairs, Assistant Professor Dr. Sornchai Mungthaisong, an active participant in international relations, suggested starting by assessing the merits of projects that are currently underway at the university. He added that there are several important priorities that the new administrators want to develop including; better networking, human resource development, joint research projects, expertise sharing and others. Furthermore, he stated that before establishing a new university ASEAN policy for achieving these priority aims decisions must be based on CRRU's past and on-going projects. In this vein and with the encouragement of Asst. Prof. Dr. Sornchai Mungthaisong this paper reports, investigates and analyzes the collaboration model of Asst. Prof. Dr. Ranida Pingmuang for the purpose of determining its effectiveness in networking, managing and using appropriate learning resources with Luang Namtha Teachers College in Lao, PDR. The paper is divided into four sections including an overview of the research process, followed by Asst. Prof. Dr. Ranida Pingmuang's project in action during the collaboration stage at Luang Namtha Teachers College, PDR, moving on to the results of the research and finally concluding with recommendations.

The mixed-method research approach was considered to be appropriate for this study. With the aims to investigate and analyze the efficient usage of multi-lingual learning resources in a collaborative project with a nearby ASEAN country, Lao, PDR, the researchers used the qualitative method to find out the effectiveness of running activities and the quantitative method to find out the satisfaction of the research participants. To elaborate, the qualitative research method referred to the (Participatory Action Research, PAR) technique which was used to collect data from the exchanging of academic knowledge activities. These activities used a multilingual brochure (appendix I) and a drama script (appendix II). The last part of the questionnaire was designed to be open-ended questions in order to give an opportunity for the participants to answer widely and deeply. The researchers also provided chances for Lao teachers and students to share some ideas for future collaborative activities between two the institutions. Beyond the qualitative method, the quantitative method was taken into consideration in term of reflecting the project participants' satisfaction towards the project. In order to get the feedback and reflection of the project, the second to the fifth part of the satisfaction evaluation form (appendix III) was used. Below shows the processes of making the learning resources and the satisfaction evaluation form.

Procedures of Developing Learning Resources and the Project Evaluation Form

The Process of Developing Multilingual Learning Resources: Multilingual Brochure

At this juncture there is a feature of the learning resources that applied a multilingual presentation. The multilingual brochure shows that interdisciplinary cooperation results in better learning resource development. The idea for the brochure came from the team members of the Faculty of Humanities who were interested in promoting and utilizing linguistic features in the collaboration project with Lao, PDR. Although the idea for a three language brochure was interesting the team had to work quickly connecting all the dots to get this task completed. Asst. Prof. Dr. Ranida Pingmuang and Ajarn Albert Lisec contacted other faculties and were able to contact two teachers from Luang Namtha who were currently

at the Tai Studies Center. With their help, a multilingual brochure was prepared to be used as an introduction to Chiang Rai Rajabhat University and as a teaching tool. Ajarn Albert Lisec suggested that hitting kill two birds with one stone the brochure as a teaching aid, too. He introduced the idea of developing a lesson centered on the information presented in the multilingual brochure.

The Process of Developing Multilingual Learning Resources: Drama

Here is an example of developing appropriate multilingual learning resources for the Luang Namtha Teachers College collaboration project. For the Lao PDR and Thailand situation, understanding and appreciating similarities and differences was a key factor in determining the types of learning resources developed. Historically and to some extent even now, Lao and Thailand are brothers and sisters. Both ancestors have shared many similar cultural features such as legends. There are many legends and rituals honoring the Naga serpent throughout many Southeast Asian countries like Thailand and Lao PDR. Therefore a popular Naga Serpent legend was selected for use in the CRRU/Luang Namtha project.

The Naga serpent is a mythical creature with snake and dragon like characteristics. The Lao and Thai belief is that they live in the deep stretches of water. In the Tamnaan Yonok Chiangsaen chronicle of Northern Thailand, Naga serpents had great magical powers to create waterways and city moats. This legend emphasizes the importance of following Buddhist principles in order to gain the protection and help of the Naga serpent. However, if rulers behaved opposite to these Buddhist principles, they would be severely punished by causing an earthquake to replace their city with a swamp. The elders of Chiang Rai say that Chiangsaen Lake in Chiangsaen District of Chiang Rai Province is an example of the ancient town being destroyed by a vengeful Naga serpent who punished the ruler and his people for catching, killing and eating a giant albino eel which was a disguised form of his son.

In another legend there are two Naga Serpents living at Sae Lake. They have good relationships between each other. One Naga was born in the deep stretches of water in Lao. His name was Phaya Sri Sudtho. The other Naga was born in the deep stretches of water in Thailand. His name was Phaya Suwan. They both had a MoU agreement to share all food and share all security responsibilities. On odd days the Naga from Lao would get food while the Naga from Thailand would provide for security around Sae Lake. On even days the Naga from Thailand would get food while the Naga from Lao would provide for security around Sae Lake. All was going well until mistrust, suspicion, greed and pride entered into their relationship. It all started when the Lao, PDR Naga, Phaya Sri Sudtho found a dead elephant and divided it equally with his friend from Thailand, Phaya Suwan. Later on an even day Phaya Suwan, the Thai Naga found a porcupine which he divided equally for his friend from Lao. But Phaya Sri Sudtho formed a sloppy conclusion which often ruins relationships. He assumed he was being cheated by the Lao, PDR Naga. In his thinking it was obvious, from the hair on the porcupine that the meat from this animal was much larger than the meat from the elephant.

The curriculum designers next needed to adapt the learning resources into a communication task that would help develop the learners' communication skills and contribute to their linguistic and intercultural development. It was decided that the teacher's (presenter's) role would be to help learners acquire language fluency through a drama activity and not to teach grammar or correct their mistakes. So the learning resource in this example provides for an opportunity learners to use bilingual language and develop their linguistic competence. The script is planned together in Thailand negotiating the language from English to Thai. Later, the English and Thai scripts are sent to Luang Namtha for the Lao teachers to translate into Lao. During the get together at Luang Namtha Teachers College, Lao students were asked to present the drama during the performance at the main hall.

The Project Evaluation Form

The project evaluation form was designed to investigate the project participants' satisfaction and reflection towards the project. There were six parts including (1) objectives, (2) general information of the respondents, (3) cross-cultural communication while doing the activities, (4) resources, (5) the reflection of the participants' satisfaction, and (6) other suggestions for future projects. In each part consists of some sub-important points.

RESULTS AND DISCUSSION

In this part of the paper, the answers to the research questions are presented. The first questions concerns networking and bonding and can be stated in the following forms.

- How can CRRU networking and bonding between ASEAN countries be improved?
- How can a better collaboration exist with ASEAN educational institutions of different culture, from another education system, from different ways of thinking and different values?

After looking at problems with some definitions of networking and bonding, it is suggested that in order to network and bond with ASEAN countries, one must have knowledge of that country' s culture, respect for that culture and tolerance for their differences. Suggestions include:

1. Each faculty produces "**English Knowledge Package**" in which the highlights, strong points, identity, brand etc. are articulated clearly in English, the ASEAN language.
2. Start interacting at the bottom up levels, projects originate from the Faculty level, cleared at the Center of International Academic Collaboration, and arranged through MoU at the President' s level.

The second research question concerns aspects of intercultural communication that can be stated in the following forms.

- How can intercultural communication be improved?
- How can communication become better with a student from another culture, from another education system, of a different age, who speaks a different language?

After looking at problems with some definitions of communication, it is suggested that in order to communicate well with someone from a different culture, knowledge of that person' s culture was necessary. This might be fine for people going to live in another country or for people who deal mainly with people from one or two other countries or cultures. However, this is impossible at CRRU which have limited number of foreigners from ASEAN. At present there are Chinese, Japanese, American, British, Korean, Lao PDR and Burmese who work or study in CRRU. Other than these we have no other ASEAN representative.

The third research question concerns ASEAN content and appropriate learning resources and can be stated in the following forms.

- How can ASEAN knowledge learning resources be improved?
- What are the process to develop and share appropriate learning resources in a cooperative way between the participating countries of ASEAN?

After looking at problems related to developing appropriate learning resources, it is suggested that in order to develop appropriate and useful learning resources one must practice PAR approach in all aspects of creating and sharing learning resources.

The fourth research question concerns CRRU management and assessment of academic ASEAN collaboration activities and can be stated in the following forms.

- How can CRRU management and assessment of MoU ASEAN plus be improved?
- What are the process to develop and share good quality management and assessment with the participating countries of ASEAN?

After looking at problems related to managing and accessing collaboration projects, it is recommend that a training be conducted for guidance and policies about ways of assessment and management of ASEAN projects

Project Assessment

The satisfaction evaluation form was divided into six parts including objectives, general information of the respondents, a cross-cultural communication while doing the activities, learning resources, the reflection of the participants' satisfaction, and other suggestions for future projects.

The Second Part: General Information of Language uses

In term of the general information, Lao teachers mostly used Lao language as mother tongue. Differently, Lao students mostly used Khamu Language as mother tongue. Apart from the first language, the majority of Lao teachers used English as a second language. In contrast, students mostly used Lao language as a second language but when negotiating language discourse with the American teacher they used the strategy of code switching extensively.

The Third Part: Cross-Cultural Communication while Doing Activities

The researchers who were the trainers of this project mainly used English language to communicate with the project participants. Thai language was the second language used. However, the researchers sometimes used both Thai and English. Oppositely, the project participants mainly used Lao language to communicate with the trainers. English was the second language used. Sometimes, English, Thai, and Lao were used. Segments of this language discourse were recorded and later used for deeper analysis with the graduate students studying linguistics at CRRU. Several teachers from the Faculty of Social Science, CRRU commented that they were impressed by the use of bilingual communication and they pointed out that a lot of code switching was happening among the Lao English teachers and their students. Two Lao lecturers were particularly interested in these phenomena and have since decided to do further research at CRRU on this topic during their graduate master's degree training.

The Forth Part: Learning Resources

The research participants had good perceptions of the handbook. The multilingual brochure, posters, and other materials were the preferred learning resources. In addition to the project material, additional learning resources were distributed from the Center of Biodiversity which both student and teachers were pleased to receive. From the comments of the Vice President of the school he said that the learning resources would be placed in the school library and made available for staff and the students.

The Fifth Part: The Project Participants' Satisfaction

In term of trainers, the process of activities, contents, place, time duration, advantages of doing the project, the process of dealing with people, the project participants were satisfied with the project. The dinner and show performance was successful and attracted local people from the community to watch the performance. Strong marks were recorded for the management of the activities as both the Thai and Lao counterpart cooperated very well. The top Lao PDR administrators gave both verbal and non-verbal messages of approval from their speeches and informal talking inside the meeting rooms, during social meals and during the grand closing ceremony in the performance hall.

CONCLUSION

The findings indicated the positive effects of this particular ASEAN collaborative project organized by Asst. Prof. Dr. Ranida Pingmuang through interdisciplinary, PAR, and multilingual approaches. However the findings could not be generalized beyond the Lao, PDR-Thailand specific context which was involved in this study. On a more positive note, the findings revealed that interdisciplinary approach especially in cross border collaboration ventures can be done successfully with highly motivated and professionally conscious people at the university workplace especially between two faculties.

Less encouraging is the current level of intercultural communication competency among the other faculties at CRRU. At present the Faculty of Humanities has the highest level of intercultural communication competency based on the larger number of English teachers and the amount of English related projects within the faculty. The other faculties have less English competency based on English learning resources currently being developed. A recent collaboration project supports this attitude. In early February 2013 the Office of Academic Collaboration invited each faculty and school to prepare English and Chinese brochures and posters for a Thai Promotional Fair in Kunming, China. This request resulted in a number of challenges that revealed many shortcomings in developing multilingual promotional material for international distribution at the faculty level. Most faculties had no “on-hand prepared” promotional materials in either English or Chinese. Most had Thai promotional material but many were not able to get posters and brochures translated in timely fashion for this Promotional Fair in China. They could not translate the Thai into other languages and failed to see the importance of doing so. Furthermore, most of the deans were either indifferent about developing such materials or they didn't have the expertise in their faculty for undertaking such tasks. They did not set aside a budget for developing intercultural learning resources. This incident confirms the need for stronger interdisciplinary cooperation among many of the other faculties at CRRU.

In spite of the many challenges associated with intercultural communication among the CRRU and the Lao PDR working group, both parties were able to overcome the minor setbacks and feel successful and proud at the end. This may be attributed to the similar cultural roots of the Lao and Thai working group. It is highly recommended that similar researches be conduct in the same fashion as this one to help assess the nature and quality of other collaborative projects between CRRU and other ASEAN educational institutions.

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Appendix I: Multilingual Brochure (Example)

4 ทศวรรษ มหาวิทยาลัยราชภัฏเชียงราย “รากแก้วของแผ่นดิน”

Four Centuries of Chiang Rai Rajabhat University “Tap Root of the Nation”

4 ທົດສະວັດ ມາຫາວິທະຍາໄລລາດສະພັດຊຽງຮາຍ. "ຮາກແກ້ວ ຂອງແຜ່ນດິນ"

สารจากท่านอธิการบดี

“ผมมีความยินดียิ่ง ที่มหาวิทยาลัยราชภัฏเชียงรายและวิทยาลัยครูหลวงน้ำทาได้เตรียมความพร้อมสำหรับการเปิดประเทศสู่ประชาคมอาเซียนในปี 2558 โดยการร่วมกิจกรรมแลกเปลี่ยนวัฒนธรรมและความรู้ทางวิชาการ ณ แขวงหลวงน้ำทา สาธารณรัฐประชาธิปไตยประชาชนลาว ขอให้ทุกท่านโชคดีและสร้างสรรค์ความสัมพันธ์ที่ดีอย่างนี้ต่อไปให้นานเท่านาน”

Press Release from the President

“I am very pleased that Chiang Rai Rajabhat University and Luang Namtha Teacher College can show their readiness for ASEAN 2015 by participating in this joint academic and cultural activity in Lao PDR. The best of luck for strong sustainable relations”

ສານຈາກ ທ່ານ ອະທິການບໍດີ (ຕ້ອງລໍອັບເດດຂໍ້ມູນຈາກ ທ່ານ ອະທິການບໍດີ)

"ຂ້າພະເຈົ້າມີຄວາມຍິນດີທີ່ສຸດ. ທີ່ຫາວິທະຍາໄລລາດສະພັດຊຽງຮາຍ ແລະວິທະຍາໄລຄູຫຼວງນ້ຳທາໄດ້ກຽມຄວາມພ້ອມສໍາລັບການເປີດປະເທດສູ່ປະຊາຄົມອາຊຽນ ໃນປີ 2558 ໂດຍການຮ່ວມກິດຈະກຳແລກປ່ຽນວັດທະນາທຳແລະຄວາມຮູ້ທາງວິຊາການໃນແຂວງຫຼວງນ້ຳທາ ສາທາລະນະລັດປະຊາທິປະໄຕປະຊາຊົນລາວ ຂໍໃຫ້ທຸກທ່ານໂຊກດີແລະສ້າງສາຍຄວາມສໍາພັນທີ່ດີຢ່າງນີ້ຕໍ່ໃຫ້ນານແສນນານ”

ประวัติมหาวิทยาลัยราชภัฏเชียงราย

มหาวิทยาลัยราชภัฏเชียงรายพัฒนาจากโรงเรียนฝึกหัดครูประชาคมนิยัตการศีกษา ในปี พ.ศ. 2512 แล้วพัฒนาเป็นวิทยาลัยครูเชียงรายในปี พ.ศ. 2516 ต่อมาในปี พ.ศ. 2535 กลายเป็นสถาบันราชภัฏเชียงรายและในปี พ.ศ. 2542 พัฒนาจนเป็นมหาวิทยาลัยราชภัฏเชียงราย ต่อเนื่องมาจนถึงปัจจุบัน รวมเป็นระยะเวลา 40 ปี

History of Chiang Rai Rajabhat University

Chiang Rai Rajabhat University has 4 decades of history beginning from Chiang Rai Teachers College in 1973. Two decades later in 1982 it changed to Chiang Rai Rajabhat Institute. At the beginning of the millennium in 2000 it changed to Chiang Rai Rajabhat University.

ປະຫວັດຂອງ ມາຫາ ວິທະຍາໄລລາດສະພັດຊຽງຮາຍ.

ມາຫາວິທະຍາໄລລາດສະພັດຊຽງຮາຍ ໄດ້ມີການພັດທະນາການສຶກສາຈາກໂຮງຮຽນເພິກຫັດຄູ ປະກາດສະນິຍະບັດການສຶກສາໃນປີ ພ.ສ. 2512 ແລະຫຼັງຈາກນັ້ນໄດ້ພັດທະນາເປັນວິທະຍາໄລຊຽງຮາຍ ໃນປີ ພ.ສ. 2516 ຕໍ່ມາໃນປີ ພ.ສ. 2535 ໄດ້ກາຍມາເປັນ ສະຖາບັນລາດສະພັດຊຽງຮາຍ ແລະ ໃນປີ ພ.ສ.2542 ໄດ້ມີ ການພັດທະນາມາຈົບກາຍເປັນມາຫາວິທະຍາໄລລາດສະພັດຊຽງຮາຍ ຕໍ່ເນື່ອງມາເຖິງປະຈຸບັນ ສໍາລັບໄລຍະເວລາທັງຫມົດ 40 ປີ

Appendix II: Drama Script (Example)

(Thai-English-Lao)

Task: This is an intercultural drama task using three languages and using drama strategies for presenting during a performance.

กิจกรรมนี้ชื่อว่า กิจกรรมละครข้ามวัฒนธรรม ซึ่งใช้สามภาษาและใช้กลยุทธ์การแสดงละครสำหรับการนำเสนอผลงาน

SCRIPT ບທພູດ

M.C. (male) ພິຣິກຮາຍ

Distinguished guests, Ladies and Gentlemen

Welcome to our drama presentation called *“The Creation Myth of the Mekong and Nan Rivers”*.

ແຈກຜູ້ມີເຄີຍຣີ ສຸກາພສຕຣີ ແລະສຸກາພນຸຣຸຍທຸກທ່ານ ຂອດ້ອນຮັບທ່ານເຂົ້າສູ່ກາຣາຮມລະຄຣ ເຣື່ອງ *“ຕໍານານກາເຄີດແມ່ນໍ້າໂຈງແລະແມ່ນໍ້ານໍານ”*

M.C. (female) ພິຣິກຮາຍູງ

We begin with the prologue or introduction to the drama. We are not on earth but in heaven on the second level called *Dawadung*. Indra is talking to one of the Celestial Beings in charge of the Thai/Lao Collaboration Project at Sae Lake. Let’s listen.

ເຣາເຣີມດ້ວຍກາຣາຣິນດາກາຣາວ່າເຣາໄມ້ໄດ້ອຸ່ຍຸບນໂລກແຕ່ເຣາອຸ່ຍຸບນສວຣຣັດຊັ້ນສອງ ຊື່ອ ດາວດິງ ອິນດຣາກໍາລັງພູດດິງຈີວິດໃນສວຣຣງສວຣຣັດ ກາຍໄດ້ໂຄຣງກາຣາວຸ່ມມື່ອໄທຍລາວທີ່ທະເລສາບ Sae ເຣີມຟິງໄດ້ເລຍຄະ

Indra: How is the MoU between Lao and Thailand?

ອິນດຣາ: ສັດູນາວຸ່ມມື່ອຮາວ່າງສາຮາຣນຣຸຊປຣາຮາຮນລາວແລະປຣາທະໄທເປັນອຸ່ຍຸ່ງໄຣຮື່ອ

Thewada: Fine.

ເທວດາ: ອ່ອ ດີມາກເລຍ

Indra: What are the details of the MoU?

ອິນດຣາ: ແລ້ວຮາຍລະເອີຍດສັດູນາເປັນອຸ່ຍຸ່ງໄຣຮື່ອ

Appendix III: Project Evaluation Form

สรุปแบบประเมินความพึงพอใจของผู้บริหาร อาจารย์ เจ้าหน้าที่และนักศึกษาต่อโครงการสร้างความร่วมมือ

ระหว่างมหาวิทยาลัยราชภัฏเชียงรายและวิทยาลัยครูหลวงน้ำทา

วันที่ 12-14 พฤษภาคม 2556 ณ วิทยาลัยครูหลวงน้ำทา

ส่วนที่ 1 วัตถุประสงค์

1.1) เพื่อประเมินโครงการสร้างเครือข่ายและความร่วมมือทางวิชาการระหว่างมหาวิทยาลัยราชภัฏเชียงรายกับวิทยาลัยครูหลวงน้ำทา

1.2) เพื่อสำรวจความพึงพอใจของผู้บริหาร อาจารย์ เจ้าหน้าที่และนักศึกษาต่อโครงการสร้างความร่วมมือ

ระหว่างมหาวิทยาลัยราชภัฏเชียงรายและวิทยาลัยครูหลวงน้ำทาเพื่อนำผลไปพัฒนาปรับปรุงโครงการฯในครั้งต่อไป

ส่วนที่ 2 ข้อมูลทั่วไปของผู้ตอบแบบประเมิน

การประเมินความพึงพอใจของผู้บริหาร อาจารย์ เจ้าหน้าที่และนักศึกษาต่อโครงการสร้างความร่วมมือระหว่างมหาวิทยาลัยราชภัฏเชียงรายและวิทยาลัยครูหลวงน้ำทา จากแบบประเมิน 20 ฉบับ มีผู้ตอบแบบประเมินเป็น อาจารย์ 8 คน คิดเป็น 40 % และนักศึกษา 12 คน คิดเป็น 60 %

ภาษาแรกของท่าน คือ

ภาษาที่สองของท่าน คือ

ภาษาที่สามของท่าน คือ

ส่วนที่ 3 การสื่อสารข้ามวัฒนธรรมระหว่างดำเนินงานกิจกรรม

รายการ	มากที่สุด	มาก	ปานกลาง	น้อย	น้อยที่สุด
1. ภาษาที่ใช้ระหว่างดำเนินงานกิจกรรม (ผู้ดำเนินกิจกรรม)					
ผู้ดำเนินกิจกรรมใช้ภาษาไทย					
ผู้ดำเนินกิจกรรมใช้ภาษาลาว					
ผู้ดำเนินกิจกรรมใช้ภาษาอังกฤษ					
ผู้ดำเนินกิจกรรมใช้ภาษาไทยและภาษาลาวสลับกันไปมา					
ผู้ดำเนินกิจกรรมใช้ภาษาไทยและภาษาอังกฤษสลับกันไปมา					
ผู้ดำเนินกิจกรรมใช้ภาษาไทย ภาษาอังกฤษและภาษาลาวสลับกันไป					
2. ภาษาที่ใช้ระหว่างดำเนินงานกิจกรรม (ผู้เข้าร่วมกิจกรรม)					
ผู้เข้าร่วมกิจกรรมใช้ภาษาไทย					
ผู้เข้าร่วมกิจกรรมใช้ภาษาลาว					
ผู้เข้าร่วมกิจกรรมใช้ภาษาอังกฤษ					
ผู้เข้าร่วมโครงการกิจกรรมใช้ภาษาไทยและภาษาลาวสลับกันไปมา					
ผู้เข้าร่วมโครงการกิจกรรมใช้ภาษาไทยและภาษาอังกฤษสลับกันไปมา					
ผู้เข้าร่วมกิจกรรมใช้ภาษาไทย ภาษาอังกฤษและภาษาลาวสลับกันไป					

ส่วนที่ 4 การใช้ทรัพยากร

รายการ	มากที่สุด	มาก	ปานกลาง	น้อย	น้อยที่สุด
1. ไปสเตอร์ที่ใช้ในการดำเนินกิจกรรม					
2. โบว์ชัวร์ที่ใช้ในการดำเนินกิจกรรม					
3. สื่อที่ใช้ในการดำเนินกิจกรรม					
4. หนังสือคู่มือการดำเนินกิจกรรม					

ส่วนที่ 5 การประเมินความพึงพอใจของผู้เข้าร่วมกิจกรรม

รายการ	มากที่สุด	มาก	ปานกลาง	น้อย	น้อยที่สุด
1. วิทยากรที่ให้ความรู้					
2. กระบวนการและกิจกรรม					
3. เนื้อหา ความรู้จากกิจกรรม / ข้อมูล /					
4. สถานที่ในการจัดกิจกรรม					
5. ระยะเวลาของการจัดกิจกรรม					
6. ประโยชน์ของกิจกรรมความร่วมมือนี้					
7. กระบวนการติดต่อประสานงานการจัดกิจกรรม					
8. ความพึงพอใจโดยภาพรวมของกิจกรรมนี้					

ส่วนที่ 6 ข้อเสนอแนะอื่นๆ

Teaching with Picture Book by Electronic Whiteboard: Improving Students' Literacy and Learning Outcomes

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Abstract: Literacy skill is not only essential for both reading and writing, but also for the extended learning. As children enter the elementary school, one of the main educational purpose is to increase their literacy. Once their vocabulary is increased, children can do more readings and have their learning extended. Limited by the lower graders' literacy, picture books become their primary reading materials. With the ample and amusing pictures, students are able to increase their comprehension and vocabulary through reading picture books. We also wonder if the electronic whiteboard which combines with the picture book teaching would improve children's interests on reading and literacy. Based on the above purpose, the lower graders were chosen as participants in the elementary school. The picture book teaching with electronics whiteboard is applied in four classes. Next, the pre-post test is carried out determine increase in literacy of the students. Furthermore, to collect the related data and references, four teachers who participated in the teacher professional communities were interviewed to know how they operate and the teachers' professional development as well as the effects of electronic whiteboard on teaching and student learning. Finally, some suggestions were given for the school teachers.

Keywords: Electronics whiteboard, Picture book teaching, Teachers' professional development

INTRODUCTION

The Programme for International Student Assessment (PISA) carried out by OECD in 2001 shows that the better the reading ability you have, the more you are capable of collecting, comprehending and determining the information. For literacy is the basis of reading, the increasing knowledge can effectively promote people participation in modern society. The students in the elementary school beginning to learn to know words. Hence, the most important of all during elementary school is to effectively enhance the vocabulary of the students and develop the basis for reading.

Asides from textbooks, picture books are another material for reading. With interesting pictures, the picture books easily attract the children to read, which might be helpful to literacy. Among the mature digitalization and the development of technology, the content of the children's books is 2D to 3D conversion and reading become a process of motion. Multimedia makes the content of children's books rich. That is why e-books are more attractive than traditional books to children. Is it possible that the electronic picture books can quickly enhance the literacy of students in primary level ?

In many countries, it's quite common to apply the interactive whiteboard in class. Some developed countries, such as Britain, United States, Austria, Hong Kong, Singapore, and Japan, invest amounts of money to improve educational resources to enhance teaching and learning (Lewin, Somekh & Steadman, 2008). Some researchers found that the

interactive whiteboard is able to motivate students to learn (Harlow, Cowie, & Heazlewood, 2010; Torff & Tirota, 2009; Wood & Ashfield, 2008). In recent years, the interactive whiteboard is also common in Taiwan classrooms. How could it improve students' learning and reading performance?

A school in this study was used, to know the actual to the students through of the picture books taught with interactive whiteboard. Qualitative method was employed to collect the learning conversion of the students and the questionnaire was used to collect the literacy progress of the students.

MATERIALS AND METHODS

Interview and Classroom Observation

In this study, the formal observation of classes was 4 times (one time per class). The points of the observation lie on the teacher's teaching guide, teaching procedure, the reaction of students and concentration of students. After the observation, an interview with the teacher should be quickly scheduled and the content of the interview should focus on the situation of the teaching at the time of observation to discuss the circumstances of the observation.

The formal interview was semi-structured. Each teacher is interviewed for two times for about 30-60 minutes per interview. The informal interview was carried out without a fixed schedule. Moreover, the group interview was also adopted. The researcher evaluated the interaction of the members through the observation of the meeting. The group interview was carried out four times for 60-90 minutes per session.

Document Data

The document data includes the pre- and post- test and the learning questionnaire of the students electronic picture book. This study conducted the pre- and post test - data for five times. First, the teachers who participated in this study chose 30 words from the picture books. Next, the test was be conducted for each group and the leader of the group would put a tick on the correct sound. The test was designed by the teachers who created the electronic picture books. The teachers selected 30 words which were frequently used and not learned in the Mandarin textbook as the material of the test.

RESULTS AND DISCUSSION

The Foundation and the Teacher Team

The team which used information technology to enhance the literacy of the students originally was formed to out the program. The teachers made sure of the procedure and mode of the innovative teaching by a series of amendments which included teaching, rethinking, re-teaching and reviewing.

The electronic teaching material designed by the team and the videos of the teaching procedure were placed on the teaching platform to share with the teachers in the school. Thus, everyone can know the progress and achievement of the team on innovative teaching. Moreover, the team designed the interactive games of the picture books. Teachers asked questions from the picture books and placed them on the school. Then, the students read the picture books and did the learning activities by themselves. They liked the teaching activities designed by teachers.

T1: The students like to listen to the stories and...they also like to play games. The last part of the lesson is the game. And then...they look forward to play games and they will try it after class. (1000607)

Teaching words with a lot of pictures attracts the students and the word flashed on the electronic board can enhance the attention of the students. Students looked forward to the flashed pictures and words.

T2: Yes. Next are the words! I think that students like to see the pictures. (10006014)

T1 saw that students liked listening to stories. They also liked listening to the stories while they read the picture books, which is just like watching the movies. The dubbing is distinctive and interesting to the students.

The Enhancement of Students' Literacy Performance

During the research process, the researcher chose 5 words from the picture books to explore the learning achievement of the students.

Table 1 Pre-post test result on the literacy performance

Picture books' test	Book 1	Book 2	Book 3	Book 4	Book 5
Pre-test	92.46%	83.20%	90.87%	91.60%	91.12%
Post-test	98.12%	92.70%	97.13%	97.68%	96.84%
differences	5.66%	9.5%	6.08%	6.26%	5.72%

Students' literacy from each picture book was enhanced using the electronic board. The differences of the percentage are between 5.66%~9.5%. This shows that these courses can enhance the literacy of the students.

Analysis from the pre- and post- test of students' learning, for the students with the lower learning achievement, their differences is much higher and the literacy rate was up to 13%.

Table 2 Pre- and post- test results of students in language performance under PR33

The name of the books (test)	Book 1	Book 2	Book 3	Book 4	Book 5
Pre-test	86.43%	77.40%	87.20%	82.96%	83.41%
Post-test	94.13%	90.36%	94.60%	91.44%	91.00%
Differences	7.7%	12.96%	7.40%	8.48%	7.59%

The Learning Attitude of the Students Became Positive

Compared with the formal courses, the students experienced the differences of the teaching picture books with the electronic white board. The creative materials and teaching were highly accepted by the students. Most students think that picture books' teaching with interactive whiteboard differed from the general courses and they were not pressured in class. When the students knew that the picture books class was up, they were delighted.

T3: “Ok, now we are going to listening the picture books’ stories”, the teacher said. When the students know that they are having the story time in the picture books class, they will be joyful and say YA! (Interview, 10006014)

“The students are highly active in the picture book’s class, which could not happen in the other classes before”, the teacher, T3 said. Because of the fondness to this class, the students do not hope that the teacher manage the class affair and even urge the teacher to start teaching at once.

The students will privately come to tell that they like the picture books class, the T4 teacher, said. In addition to the pictures, the dubbing of the picture books also can excite their interest.

Narrow the Gap between the Students and the Books

This kind of courses can motivate the students’ reading interest and ability. With limited vocabulary, they were not willing to read books with lots of words before the picture books class. Now the students could read the paper books on their own initiative and learn new words.

T4: Yes. They are more.....willing to read the words. Before, the students might be not good at reading, so they dislike to read the words and only to see the pictures. Now, when these students experience a series of the picture books’ teaching, they gradually can see the words and then read those unknown words. This is helpful to their reading and the students will be more and more interested. (1000602)

After the class, the students actively found out the picture books in the bookcase in the corner of classroom or borrow books from the library to do more detailed reading. Due to the experiences of reading the electronic picture books, the students will read the same books together after class. With the improvement of the reading atmosphere in class, the students learn enjoy and share.

T4: Right. Sometimes they will share a book. When someone finds the fun and interesting books, everyone will read it together. Some high-achieved students will teach the students with lower-achieved. The learning effectiveness is also well. (1000602)

When the students sometimes found the picture books taught in the class elsewhere, they will be excited. The gap between the students and books are invisibly more and more closer.

T3: They sometimes tell that they found the same book in the library ... While they get the book, they will be excited and run to say that “this is the same book we learn in class”. I guess the students like reading. (10006014)

The Teachers Apply the Content of the Picture Books to Teach about Life Instead of Preaching.

After teaching with picture books, the teachers will apply the appropriate concepts in the picture books to lead the students. The students would be more willing to obey when the teachers adopt positive encouragement instead of name calling.

T2: On occasion the school promoted water conservation, but the students still let the tap run lots of water. Thus, I emphasized the importance of the conservation with the picture books they learned Book3 -”Mottainai Grandama”, and the students begin to self-reflect about the waste behavior in their daily life. (1000608)

T1: The students can play the interactive games after class. Besides making deeper impression of the words on the students, they can build the concept of obeying orders during the process of taking turns.

When the program was finished, the teacher still thought that the team should keep on working. Therefore, the senior teachers stayed in the team of the teachers' professional development with other new teachers. These teachers found that the courses of picture books also made much influence on teaching other subjects. For instance, employing information technology on teaching has a great effect to motivate the students and can be seen in other of course designs.

T3: We found that the students like to actively participate in some activities including expressing, games and acting. The interactive materials produced by the digital media are especially can catch the students' eyes. In the future, the digital media can be integrated into the teaching of the other subjects, which must enhance the students' motivation of learning. (10006014)

CONCLUSION

In this case school, the teacher team originally is founded for carrying out a creative teaching program. The combination of information technology and picture books in teaching to enhance students' literacy. After teaching of 5 picture books, the literacy of students was enhanced by over 6 %. The students with low achievement under PR33 made progress of 10%.

Furthermore, the research found that the attitude of the students became more positive when they have lots of fun in the picture books class. The teachers boosted the children's literacy and achievement without pressure and the students liked this way to learn words. This resonates Talley, Lancy & Lee (1997) that if preschoolers had ever read the electronic picture books at home, they would demonstrate more willingness to read and it's conducive to school education.

When the students learn more words, they are willing to read the books. Moreover, the students share the stories with their classmates. Some students with higher level of achievement are ready to teach the students in the lower level. Besides, the teachers could apply the content of the picture books to actual life education instead of preaching. As it further confirms the interpretation of findings in the literature whereby Lu & Chen(2008), and Lin(2010) who combined the interactive whiteboard with instruction is likely to be helpful to encourage students' learning motive and provide vivid content thereby enhancing children's reading willingness, improve the comprehension, and extend their imagination .

Since the research began with the teacher team led by the administrators, the teacher designed picture books curriculum and shared each teaching portfolio to help the students make much progress in literacy. A suggestion for schools is to encourage the teachers to set up a teacher professional development community for creative teaching and curriculum design cooperation.

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Comparative Study of Concept Mapping and Traditional Instructions on English Reading Comprehension Abilities of Vocational Certificate Students at Chiang Mai College of Agriculture and Technology

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Abstract: The objectives of this study were to: (1) compare the students' English reading comprehension abilities between using concept mapping and the traditional instruction, and (2) study the effects of concept mapping and traditional instruction in English reading comprehension abilities. The research questions were: (1) are there differences in students' English reading comprehension abilities between using concept mapping and the traditional instruction? (2) what is/are the effect(s) of concept mapping and traditional instruction on students' English reading comprehension abilities? The samples were 80 second year vocational certificate students at Chiang Mai College of Agriculture and Technology. The students were split into two groups, of 40 students each, by purposive random sampling. The first was the experimental group, taught using concept mapping instruction while the other, the controlled group, taught using the traditional instruction. The period of the study was six (6) weeks, with two (2) hours session per week. The instruments were pre-and post-tests, having parallel reading comprehension and questions covered were related to the agricultural field. The results showed that there were significant differences in students' English reading comprehension abilities using concept mapping and traditional instruction ($t=3.53$, $p=0.00<0.01$). The study also found out that the students' English reading comprehension abilities were significantly improved after learning through the concept mapping instruction.

Keywords: Concept mapping instruction, traditional instruction, English reading comprehension abilities, vocational certificate students.

INTRODUCTION

Reading is an important part of the four necessary language skills for acquiring knowledge and gathering information, academic success and professional development for those learning English as a second or foreign language (ESL/EFL) [1]. However, Thai students often have a low level of reading proficiency [2]. Additionally, Singtui (2008), cited in Siriphanich [3] states that the students who have low ability in reading comprehension cannot reorganize the information learned from the text and cannot connect their own knowledge to the new information received from the reading text. These studies reveal that Thai students have difficulties in reading English texts which in turn impede their reading achievements.

Similarly, at Chiang Mai College of Agriculture and Technology (Chiang Mai CAT), where the researcher works, reading comprehension is a particular problem for vocational certificate students. The students approach their reading assignment by putting all their effort and concentration into the passages they read. However, they cannot understand the meaning of certain texts; cannot identify the main idea, nor remember the content they have read in a previous section. In this regard, there is a need to use the supportive tools and strategies to improve students' reading ability which can enhance their reading comprehension.

Novak and Canas [4] claim that concept mapping has been chosen by educators as a strategy to empower students to be more effective readers and knowledge creators. Furthermore, concept mapping has been shown to support struggling readers by building off of students' prior knowledge and asking them to reflect on their understanding while reading [5]. In the English reading field, concept mapping is beneficial for students in terms of reading comprehension, recalling and organizing [6]. Hence, concept mapping is a graphical representation that can help enhance text comprehension and can lead to a more meaningful information retention. Furthermore concept mapping as a strategy can be used to improve students' ability in English reading comprehension. However, there is no research that used concept mapping instruction to enhance English reading comprehension abilities among vocational students in Thailand. Therefore, the researcher would like to use concept mapping framework to compare and evaluate students' English reading comprehension ability for vocational certificate students at Chiang Mai CAT.

Research Objectives

1. To compare the students' English reading comprehension abilities using concept mapping and traditional instruction.
2. To study the effects of concept mapping and traditional instruction in English reading comprehension abilities.

Research Questions

1. Are there differences in students' English reading comprehension abilities between using concept mapping and traditional instruction?
2. What is/are the effect(s) of concept mapping and traditional instruction on students' English reading comprehension abilities?

Research Hypotheses

1. There is a difference in students' English reading comprehension abilities using concept mapping and traditional instruction.
2. The students' mean score in the post-test using concept mapping instruction is higher than the post-test using traditional instruction.

Limitation of the Research

1. The goal of this study is to compare concept mapping and traditional instruction on English reading comprehension abilities.
2. The population of this study was limited to the second year vocational certificate students at Chiang Mai CAT. Therefore, this research cannot be generalized to other students with different educational levels or across disciplines.

MATERIALS AND METHODS

1. Population and Samples

1.1 Population: 160 second year vocational certificate students enrolled in the English for Agriculture and Technology course at Chiang Mai CAT in the second semester of academic year 2012.

1.2 Sample: 80 second year vocational certificate students enrolled in the English for Agriculture and Technology course during the second semester of academic year 2012.

2. Variables in this Study

2.1. Independent variables: Teaching methods based on concept mapping and traditional instruction.

2.2 Dependent variables: The students' English reading comprehension abilities using concept mapping and traditional instruction.

3. Research Instruments

3.1 The six agricultural English reading comprehension selection, covering the objectives of the course syllabus.

3.2 The two lesson plans: six concept mapping instruction and six traditional instruction lesson plans. Each one presented two (2) hours per week.

3.3 The Pre- and Post-tests, having three parallel reading comprehension and level of difficulty. It consisted of 20 multiple-choice questions, with four choices each.

4. Research Procedure

This research was a quasi-experimental research, with two groups of students: experimental and control groups. The experimental group was taught using the concept mapping instruction, while the control group was taught using the traditional instruction. The study was conducted two hours once a week for six weeks. The study took place during the second semester of the academic year 2012. The processes of the study were as follows:

1) Each group of students: the experimental and the control groups; consisted of forty students by Purposive Random Sampling [7].

2) The Pre-test was given to the samples at the beginning of the course to measure students' pre-instructional English reading comprehension ability level.

3) In each lesson, the experimental group was taught through concept mapping while the control group was taught through traditional instruction.

4) At the end of the study, both the experimental and control groups took the same Post-test to evaluate students' post- instructional English reading comprehension ability level.

5. Data Analysis

The data analysis was divided into two sections:

1) Analysis of research tools

To check whether; the reading comprehension tests were reliable and valid, it was tried out with 40 students not belonging to the samples. The difficulty, reliability and validity was checked the by using technique 27 % of the Statistical Program of the Item Analysis Table by Jung Teh Fan [8]. The level of difficulty and the P-value for pre-and post-tests were 0.50 and 0.51, respectively. The P-value (0.50 to 0.51) indicates that the tests had a moderate level of difficulty which was valid for testing [9]. For checking reliability, the Kuder-Richardson formula (KR-20) was used. The results of pre-and post-tests showed reliability of 0.7014 and 0.7048, respectively. The value range of 0.70-0.80 can be interpreted as good reliability [10].

2) Analysis of research questions.

Inferential statistics: analysis of independent Sample t-test was used to find the value of means and standard deviations and to compare the differences in the samples' English reading comprehension abilities of the two groups.

RESULTS AND DISCUSSION

Research Question One

Are there differences in students' English reading comprehension abilities using concept mapping and traditional instruction?

Table 1 Mean (\bar{X}) and standard deviation (SD) of Post-test scores for the experimental and control groups.

Groups	\bar{X}	SD	t	Sig.
Experimental (N=40)	15.18	1.81	3.53**	0.001
Controlled (N=40)	13.83	1.59		

** Significance at level 0.01

Table 1, shows the data obtained in the Post-test, the mean score for the experimental group is 15.18, while the mean scores of the control group is 13.83. The mean scores in the Post-test of the experimental group is higher than the control group. Moreover, the differences in students' English reading comprehension abilities using concept mapping and traditional instruction is statistically significant ($t=3.53, p=0.001<0.01$).

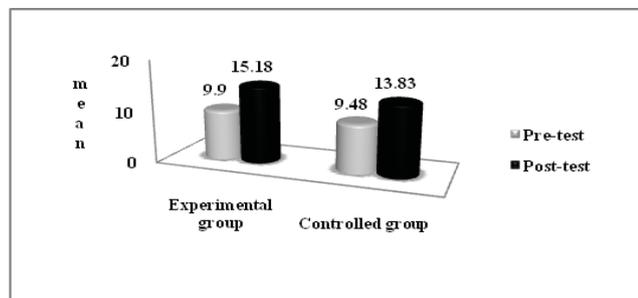


Figure 1 The students' Pre- and Post-tests mean scores.

Figure 1 space shows the mean score in the Pre-test for the experimental group ($\bar{x}=9.9$) is higher than the control group ($\bar{x}=9.48$). Moreover, the mean scores in the Post-test of the experimental group ($\bar{x}=15.18$) is also higher than that the control group ($\bar{x}=13.83$). Therefore, there are differences in students' English reading comprehension abilities between the two groups.

Research Question Two

What is/are the effect(s) of concept mapping and traditional instructions on students' English reading comprehension abilities?

Table 2 Pre and Post-test results of experimental group

Experimental Group (N=40)	\bar{X}	SD	t	Sig.
Pre-test	9.90	1.54	35.74**	0.00
Post-test	15.18	1.81		

** Significance at level 0.01

According to Table 2, the mean score in the Post-test for learning through concept mapping is higher than the mean scores of the Pre-test (\bar{X} =15.18 and 9.90, respectively). The two tests at level 0.01 level ($t=35.74$, $p=0.00<0.01$). This shows that the students' English reading comprehension ability improved after learning through concept mapping method.

Table 3 Pre and Post-test Results of controlled group

Control Group (N=40)	\bar{X}	SD	t	Sig.
Pre-test	9.48	1.26	24.51**	0.00
Post-test	13.83	1.59		

** Significance at level 0.01

According to Table 3, the mean score in the Post-test for learning through the traditional instruction is higher than the Pre-test (X =13.83 and 9.48, respectively). The two tests are significantly different at 0.01 level ($t=24.51$, $p=0.00<0.01$). This shows that the students' English reading comprehension ability improved also after learning through the traditional method.

CONCLUSION

Based on the findings, the mean score in the Post-test of the experimental taught by concept mapping was higher than the control group taught by the traditional method. The results also showed that there were statistically significant differences between the two groups. Moreover, teaching through concept mapping was more effective than that of the traditional method in improving students' English reading comprehension achievement. These findings support concept mapping as a training method to engage students in learning and recalling their own knowledge structure [11]. However, the traditional method of teaching may heighten cognitive demand, which leads attention away from the important aspects in learning [12]. Hence, learning through concept mapping can be an effective tool on teaching and learning, help in enhancing students' English reading comprehension ability and lead to a more meaningful learning.

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Language Learning Strategies of Industrial Education Students at King Mongkut's Institute of Technology Ladkrabang

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Abstract: The objectives of this study were to: (1) investigate the use of English language inlearning strategies in the Industrial Education of five different programs at King Mongku's Institute of Technology Ladkrabang, and (2) compare students' English language learning strategies among five different programs at King Mongkut's Institute of Technology Ladkrabang. The research questions were: (1) What are the particular English language learning strategies which the Industrial Education students use? (2) What are the differences or similarities in English language learning strategies among five different programs of the Industrial Education? The samples were 161 second year Industrial Education students enrolled in five different programs. The research instruments used in this study were Oxford's (1990) Strategy Inventory for Language Learning (SILL), and students achievement scores from Foundation English I and Foundation English II course which were the compulsory courses in their first year 2011. Results showed Middle English abilities students employed metacognitive strategies (mean 4.06) the highest, followed by compensation strategies, cognitive strategies, social strategies, affective strategies, and memory strategies. The Low English Abilities students reported that they most frequency used metacognitive strategies (mean 3.83) followed by, compensation strategies, cognitive strategies, social strategies, affective strategies, and memory strategies..

Keywords: Language learning strategies, English as a foreign language, Strategies inventory for language learning (SILL)

INTRODUCTION

Although many research studies had focused on teaching students to use a variety of English language learning strategies in order to comprehend, there had been limited studies about English language learning strategies used by Thai learners at the upper secondary level. Therefore, this study investigated English language learning strategies used by second year students of the King Mongkut's Institute of Technology Ladkrabang, Faculty of Industrial Education in three programs (Architectural Education, Engineering Education and Agricultural Education)

Additionally, when students were asked about how they use the knowledge from their English courses in their university study, some students said that they seldom used the knowledge gained from their English courses, and their English background was inadequate for their academic needs in the university. Other students indicated that they needed more practice in English provided by the school since they had problems with the English language.

Therefore, this study was carried out to investigate the English language learning strategies employed by second year Industrial Education students. These students had their

knowledge both from their high schools and from compulsory courses on their first year in the university level. From the information found, the second year students should be suitable for this study.

MATERIALS AND METHODS

Population and Samples

The population in this study was undergraduate students at King Mongkut’s Institute of Technology Ladkrabang. 181 2nd year Industrial Education students were the sample in this study. The respondents were enrolled in three programs: Architectural Education, Engineering Education and Agricultural Education.

Research Questions

1. What were the particular English language learning strategies which the Industrial Education students use?
2. What were the differences or similarities of English language learning strategies among student enrolled in the three programs of the Industrial Education?

Research instruments

The questionnaire was used to obtain personal information and to identify the respondents' English language learning strategies. The questionnaire was adapted from the SILL (the Strategies Inventory for Language Learning) version 7.0 (Oxford and Burry-Stock)[1].

Data Analysis and Statistical Procedures

The data were analyzed by a statistic package to find out the frequency, percentage, mean, and standard deviation. The average level of English language learning strategies were based on the framework of SILL as follows:

Level of Use	Interpretation	Scale
High	Always use	4.5 to 5.0
	Often use	3.5 to 4.4
Medium	Occasionally use	2.5 to 3.4
Low	Seldom use	1.5 to 2.4
	Never use	1.0 to 1.4

RESULTS AND DISCUSSION

Table 1 The Demographic Background of the students

Students’ Characteristics	N	Percent
Gender		
Male	58	32.04
Female	123	67.96
Total	181	100
Programs		
Architectural Education	92	50.83
Engineering Education	65	35.91
Agricultural Education	24	13.26
Total	181	100

As seen in Table 1, there were 181 students from the 3 programs: 92 architectural education students (50.83%), 65 engineering students (35.91%) and 24 agricultural students

(13.26%). The majority of the sample were female (N=123, 67.96%). There were only 58 male students (32.04%).

Research Question One

What are the particular English language learning strategies which the Industrial Education students use?

Table 2 Mean (\bar{X}), Standard Deviation (SD) of the Use of English Language Learning Strategies

Strategies	N	<i>Use of English Language Learning Strategies</i>			
		\bar{X}	SD	Level	Interpretation
1. Memory	181	2.08	0.06	Low	Seldom Use
2. Cognitive	181	2.87	0.05	Medium	Occasionally Use
3. Compensation	181	2.78	0.18	Medium	Occasionally Use
4. Metacognitive	181	3.86	0.12	High	Often Use
5. Affective	181	2.28	0.14	Low	Seldom Use
6. Social	181	2.46	0.08	Medium	Occasionally Use
Overall	181	2.72	0.05	Medium	Occasionally Use

As seen in Table 2, the overall level of the use of English language learning strategies was occasionally used on medium level ($\bar{X} = 2.72$). In details, metacognitive strategies often used at high level ($\bar{X} = 3.86$; SD = 0.12) while the students were occasionally used cognitive compensation, and social strategies at medium level ($\bar{X} = 2.87$; SD = 0.05, $\bar{X} = 2.78$, SD = 0.18, $\bar{X} = 2.46$; SD = 0.08, respectively).

To clearly illustrate the comparison of the use of English Language Learning Strategies between three programs, the graphs in Figure 1 shows mean of six strategies level as below:

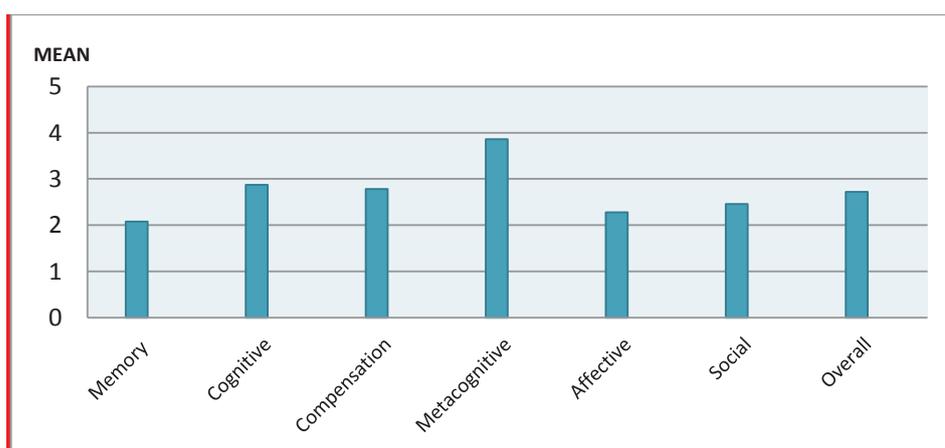


Figure 1 The Use of English language learning strategies

Figure 1 illustrates the difference of the six strategies. The overall level of students' use of English language learning strategies was medium with a mean of 2.72. metacognitive strategies were at high level with the mean of 3.86, while the medium level of students' use were cognitive, compensation, and social strategies with a mean of 2.87, 2.78 and 2.46,

respectively. While the lowest level of students' use was memory strategies with a mean of 2.08.

Discussion

In this study, metacognitive strategies were used in high level. Medium level use were compensation, cognitive and social strategies. memory and affective strategies were used by students at low level. Li Xuan[2] reported similarly findings. She indicated that there were high level use of metacognitive strategies. compensation and cognitive strategies have the same result as that of Li Xuan.

Research Question Two

What are the differences or similarities of English language learning strategies among three different programs of the Industrial Education?

Table 3 Mean (\bar{X}), Standard Deviation (SD) of students' use of English language learning strategies

Strategies	Architectural Education (N=92)				Engineering Education (N=65)				Agricultural Education (N=24)			
	\bar{X}	SD	Level	Interpretation	\bar{X}	SD	Level	Interpretation	\bar{X}	SD	Level	Interpretation
1. Memory	2.02	0.10	Low	Seldom Use	2.24	0.06	Low	Seldom Use	1.90	0.11	Low	Seldom Use
2. Cognitive	2.90	0.06	Medium	Occasionally Use	2.95	0.05	Medium	Occasionally Use	2.58	0.10	Medium	Occasionally Use
3. Compensation	3.53	0.09	High	Often Use	3.39	0.06	Medium	Occasionally Use	2.97	0.09	Medium	Occasionally Use
4. Metacognitive	4.00	0.15	High	Often Use	3.81	0.09	High	Often Use	3.43	0.14	Medium	Occasionally Use
5. Affective	2.33	0.19	Low	Seldom Use	2.31	0.11	Low	Seldom Use	2.00	0.21	Low	Seldom Use
6. Social	2.48	0.09	Medium	Occasionally Use	2.57	0.10	Medium	Occasionally Use	2.07	0.10	Low	Seldom Use
Overall	2.88	0.05	Medium	Occasionally Use	2.88	0.02	Medium	Occasionally Use	2.49	0.04	Medium	Occasionally Use

As seen in Table 3, in the overall level on the use of English language learning strategies among students enrolled in the three different programs were occasional use at medium level. In detail, for Architectural students, metacognitive and compensation strategies were often used at high level ($\bar{X}=4.00, \bar{X}=3.53$), while cognitive and social strategies were occasionally used as medium level ($\bar{X}=2.90, \bar{X}=2.48$). Only memory and affective strategies were seldom used at low level ($\bar{X}=2.02, \bar{X}=2.33$). Among engineering students, metacognitive strategies were often used at high level ($\bar{X}=3.81$), while cognitive, compensation and social strategies were occasionally used at medium level ($\bar{X}=2.58, \bar{X}=3.39, \bar{X}=2.57$, respectively). Only memory and affective strategies were seldom used at low level ($\bar{X}=2.24, \bar{X}=2.31$). For agricultural students, cognitive, compensation and metacognitive strategies were occasionally used at medium level ($\bar{X}=2.58, \bar{X}=2.97, \bar{X}=3.43$ respectively). Memory, affective and social strategies were seldom used at low level ($\bar{X}=1.90, \bar{X}=2.00, \bar{X}=2.07$).

Discussion

From the analysis of the responses among three programs, it can be stated that architectural education and engineering education students used metacognitive strategies at high level. This may be because architectural and engineering education students learned much more frequently such as arranging and planning their learning, centering their learning and guessing intelligently, while they may have to overcome limitation in speaking and writing (Oxford).[3] This study confirmed Qingquan Ni[4], she indicated that English major students most frequently used metacognitive strategies than non-English major students.

CONCLUSION

The study showed the students' use of English language learning strategies. Language learning strategies are “steps taken by the learner to facilitate the acquisition, storage, retrieval, or use of information” (Oxford and Crookall) [4]. They are important for learners because they involve students in taking charge of their own learning process (Hsiao and Oxford)[5]; they are essential to develop the communicative competence of language learners. Thus, this study which focused on language learning strategies should be important not only for EFL learners but for the teaching - learning activities.

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Perceptual Learning Styles of Vocational Education Student Sat Trat Technical College

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Abstract: The objectives of this study were to investigate the perceptual learning styles of vocational education students in six programs and compare them with different programs at Trat Technical College. The samples were 170 second-year students from six diploma programs: Building Construction Technology Mechanical Technology, Electrical Power Technology, Electronics Technology, Accounting, and Marketing, who enrolled in developing Skills for English Communication 2 during the first semester of 2012 academic year. The research instrument used in collecting the data was a five-point Likert scale adopted from Reid's Perceptual Learning Style Preference Survey. The quantitative data were analyzed using the descriptive statistics of arithmetic mean, standard deviation and inferential statistics of a one-way ANOVA. It was revealed that students from the six programs mostly preferred individual learning style while group learning style was chosen as the least learning style. One-way ANOVA analysis indicated that there was a significant difference between six programs.

Keywords: Learning styles, Perceptual learning Styles, Vocational education students

INTRODUCTION

One of the languages in the world is English. A large number of research studies, journals, and textbooks are published in English. Learning or speaking English for different purposes, like travel or business have been done by more people. In this regard, learning English is important in being able to take part in the contemporary global trend for people [1]. More than fifty countries have selected English as their official language and use it in various areas of government and business [2].

The Second Decade of Education Reform (2011-2018) has focused on educational improvement for career by enhancing 3% per year of English ability and foreign language with economic significance [3]. The second and foreign languages play essential role in learning for specific purposes like career, education or personal interest [4]. According to the Thai National Education Act, it can be summarized that the curriculum should be an organized learning process that should indicate and respond to the learner's needs [5]. Students' requirements in having perception and habituation of their learning styles may be expected. According to Pask [6], knowing students' learning styles is significant in learning. They should be made aware of their learning styles. It is the responsibility of teachers to guarantee this. Consequently, this kind of survey may be what teachers need to assess the learning styles of their students. The results should guide teachers to meet the students' learn when they teach.

There are some researches in Thailand focused on learning styles. Nimmanpisood [7] adapted the PLSPQ to study the learning styles in English language subject of vocational certificate students. Buranarek [8] developed Anthony Grasha and Sherly Reichman's questionnaire to study and compare learning styles of vocational certificate students. Simsek [9] used the PLSPQ to explore the language learning styles of Thai secondary school students of

English as a foreign language. Boonsuk [10] applied the PLSPQ to investigate, evaluate and identify the language learning styles of EFL Pondok schools students in Mattayom Suksa 5. Banbang [4] employed the PLSPQ to investigate and compare the learning styles of undergraduate students in engineering and applied science.

Moreover, there is a must to investigate the learning style differences between students from different academic programs because research in this area is deficient. A relentless education is the understanding and application of an individual's unique learning styles. For the reason that persons are distinctive in their characters, it is accepted and determined by the number of researches [11, 12, 13, 14, 15]. Felder [16] claims that the students who feel uncomfortable about their learning in classrooms may ascribe their failures to false discretions leading to give up learning in a particular class. However, there are researches only in vocational certificate and tertiary students, but no research emphasized on vocational diploma students' perceptual learning styles in Thailand. Thus, this study intends to investigate and compare the perceptual learning styles of diploma students in six programs at Trat Technical College.

Objectives of the Study

1. To investigate the perceptual learning styles of the vocational education students in six programs at Trat Technical College.
2. To compare the perceptual learning styles of vocational education students from different programs at Trat Technical College.

Research Questions

1. What are the perceptual learning styles of vocational education students in six programs at Trat Technical College?
2. Are there differences between the perceptual learning styles of vocational education students from different programs?

MATERIALS AND METHODS

Population and Samples

The population was 477 diploma students who were learning English as a foreign language at Trat Technical College, Thailand. This study was focused on investigating the perceptual learning styles of 170 second year diploma students who enrolled in *Developing Skills for English Communication 2* in the first semester of academic year 2012 from the six programs; Building Construction Technology, Mechanical Technology, Electrical Power Technology, Electronics Technology, Accounting, and Marketing at Trat Technical College.

Instrument

The researcher surveyed and collected data by using questionnaires. The survey for this study consisted a two-part questionnaire. The first part of the survey gathered students' individual demographic background while the second part consists the Perceptual Learning Styles Preference Questionnaire (PLSPQ) [17] to determine the students' learning styles.

To measure six learning styles; visual, auditory, kinesthetic, tactile, group learning and individual learning, the questionnaire consists 30 close-ended questions with five-point Likert scale ranging from 1 to 5. According to Reid's classification, three levels for learning styles preferences were as follows:

Level of Interpretation	Score
Major learning style preference	38 to 50
Minor learning style preference	25 to 37
Negligible learning style preference	0 to 24

The meaning of learning styles preferences' average value were as follows:

Rank	Frequency	Average
1	The highest	4.50 to 5.00
2	High	3.50 to 4.49
3	Medium	2.50 to 3.49
4	Low	1.50 to 2.49
5	The lowest	1.00 to 1.49

Data Analysis and Statistical Procedures

1. Analysis of Research tools

In finding validity and reliability of the research tools, a pilot questionnaire was tried out with 65 diploma students in three programs; Production Technology, Business Computer, and Information Technology who did not belong to the samples. The reliability of PLSPQ as assessed by Cronbach Alpha was 0.898.

2. Analysis of research questions

Descriptive statistics was used to analyze all data to answer the research questions. Statistical procedures, arithmetic mean, and standard deviation were used to answer research question one. The data from the PLSPQ were analyzed through a computer program. One-Way ANOVA was used to determine the significant differences at $p < 0.05$ level in answering research question two.

RESULTS AND DISCUSSION

Students' Demographic Background

Table 1 shows the summary of the demographic background of samples by sex and programs.

The 170 second year diploma students in six programs enrolled in *Developing Skills for English Communication 2* during the first semester of academic year 2012 at Trat Technical College were 93 male students (54.7%) and 77 female students (45.3%).

This study showed that the majority of the samples were Accounting students (N =59, 34.7%), followed by Mechanical Technology and Electronics Technology students (N =25, 14.7%), Building Construction Technology students (N = 24, 14.1%), Electrical Power Technology students (N = 23, 13.5%), and Marketing students (N = 14, 8.2%).

Table 1 Summary for Demographic Background of Samples by Genders and Programs

Sample Characteristics	N	Percent (%)
Sex		
Male	93	54.70
Female	77	45.30
Total	170	100.00
Program		
Building Construction Technology	24	14.10
Mechanical Technology	25	14.70
Electrical Power Technology	23	13.50
Electronics Technology	25	14.70
Accounting	59	34.70
Marketing	14	8.20
Total	170	100.00

Analysis of Research Question One

Research Question One: *What are the perceptual learning styles of vocational education students in six programs at Trat Technical College?*

To answer the research question one and to investigate the perceptual learning styles of vocational students in six programs, the data are shown in Table 2 below:

As seen in Table 2, the majority of students' perceptual learning styles were group (40.57), kinesthetic (38.78), auditory styles (38.3), while visual (34.77), tactile (36.29) and individual styles (28.68) were considered minor learning styles.

To illustrate the comparison of students' perceptual styles, Figure 1 shows the overall of mean in students' perceptual learning styles.

Table 2 Mean and Level of Perceptual Learning Styles

Programs	Perceptual Learning Styles					
	Visual	Auditory	Kinesthetic	Tactile	Group	Individual
	Mean	Mean	Mean	Mean	Mean	Mean
Building Construction Technology	34.75	37.92	40.5	36.92	41.17	27.17
Mechanical Technology	42.08	43.92	42.32	41.36	44.56	38.96
Electrical Power Technology	31.39	36.17	36.87	33.65	39.65	24.35
Electronics Technology	34.16	37.12	37.44	35.04	39.6	26.72
Accounting	36.37	40.14	40.1	37.36	42.85	29.76
Marketing	29.86	34.57	35.43	33.43	35.57	25.14
Overall	34.77	38.31	38.78	36.29	40.57	28.68
Level of Learning	Minor	Major	Major	Minor	Major	Minor

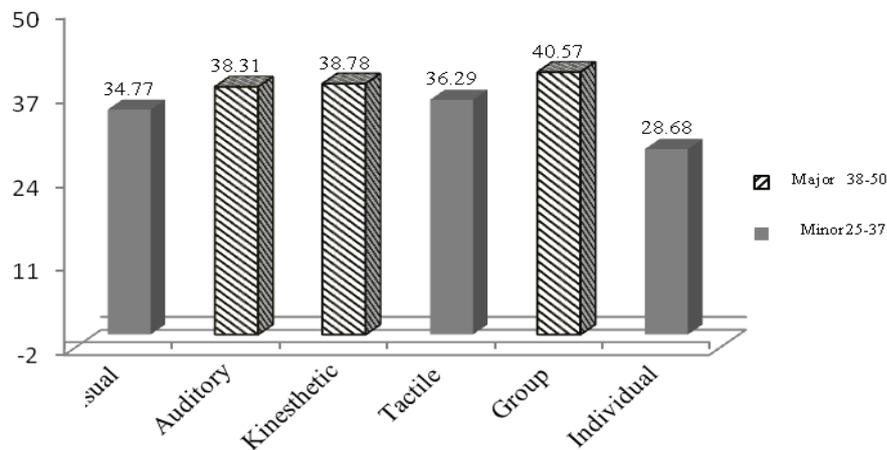


Figure 1 Overall of Mean in Students’ Perceptual Learning Styles

As seen in Figure 1, the overall mean of students’ perceptual learning styles are shown in two levels: major and minor levels. Group (40.57), kinesthetic (38.78), and auditory styles (38.3) are in the major level, while visual (34.77), tactile (36.29) and individual styles (28.68) are in the minor level.

To investigate students’ perceptual learning styles in the six programs, the result showed the two levels of perceptual learning styles: major and minor levels. The major level included group, kinesthetic and auditory styles, while the minor level included visual, tactile and individual styles. This study confirmed Boonsuk [10] and Nimmanpisut [7], studies found that group style was in major level. While Banban [4] and Simsek [9], studies indicated that kinesthetic style was in the major level. Although such a vocational curricular and teaching technique in English language classroom, teacher can conduct activities for the group and kinesthetic learners e.g. role play and group discussion [16].

Analysis of Research Question Two

Research Question Two: *Are there any differences between the perceptual learning styles of vocational education students from different programs?*

To answer this research question and to investigate whether the six learning styles were influenced by programs of study, an ANOVA analysis was performed to analyze the data as in Table 3 below:

Table 3 The Comparison of Students' Perceptual Learning Styles in Six Programs

Learning Styles of Student	F	P-Value
Building Construction Technology	1.931	.019
Mechanical Technology	1.533	.113
Electrical Power Technology	2.871	.001*
Electronics Technology	2.496	.002*
Accounting	2.462	.001*
Marketing	2.284	.011

Significant Level at 0.05 ($p \leq 0.05$)

As seen in Table 3, significant differences were found according to learning Styles ($p \leq 0.05$) in three programs: Electrical Power Technology ($p=0.001$), Electronics Technology ($p=0.002$), and Accounting ($p=0.001$). There was no significant difference of students' learning styles in Building Construction Technology ($p=0.019$), Mechanical Technology ($p=0.113$), and Marketing ($p=0.011$).

To compare the mean and standard deviation of each group to the 6 six learning styles, significant differences were found in Electrical Power Technology, Electronics Technology, and accounting students. Table 4 shows the comparison of students' learning styles in each program.

Table 4 Mean (\bar{X}), Standard Derivation (SD) and Rank of Each Learning Styles in each program

Learning Styles	EP(N=23)			EL(N=25)			AC(N=59)		
	\bar{X}	SD	Rank	\bar{X}	SD	Rank	\bar{X}	SD	Rank
Visual	3.14	0.43	2	3.42	0.52	3	3.64	0.64	2
Auditory	3.61	0.43	2	3.71	0.52	2	4.01	0.51	2
Kinesthetic	3.74	0.49	2	3.74	0.49	2	4.01	0.66	2
Tactile	3.37	0.45	3	3.50	0.60	2	3.73	0.65	2
Group	3.96	0.46	2	3.96	0.46	2	4.28	0.53	2
Individual	2.43	0.81	4	2.67	0.83	3	2.98	1.02	3

Note: EP = Electrical Power Technology, EL = Electronics Technology, and AC = Accounting

As seen in Table 4, all programs of students mostly ranked individual style as their least learning style preference, while visual, auditory, kinesthetic, tactile, and group styles were ranked above the Individual style. The result showed the rank order in Electrical Power Technology, Electronics Technology, and Accounting mostly ranking their learning style preference in Rank 2.

The result showed that students' chose individual style as the least preferred perceptual learning style while the other perceptual learning styles were higher. This study confirmed Simsek's [9] and Boonsuk's [10] findings, they indicated that individual style was the lowest rank in students' perceptual learning styles. In terms of student level, this study investigated the diploma level, the result showed the near paralleled finding with secondary level students indicating that individual style is lowest learning style preference.

CONCLUSION

The results revealed that students in six programs preferred group, kinesthetic and auditory learning styles as their major learning styles, while visual, tactile and individual learning styles were employed as their minor learning styles. The results indicated that significant differences were found according to learning styles in three programs: Electrical Power Technology, Electronics Technology, and Accounting. There was no significant difference of students' learning styles in Building Construction Technology, Mechanical Technology, and Marketing.

This study showed the meaningfulness of perceptual learning styles. Teachers can select the teaching style and materials in their English language classroom i.e. group discussion, role play [18] or games and pictures [5]. The students' perceptual learning styles can be the implications for curriculum design e.g. student-centered learning approach in the vocational diploma curriculum [3]. Thus, the classroom of language teaching and learning can be more effective .

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Well-being Indicator of the Fishery Industry by Foreign Labor in Samutsakhon Province

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Abstract: The purpose of this study was to develop an indicator for well-being of foreign workers in the fishery industry in Samutsakhon province. Four hundred Myanmar workers were recruited in the study and questionnaire was used to obtain data. Working and living conditions were determined by human achievement index before reviewing the standard for well-being amongst foreign workers. It was suggested that health status of foreign workers in Samutsakhon province were at a moderate level and the factors that effect on the health conditions of these workers were the better quality of life and working conditions.

Keywords: Well-being, Foreign Labor, Fishery industry

INTRODUCTION

The fishing industry is a lucrative, economic sector in Thailand, generating jobs and incomes to the Thailand. However, the industry is different from others in terms of employment condition and working environment compared to other professions, notoriously known as a difficult, dirty, and dangerous with low payment. That is why it is found unattractive among the Thai labor. As a result, there has been a lack of labor in the industry. Employers and business operators, who are in need of low-skilled domestic labor, required immigrant workers to continue their business operations [5]. Immigrant workers in Thailand are classified as those who legally and illegally work. Although they have been protected by law, like their Thai counterparts, in practice, They do not received those benefits in working condition, wage, living condition and health services. These elements are critical to the well-being of immigrant workers. Meanwhile, Thailand is aware of the importance of immigrant workers in society and needs to provide social security and a good living condition to them. However, any policies with regard to such issues have not yet been implemented practically and regularly. As a result, the country was fails to accomplish the goals, putting the workers at risk of their rights being violated under unjust treatment. Without serious attention, it might end up in a permanent stage of lacking immigrant workers in the future. This study began as a review of practices by government sectors and other related organizations, leading to a formation of policy and regulation in managing health well-being standard of immigrant workers in the fishing industry in Thailand.

MATERIALS AND METHODS

Data collection and the measurement of health well-being on working condition with living condition in the household including other general being, were obtained by observations and interviews. The sample group was selected who has Myanmar nationality (Burmese) working in the fishing industry in Samut Sakhon province with a total number of 400 individuals from May 2011 – June 2012 using questionnaires designed by the author based on Human Progress Index. Each of the questionnaires has 5 parts with 75 questions and

the 5 rating scale including Highest, High, Moderate, Low and Lowest. The results were based on verbal interactions with volunteers from Labour Right Promotion Network Foundation (LPN) and the author working on field trips before analyzing the obtained data for further conclusion

We used descriptive statistics to describe results of this study including frequency distribution, mean and standard deviation and quantitative analysis in testing difference by using the t-test statistics and examined the relationship of general elements and also health elements, using the One Way Anova statistical test.

RESULTS

The sample group was collected from has Myanmar nationality who working in the fishing industry in Samutsakhon province, Thailand. with a total number of 400 individuals. Most of them are feminine, an average age is between 15 – 30 years old, studied in a primary level, employed in fishing industries especially freezing and single status.

1. Health level involving conditions in the household living has the mean of 2.84, classified as a medium level, depending on 7 dimensions including health, education, working environment, income, housing and the environment, living condition in the household and community, transportation and communication (Table 1).

Table 1 Health level involving conditions in the household living.

Elements	Indicators	Mean	SD	Level
1. Health	1. Baby with weight under standard (percentage)	1.58	1.36	Lowest
	2. Ailing population (percentage)	1.82	1.26	Low
	3. Disabled population and/or having chronic disease (percentage)	1.86	1.39	Low
	4. Having 3 full meals a day	3.53	1.54	High
	5. Getting enough sleep (8 hours or more)	3.89	1.52	High
	6. Drinking/smoking or using other drugs	1.65	0.86	Lowest
2. Education	1. Having children in education	1.96	1.68	Low
3. Working life	1. Unemployment rate in family	3.19	1.49	Moderate
	2. Employing child labor aged 15-17	2.83	1.02	Moderate
4. Income	1. Enough income for household expense	2.86	1.11	Lowest
	2. Debt	3.02	1.52	Moderate
	3. Sending money home	4.82	0.83	Highest
5. Household and environment	1. Owning a house	1.00	0.00	Lowest
	2. Having a recreational place at home	1.81	1.40	Low
6. Household and social living condition	1. Having a TV/ refrigerator/ electric fan	3.81	1.07	High
	2. Using cooking gas	3.57	1.61	High
	3. Having a restroom/ bathroom	3.88	1.14	High
	4. Having a quarrel and fight in family	1.70	1.02	Lowest
	5. Having family members to care for in Thailand and the country of origin	4.48	0.86	Highest
	6. Feeling satisfied with the current living condition	1.47	0.64	Lowest
7. Transportation and communication	1. Owning a cell phone	4.89	0.36	Highest
Total		2.84	0.41	Moderate

2. Levels of health well-being in relation to working condition with the mean of 2.64 classified as being in a moderate level, depending on 4 element; namely, health, working condition, housing and environment, and transportation and communication (Table 2).

Table 2 Levels of health well-being in relation to working condition.

Elements	Indicators	Mean	SD	Level
1.Health	1.Having an annual medical check-up	4.16	1.58	High
	2.Having first aid kits in case of accident	4.41	1.16	Highest
	3.Having has an accident at work within the past 3 months	1.83	1.34	Low
	4.Having an individual safety protection gear	1.66	1.46	Lowest
	5.Getting healthcare benefits in case of accident	4.28	1.47	Highest
2.Working condition	1.Transporting/ selecting/ rinsing sea animals with water	3.20	1.91	Moderate
	2.Cleaning the pier and sea animal container	1.89	1.58	Low
	3.Working underwater	1.26	0.98	Lowest
	4.Drinking/ smoking during work	1.68	1.13	Lowest
	5.Working 24 hours a day	1.40	1.07	Lowest
	6.Employing child labor	1.69	1.18	Lowest
	7.Using machinery at work	3.39	1.41	Moderate
	8.Working in extreme coldness/ heat that might be dangerous	3.34	1.56	Moderate
	9.Having a work manual	4.00	1.69	High
	10.Having a free time during work	3.16	1.38	Moderate
	11.Having work is considered risky	2.69	1.71	Moderate
	12.Personal safety gear is prepared by employer	1.35	0.79	Lowest
	13.Having enough personal safety gear			
	14.You are satisfied with your current working condition	1.23	0.52	Lowest
	1.50	2.64	Lowest	
3.Transportation and communication	1.Being suggested by supervisor before work	4.46	0.92	Highest
	2.Having a safety manual during work	4.12	1.57	High
4.Household and environment	1.Being on board less than 1 month	1.42	1.22	Lowest
Total		2.64	0.23	Moderate

3. Levels of health well-being in relation to general living condition with the mean of 2.69 in a moderate levels including 4 dimensions; namely, housing and environment, household and community living, participation and transportation and communication (Table 3).

Table 3 Levels of health well-being in relation to general living condition

Elements	Indicators	Mean	SD	Level
1.Housing and environment	1.Suffering from drought or flood	1.00	0.00	Lowest
	2.Having a drainage system	3.51	1.83	High
	3.Having an incinerator in community	3.73	1.79	High
	4.Being affected by pollution	4.65	0.73	Highest
2.Household and social living condition	1.Having an elderly living alone	2.71	1.61	Moderate
	2.Having an orphan forsaken or affected by AIDS	2.02	1.44	Low
	3.Having the family leader involved in divorce, widow or separation in family	3.36	1.49	Moderate
	4.Serious crime and terror	1.75	1.45	Lowest
	5.Drug trafficking charge	2.03	1.60	Low
	6.Road accident	3.59	1.32	High
	7.Satisfaction on general living condition	1.42	0.62	Lowest
3.Participation	1.Having merit-making activities, listening to sermons and participating in meditation	4.65	0.63	Highest
	2.Joining foreign cultural events and traditional arts	3.79	0.97	High
	3.Having an election and other political activities	1.08	0.56	Lowest
	4.Administrative Organization Having a family member of Provincial	1.22	0.80	Lowest
4.Transportation and communication	1.Internet access	2.64	1.63	Moderate
Total		2.69	0.37	Moderate

CONCLUSION AND DISCUSSION

Well-Being Index was applied with immigrant workers in the fishing industry in Samut Sakhon province. It was found that the female sample group was more than the male, aged between 15-30 years old, having Burmese nationality. They majority of them had a primary education, working as employees in factories and the rest worked as employees including businesses at the pier, fish markets and the jetty, workers in seafood processing factories, and crew in fishing boats/ seafood transportation vessels. With regard to the working condition of employees in industrial factories, it was found that the majority of the sample group work in the cold storage industry and the rest worked the fish ball industry, can industry, the fermented food industry and the salted food industry. On working conditions of employees in the pier business, fish market and the jitty, it was found that the sample group worked in transporting sea creatures. The rest of them were worked in the selection of sea creatures and the cleaning of containers. The majority of them were single while the rest were married, widowed, separated and divorced. They had an opinion on their living condition in the household in a moderate level with the mean of 2.84.

The sample group had an opinion on their working condition in a moderate level with the mean of 2.64. They also had an opinion on general living condition in a moderate level with the mean of 2.69. In terms of other suggestions and opinions, it could be concluded that the general health of the sample group was good. Their work was involved with risky condition.

However, their employers had prepared personal protective equipment (PPE). The amount of the PPE was enough for them. The employees were also provided other benefits. They demanded equal rights in social welfare to their Thai counterparts including the exemption of paying a commission and the right to have a medical treatment in every hospital countrywide.

According to the results of this study, general living condition in the household of immigrant workers in the fishing industry was in a moderate levels including 7 dimensions; namely health, education, working condition, income, housing and environment, household and community life, transportation and communication. This was correlated with a research by Pimpan et al [1]. stating that health risk behavior, environmental sanitation in housing, working condition and environment were correlated to health well-being of immigrant workers in Samut Sakhon province. This is also correlated to AYE [6]. stating that the quality of life of Burmese immigrant workers in food processing factories in Samut Chedi district of Samut Prakarn province was in a moderate level depending on 5 elements, physical and mental health, their relationship with society, environment and general health.

In general, the working condition of immigrant workers in the fishing industry in Samut Sakhon province was in a moderate level meaning that even though their work is hard and risky, before work, the supervisor usually advises them about possible dangers. At time of accident, the workers are provided first aid kits. Annual medical check-up is also provided to them. When working with machinery, the workers have received a working manual for individual safety. Their work was involved extreme heat and coldness which might be dangerous and the transportation of sea creatures. The employees had free time during work. There were a few cases of child labor. They were also allowed to drink/ smoke sometimes. This is correlated to a research by Theerawat [2]. stating that there should be no discrimination against immigrant workers. The current labor law should be improved in relation to current trends and suggestions by International Labor Organization; such as a prohibition not to hire children aged under 18 years to work in a fishing boat because the work is very hard and dangerous. Employees deserve the right to have free medical check-up before going on board to the sea. Employers have a responsibility to organize training programs on working in sea ship for their workers. Safe, healthy food with enough nutrients for employees, including free medical treatment and safety gear for individuals working with machinery, was also provided.

Living conditions of immigrant workers in the fishing industry in Samut Sakhon, in general, was in a medium level, evidently shown in how they could accept their living condition and the environment in community. Moreover, they were provided a chance to have political and social participation. This is correlated to a research by MIKA [4]. stating that immigrant workers in Thailand's province of Samut Sakhon in the seafood processing industry were satisfied with their living quality, both mentally and physically. This is also correlated with a research by Nonthapat [3]. stating that the Thai society should change its attitude toward

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Community Based Ecotourism Management for Strengthening Community by using the Participatory Action Process

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Abstract: This research aims to study the Huay Mai villagers' participation in community-based eco-tourism management. This qualitative research was conducted by using the participatory action research process (PAR), as a tool in creating the learning process of Huay Mai community. The community stakeholders participated in thinking, doing, solving, and developing Huay Mai's eco-tourism management process that was appropriate for the community's context to lead to an improvement in the quality of life. The research results revealed that problems and obstacles in eco-tourism management of Huay Mai community included lack of information announcement within the community. Many of the villagers and youths are not aware of the knowledge potential in Huay Mai community, and many lack tour guide skills. Judging from these problems, the community leaders' potential must be developed for them to be effective local guides. There were three activities: (1) Participatory eco-tourism management training based on the best practice at Bann Mae Kam Pong Homestay, (2) history and knowledge training of Huay Mai community, and (3) tour guide skills training to supporting the community's tourism potential. These three potential development activities showed good results. It was observed that the tour guide volunteers gained confidence in speaking, as well as performing tour guide duty correctly and appropriately. Moreover, the community stakeholders had set the approach and pattern for eco-tourism management by using Huay Mai villagers participation as followed: (1) established the Huay Mai tourism club (2) determined the tourism club's management structure and persons in charge of the duty, based on election from the club's members (3) planned tour programs responding to the potential and appropriateness of the area (4) imposed rules and regulations on members and tourists practice, and (5) determined criteria and principles for distributing the profits obtained from tourism activities management among the members.

Keywords: Eco-tourism management, Participatory action research, Life improvement

INTRODUCTION

During the past decades, tourism has become one of the world's most profitable industries but, in the same time, one of the most destructive human activities in terms of environmental ruining. Negative impacts such as environmental pollution and enormous waste management problems, the violation of human rights, modification of culture, etc., have affected many local peoples in communities around the world (Zhuang, 2010). These problems led to paradigm shift from mass tourism as community based ecotourism which is referred to a variety of terms such as "green tourism" (Cater, 2001), "nature tourism" (Arnegger, Woltering, and Hubert, 2010) or "ecotourism" (Reimer and Walter, 2013). Thus, community based ecotourism (CBET), becomes one choice which is interesting to realize in the next decade for sustainable development by community participation.

The Huay Mai community is located in Song district, Phrae province Thailand. The used study CBET approach to be strengthened by using the participatory action research process. The keys of research success were (1) the development of Huay Mai's ecotourism management that is appropriate for the community context and led to improve the environmental protection consciousness of local people, (2) preserving the local cultures and actively contributing to the economic and social well-being of local communities, as well as (3) conserving the natural environment by community participation. It was community-based ecotourism management which empower the local communities, make them self-reliant and raise their collective self-esteem about Huay Mai's local wisdom and culture. Huay Mai's ecotourism management was designed by using a group process for local decision-making, working together with Huay Mai 's CBET stakeholders, and solving community problems together (Wang, 2013).

Additionally, in the CBET 's situation analysis of Huay Mai community, it was found that the strength of Huay Mai community were the wealth of natural resources and biodiversities in Doi Luang Wildlife Reserve and the unique Huay Mai lifestyle. There were various storytelling, history, local tradition and local wisdom (Siriporn Phuntulee, 2009). Besides, the related stakeholders both of government organizations and NGOs participated in thinking, analyzing, synthesizing for developing Huay Mai's CBET management. On the other hand, the weak points revealed that Huay Mai community lacked the knowledge, understanding about the concept of ecotourism management and tour guide skills to present and to attract tourists. That is why the researchers realized the importance of community based ecotourism management to develop the potential of local guides in Huay Mai community for strengthening the community's self-reliance towards sustainable development concept.

MATERIALS AND METHODS

This research is a qualitative research using participatory action process as a tool to create learning process in Huay Mai ecotourism management. The sample population were about 100 people from key informants in 17 villages of the Huay Mai community, consisting of community leaders, children and teenager groups, occupational group network, village folk philosophers and villagers who were interested in Huay Mai ecotourism management. Data were collected through in-depth interviews, participatory observation, learning exchange with focus group discussion and summarizing the learned lessons. People in Huay Mai community participated in the thinking, doing, solving, developing and evaluating processes with the researchers. In terms of data analysis, content analysis was used by collecting information in each activity, reorganizing, classifying a category towards objectives and activities, analyzing in parallel contexts and arranging the learning exchange stage for summarizing in each stage of the research. These processes were conducted by the community and the research team's participation to analyze, define and evaluate the indicators.

RESULTS AND DISCUSSION

This research reflected on the problems in Huay Mai 's ecotourism management which were lacking of knowledge and understanding about the participative ecotourism management of local guide and tour guide skills to present and to attract tourists. Hence, Huay Mai people and the related stakeholders in Huay Mai community participated in thinking, doing, developing and brainstorming to solve these problems and develop their potential to be excellent local guide. These processes made Huay Mai people see their identity, be aware of the problems and realize the potential of their own community.

Moreover, the learning processes in every step led to set the patterns of Huay Mai 's CBET management to be strengthened and self-reliant towards sustainable tourism concept with community participation.

Three Activities for Developing the Potential in Huay Mai 's CBET Management

There were three activities which led to the development of the potential of Huay Mai community leaders to be excellent local tour guides in Huay Mai 's CBET management. There were as follow;

Field Trip Training from the Best Practice at Bann Mae Kam Pong Homestay

This activity aimed to study how to successfully manage ecotourism in their own community, from the Bann Mae Kam Pong community which acquired the best practices on CBET management in northern Thailand. The learning lesson led to create crash course learning on CBET management which could appropriately be adapted and apply in the Huay Mai community context by using community participation. The mutual benefit determination for membership in Huay Mai 's ecotourism club could increase income in Huay Mai community, as well.

Training on History and Knowledge of Huay Mai Community

This activity emphasized the study about the social, cultural, ecological and intellect capitals of the Huay Mai community through lecture presentation and storytelling from local philosophers. The training on history and knowledge of Huay Mai community consist of background, history, local wisdom, culture and tradition. This process desired to train local guides in Huay Mai community in order to communicate and accurately transmit the information in the same manner to tourists. This training created the consciousness of preservation in the local cultures and wisdom of the Huay Mai community. Furthermore, it made the local people become aware of the environmental protection consciousness, and conserve the local history through Huay Mai community participation.

Workshop Training on Tour Guide Skill for Supporting Community Tourism

There were two curricula to improve the knowledge and the practice of excellent local tour guides in Huay Mail community. The first one was the public communication topic and the second one was the service psychology topic which trained the community number lecture and practice the role playing. The result of the training made the local guides, the Huay mai leaders, learnt more knowledge on public communication technique. This made Huay mai leaders able to persuade the tourists with service mind and behaved correctly as a good local guide with self-confidence.

The Main Mechanisms of CBET Management in Huay Mai Community

There are three main mechanisms of participatory management in Huay Mai 's ecotourism management, i.e.

The Civil Society Mechanism

Huay Mai people from seventeen villages participated in searching for the problems of CBET in Huay Mai community about the strength, the weakness, the threat and the opportunity of Huay Mai 's CBET. And then, they participated in planning to solve the problems together and continuously developing their potential in every activities to good local guides and being a great host as well. Moreover, they set up community rules for ecology conservation and local cultural heritage prevention in Huay Mai community for the next generation.

The Academic Mechanism

There were various external organizations such as Maejo University, Phrae Campus, Takorniyom, by an NGO, etc. Who provided academic support for learning activities, trainings and workshops to educate Huay Mai people in developing knowledge and skill about ecotourism management concept and service as a good tour guide.

The Government Mechanism

It was important to gain the information about community plans from the brainstorming stage of the people in Huay Mai community as the master plan for applying and taking action in on what exactly the community needs.

The Pattern of CBET Management by Community Participation

After the potential development with three training programs, Huay Mai people, local guides and Huay Mai community stakeholders set the approach and patterns for ecotourism management by using Huay Mai villagers participation as follows: (1) established the Huay Mai ecotourism club as the agency coordination center (2) determined the tourism club's management structure and persons in charge who were elected from the club's members (3) planned tour programs responding to the potential of the area. (4) imposed rules and regulations on members and tourism practice, and (5) determined the criteria and principles for distributing the profits obtained from tourism activities among the members. The pattern of ecotourism management in Huay Mai community consisted the Bann Non Klang community, Hmong Community and Ban Num Kha community (Somnuk, 2009; Boonthum, 2003), respectively.

Lastly, Huay Mai 's CBET management was the one approach or concept that emphasized the unique activities in a community leading to more "worthy" creation in "values" system of Huay Mai community (consistent with Thaveephon, 2007). Moreover, Huay Mai 's CBET management entirely realized the social capitals preservation consciousness in Huay Mai community.

CONCLUSION

The CBET was a major contributor to socio-economic development and it could be used as a tool to reduce poverty not only in the national level but also the rural areas. The Huay Mai 's CBET management focused on community participation under its local context to be strengthened, sustained and self-reliant by itself. This case applied the concept of community based ecotourism. According to Walter (2011), the CBET emphasized the principles of local participation, control or ownership of ecotourism initiatives. Furthermore, CBET is focused on the environmental conservation and local livelihood benefits. Nevertheless, this model promoted the customary and local cultures in Huay Mai community. Lastly, it promoted the local human rights and traditional resources. Therefore, Huay Mai people and the related stakeholders set the approach and patterns for Huay Mai 's CBET management by using community participation as follows: (1) established the Huay Mai tourism club (2) determined the tourism club's management structure and persons in charge who were elected from the club's members (3) planned tour programs responding to the potential of the area (4) imposed rules and regulations on members and tourism practice, and (5) determined criteria and principles for distributing the profits obtained from tourism activities among the members.

From the after action review (AAR) stage, it was found that most of the tourists who travelled in Huay Mai community were more satisfied. They were more impressed in the services of the Huay Mai 's local tour guides. Besides, Huay Mai people were proud of

themselves for increasing the income for their family and shown the potential empowerment of the Huay Mai 's CBET management toward sustainable development.

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Propositions of the Complementary Roles of Customer Orientation, Entrepreneurial Proclivity, and Information Technology Utilization on New Product Development Success

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Abstract: The quest for a single dominant strategic orientation has been hampered by the growing stream of research that has provided evidence that firms with balance multiple orientations or integrate complementary orientations simultaneously can achieve competitive advantage and superior performance. Implementing multiple strategic orientations enables a firm to integrate different sets of organizational capabilities that can foster the development of core competencies. In today's highly competitive and fast moving markets, product innovation has been strongly advocated as a means by which firms can survive and remain profitable, and as such, new product development activities and processes must be developed into core competencies. Thus, determining which strategic orientations do indeed complement one another in order to enhance new product development processes and outcomes deserves further consideration. From an integrative review of new product development literature in marketing, strategic management, and information technology (IT), several propositions are proposed that link customer-orientation, entrepreneurial proclivity, and IT to new product development success. The main premise of the paper was that the isolated effect of any one of these three strategic orientations was less than any combined effect of the three. The dynamic capabilities perspective supported these propositions, which was a meaningful view to explain a firm's ability to integrate, build and reconfigure necessary competences in order to cope with rapidly changing environments. Based on this view, firms that adopt a customer focus, implement an entrepreneurial mindset, and fully utilize IT demonstrate dynamic capabilities and organization-wide convictions that enable a firm to employ different forms of learning about market needs and to integrate that learned information into NPD activities and processes. A discussion of the theoretical contributions, practical implications, and future research directions was also presented.

Keywords: Customer orientation, Entrepreneurial proclivity, Information technology, New product development, Dynamic capabilities

INTRODUCTION

Strategic Orientations and New Product Development Success

The strategy literature is replete with studies that have attempted to identify strategic orientations that have the most favorable impact on organizational processes and firm performance. However, the quest for a single dominant strategic orientation has been challenged by the recent growing stream of research that has provided evidence that firms that balance multiple orientations or integrate complementary orientations simultaneously can achieve competitive advantage and superior performance.

In fast-changing business environments, the survival and sustained growth of firms has been highly dependent on the firm's ability to create new products. Significant attention

has been given, by both practitioners and academics, to new product development (NPD) because it has been widely regarded as a critical means for firms to stay competitive and sustain profitability [1]. The NPD process involves the coordination of resources and functional capabilities in order to create new products or to make modifications and improvements to the firm's current ones. Because NPD is a complex interfunctional activity that requires high levels of strategic integration and the deployment of firm competencies for success, there is a broad spectrum of NPD research. For long-term success in NPD, managers have been advised to ensure a proper configuration of different sets of organizational capabilities [2]. Consequently, determining which strategic orientations complement one another in order to enhance NPD success deserves further consideration.

In this paper, NPD success refers to three NPD process outcomes, namely process efficiency (i.e. process speed and productivity), product effectiveness (i.e. fitness of the new product with firm competencies and market needs), and product financial success (i.e. market share, revenue, and margin). Major streams of NPD inquiry have focused on identifying critical determinants of NPD success, such as environmental influences [3], interdepartmental collaborations [4], and strategic orientations [5]. Several studies have examined the effect of various strategic orientations on NPD success but have focused on comparing their relative, rather than their interaction, effects [6]. Only a few studies have examined the interaction effects of multiple strategic orientations on NPD success. For instance, Boso et al. [7] found that exporters who demonstrate both market-oriented and entrepreneurial behaviors have higher success in exporting new products. Mu and Di Benedetto [8] found that the joint effects of market-, entrepreneurial-, and technology-orientation on new product newness, new product advantage and the number of new products introduced are higher than their independent effects. These two prior studies suggest that NPD processes can be enhanced when firms adopt more than one strategic orientation. This paper aims to contribute to this emerging line of NPD inquiry by proposing the complementary effects of strategic orientations from three different business disciplines on NPD success.

A review of relevant NPD literatures in marketing, strategic management and information systems reveals that the role of strategic orientation on NPD success has been viewed from different perspectives. From this broad range of work, the premise here is that efficient and effective execution of NPD activities rely on different firm resources and capabilities. Moreover, NPD is an information- and knowledge- intensive process that depends on the acquisition, dissemination and utilization of information [9], thus, the manner in which information is managed throughout the NPD process is an essential capability to achieve NPD success [10]. Based on this view, firms that adopt a customer focus, implement an entrepreneurial mindset, and fully utilize IT demonstrate dynamic capabilities and organization-wide convictions that enable them to employ different forms of learning about market needs and to integrate learned information into NPD activities and processes. The main thesis of this paper is that the isolated main effect of any one of these three strategic orientations on NPD success is less than any combined effects of the three. These propositions are grounded on the dynamic capabilities perspective, which is a meaningful view to explain a firm's ability to integrate, build and reconfigure necessary competences in order to cope in rapidly changing environments [11]. Thus, this paper contributes to the strategy and NPD literature by identifying key organizational capabilities that can lead to more effective and efficient NPD.

The remainder of this paper is as follows. The theoretical foundations are discussed in the next section. This is followed by a discussion on each of the strategic orientations of interest in, and an explication of how customer orientation, entrepreneurial proclivity and IT orientation act in complementarity to achieve NPD success. The theoretical contributions,

practical implications as well as suggestions for future research are presented it in the conclusion.

THEORETICAL FOUNDATIONS AND CONCEPTUAL FRAMEWORK

The purpose of a firm's existence is to provide value to various stakeholders. To execute value-creating strategies, firms deploy and integrate their resources as complex bundles of skills and accumulated knowledge that enable them to utilize their assets, coordinate activities, and demonstrate their capabilities [12]. In turbulent environments, firms may transform or reconfigure their organizational capabilities to adapt to and/or exploit opportunities in the new environment. These types of 'dynamic' capabilities are comprised of specific strategic and organizational processes such as alliances, NPD, and strategic decision making [13]. Recent literatures focused on identifying dynamic capabilities that are associated with firm strategic orientations.

Strategic orientation centers on how firms should interact with their external environments such as customers, competitors, and technology, in order to conduct business. While strategic orientation takes an outward view, dynamic capability takes an inward view. In essence, strategic orientation, in terms of 'strategic choice,' drives the manner in which firms acquire, allocate, and utilize their assets in order to create dynamic capabilities. The integration of these two views is useful to explain how strategic orientations affect a firm's internal processes, in particular, the process of resource transformation and reconfiguration. Moreover, with the integration of reconfigurational constructs, certain strategic orientations can be contingent upon, synergistic or complementary with one another, and the attempt to integrate various processes of different strategic orientations is, in and of itself, the process of developing dynamic capabilities [14]. Because strategic choices determine a firm's resource allocation of resources for the execution of certain organizational functions and tasks, academics and practitioners alike are interested in knowing which strategic orientation best achieves particular firm performance outcomes, such as that of NPD success [15]. Therefore, based on these views, it is argued here that firms that synergize customer, entrepreneurial, and IT orientations demonstrate dynamic capabilities and organization-wide convictions that enable them to employ different forms of learning about market needs, and to integrate learned information into NPD activities and processes.

Customer Orientation and NPD Success

At the firm level, customer orientation describes a firm's commitment to understanding the needs of customers in order to create customer value and customer satisfaction. Customer oriented firms demonstrate continuous generation, dissemination, and utilization of market intelligence. Customer focused firms serve the interests of customers and apply customer-led or market-driven approaches to NPD. In other words, customer oriented firms design customer involvement activities that enable the firm to learn about customers' problems and needs by effectively listening to them. Related customer-orientation capabilities include market-sensing capabilities, customer-relating capabilities [16], and customer response capabilities [17], which ensure that all functional activities and organizational processes are effectively aimed toward anticipating and responding to dynamic market changes ahead of competitors. Such customer-involvement activities include direct customer contact channels via focus groups and customer surveys to obtain market intelligence on how to design and deliver new products that have value to buyers. Moreover, customer-oriented firms develop close relationships with their customers in order to generate deeper insights of their needs.

Because of the seemingly strong dependence on the voice of customers, customer orientation has been scrutinized for leading firms to merely developing ‘me-too’ products and incremental product innovations. Furthermore, critics of customer orientation claim that this strategic focus on knowing the current and expressed needs of customers lacks foresight for the development of new products.

Findings from the few empirical studies that have examined the effects of customer orientation and its related capabilities on NPD success are mixed, with customer orientation having a positive influence [18] and specific activities such as customer involvement having a positive effect [19], a negative effect [20], or no effect at all [21]. While these prior studies have advanced our understanding of customer-focused activities and NPD, several academics suggest that capabilities related to customer orientation alone are insufficient to have a consistent long-run impact on NPD success. Berthon et al. [22] state that customer orientation and an orientation towards innovation, are distinct but have the potential to interact in a facilitative or inhibitory manner. An entrepreneurial proclivity is one such orientation.

The Complementary Role of Entrepreneurial Proclivity

Entrepreneurial proclivity reflects the degree to which a firm’s business strategy is oriented to the pursuit of new market opportunities and to the renewal of existing areas of operation through the introduction of innovations. This strategic orientation emphasizes finding and seizing external opportunities and making a commitment of resources to increase internal innovative behaviors and competitive advantages [23].

Entrepreneurial firms, in contrast to customer oriented ones, are more technology-driven and tend to possess strong engineering skills and R&D for the development of technologically advanced products. Entrepreneurial capabilities reflect a firm’s ability to sense, select, shape and coordinate internal and external conditions for the exploration and exploitation of opportunities [24]. Exploration and exploitation are different capabilities of market learning. Exploratory market learning involves the acquisition and use of knowledge beyond the firm’s current customer and competitor boundaries to foster a new set of skills, knowledge and experiences, whereas exploitative learning involves the acquisition and use of knowledge of the firms’ current customers and competitors to build upon its current skills, expertise and experiences. Kim and Atuahene-Gima [25] advocate simultaneous exploratory and exploitative market learning to achieve new product advantages since their study discovered that both forms of market learning enhance new product differentiation and cost efficiency. Moreover, they found that the effect of exploratory market learning on NPD cost efficiency is much higher under turbulent market environments, whereas, exploitative market learning brings about higher costs and greater risks because the market research extends beyond the product-market domains of the firm.

Such entrepreneurial capabilities to acquire information are necessary, but are insufficient in themselves, for achieving NPD success in terms of market acceptance of the new product [26], i.e. product effectiveness. Some research supported the notion that entrepreneurial proclivity leads to the development of ‘radically’ new products, but some other studies found that an entrepreneurial orientation has been associated with poorer new product performance [27]. Part of this poor product performance has been attributed to the lack of inherent customer value in radical product innovations launched by entrepreneurial firms [28]. For instance, when Whirlpool Inc., a global leader of household appliances innovations, launched its technologically-advanced automated washing machines in India, market acceptance was dismal, and the company could better penetrate the Indian market when it introduced a new simpler twin-tub machine that required consumers to perform some of the work, a labor-intensive process that consumers were content with [29]. In essence, a new product cannot merely be innovative to be successful; it must also be meaningful to

users. Thus, while exploratory and exploitative learning capabilities help to identify opportunities for NPD, the implementation of market-sensing, customer-relating, and customer response capabilities would help to ensure new products that are developed by the firm offer customer value, which ultimately leads to higher levels of NPD success. Therefore, proposition 1 is that the synergistic effect of customer orientation and entrepreneurial proclivity result in higher NPD success as compared to the independent main effect of each.

The Integration of Information Technology for NPD Success

Information technology (IT) comprises hardware devices and software technologies that can be used for the storage, sharing, and/or manipulation of data. Organizations integrate IT into their business processes in order to enhance information efficiencies and information synergies [30]. The traditional roles of IT have generally been to automate manual tasks, provide information for decision making, and to transform business processes. Recently, IT has become widely regarded as a valuable facilitator for quicker organizational learning. As such, a strategic IT orientation views organizational IT as a competitive imperative as well as an enabler of new business opportunities [31]. However, when a firm's IT infrastructure is not adequately designed or is not effectively utilized, it can hinder and impede organizational processes and communication, thereby reducing a firm's agility and increasing operational costs.

IT capability is the firm's ability to use its IT systems as a means to acquire, store, process, combine, reconfigure and deploy information resources in support and enhancement of business strategies and work processes. IT capabilities include several dimensions: infrastructure capability, which describes the firm's ability to deploy shareable platforms; business spanning capability, which is the ability of the firm's management to envision and exploit IT resources to enhance the attainment of business objectives; and proactive stance, which reflects the firm's ability to stay current with IT innovations and to foster a climate that supports new ways to use IT.

IT capabilities enable the organization to diffuse market information effectively across all relevant functional areas so that it can direct NPD. This more efficient and comprehensive management of information within and between organizational departments can ultimately improve coordination in an organization. Several researchers found that better information transmission across functional areas leads to more successful new products [32].

Some prior studies have shown that IT is a complementary asset of customer orientation that enhances NPD speed [33] and provides higher information quality that enhances customer service performance, i.e. greater customer satisfaction [34]. Thus, proposition 2 is the interaction effect of customer orientation and IT orientation on NPD success will be greater than their main effects.

Entrepreneurial firms are more likely to integrate IT into their organization [35]. The role of IT is claimed to facilitate the sharing of information and knowledge gained through exploratory and exploitative market learning [36]. As such, proposition 3 is the synergistic effect of entrepreneurial proclivity and IT orientation on NPD success will be greater than their main effects. Since both customer orientation and entrepreneurial proclivity involve different forms of information gathering and learning, IT facilitates the generation and dissemination of information, with the information obtained from the customers and the information obtained from current and unfamiliar product-market domains, being taken into account by every department to guide NPD, reduce operational costs, and to shorten NPD cycle times. Therefore, the final proposition offered here is that superior NPD success is achieved when a firm demonstrates high customer orientation, strong entrepreneurial proclivity, and a high IT orientation. A summary of the three focal strategic orientations and their related capabilities are presented in Table 1.

Table 1 Customer Orientation, Entrepreneurial Proclivity, IT Orientation and Related Capabilities

Strategic Orientation	Related Capabilities	Key Role for NPD Success
Customer orientation describes a firm's commitment to understanding current and future needs of customers in order to create customer value and customer satisfaction	<ul style="list-style-type: none"> • Market sensing capability is the firm's ability to be aware of market changes and to forecast accurately responses to marketing actions • Customer relating capability is the firm's ability to create and manage close customer relationships • Customer response capability refers to the firm's ability to serve customer needs through effective and quick actions 	<ul style="list-style-type: none"> • Learning through customer involvement facilitates product integrity, i.e. product vision that fits with customers and the firm
Entrepreneurial proclivity reflects the degree to which a firm's business strategy is oriented to the pursuit of new market opportunities and to the renewal of existing areas of operation through the introduction of innovations	<ul style="list-style-type: none"> • Entrepreneurial capability reflects a firm's ability to sense, select, shape and coordinate internal and external conditions for the exploration and exploitation of opportunities • Explorative market learning capability is the firm's ability to acquire and use market information that is beyond the firm's current product-market knowledge domain • Exploitative market learning capability is the ability of the firm to best utilize its existing knowledge and experiences within the firm's current product-market domain 	<ul style="list-style-type: none"> • Learning from beyond the firm's current business and market domains creates new and radical market information to enhance new product differentiation • Learning curve expands and the firm can achieve reduced operational costs from building upon its current knowledge and experiences in NPD
IT orientation reflects the extent to which organizational IT is used as a competitive imperative and as an enabler of new business opportunities	<ul style="list-style-type: none"> • IT infrastructure capability reflects a firm's ability to deploy shareable platforms • IT business spanning capability describes the ability of the firm's management to envision and exploit IT resources to enhance the attainment of business objectives • IT proactive stance is the firm's ability to stay current with IT innovations and to foster a climate that encourages new ways to use IT 	<ul style="list-style-type: none"> • Enhances learning by integrating information from internal and external sources to direct NPD • Effective structure of information improves information quality, reduces communication misunderstanding, and lowers barriers for information exchange, all of which improve the speed and productivity of NPD

CONTRIBUTIONS AND CONCLUSION

This paper discussed the complementary roles of customer orientation, entrepreneurial proclivity and IT orientation on NPD success. By doing so, the paper makes a theoretical contribution to the stream of research on dynamic capabilities, particularly in the capabilities achieved through a firm's adoption of multiple strategic orientations. This paper also offers practical implications to managers by explaining the distinct set of capabilities necessary for the execution of today's most widely advocated strategic orientations. Thus, managers know that while the pursuit of complementary strategic orientation is complex, well-developed capabilities can be more advantageous, at least in terms of NPD success.

Due to limited empirical evidence of the synergistic effect of customer, entrepreneurial, and IT orientations on NPD, further research in this area is warranted. An empirical analysis of the synergistic effects of these three orientations on NPD success would reveal whether the interaction is truly a dynamic capability of the firm. Moreover, it would be important to keep in mind that while dynamic capabilities are more prevalent in turbulent environments, other contextual influences such as firm size, industry type, and national culture, should be considered in future studies.

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Model for Developing the Small Schools to Learning Organizations by 5 Disciplines of Peter Senge for Develop Teacher and Education Quality Continually

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Abstract: This research was conducted 1) to study and develop the small school development for the learning organization as Peter Senge's 5 discipline to continuously develop teachers and education quality, 2) to compare education quality in the issue school selected for development at the pre-test and the post-test, 3) to compare the learning organization level for the school at the post-test and the pre-test and 4) to ask teachers for satisfactions on the development form. Samples that apply this development form to test and improve were 4 basic schools in the academic year 2011-2012. The tools that used in this research were learning organization level evaluation forms and the satisfaction on the form questionnaires.

The results were these followings: 1) the development small school form for the learning organization as Peter Senge's 5 disciplines to continuously develop teachers and education quality with the 10 steps including giving teacher an understanding, creating visions and selecting issues about the education development that solving or developing, reasons and factors analysis, solving development, measurement and evaluation method development, testing the method with students and the publicity method exchange, learning, evaluation, analysis and improvement. While carry on these 10 step, it depend on the 5 drivers including cognizance creating, serious and continuous monitoring, motivation and condition, and organization restructure. 2) This form made the education quality in the selected issue was developed. 3) This form leveraged the learning organization level for 4 schools 4) Teachers in all 4 schools satisfied on this form in the high level.

Keywords: Learning organization, Teachers reform, Educational reform

INTRODUCTION

From the evaluation result of the National Education Act schools in 1999, it was found that there were many successes, such as organizational restructuring to increase unity. However, there are still many issues needed to be urgently improved and developed, one of these issues is management efficiency. It has been found that there were many education institutes, especially small schools, with below standard performance, low achievement of students, and lacks resources and properties. In the service dimension, it was found that decentralization was not implemented in the education institutes, education zone, and the local administration office. This caused the lack of participation in management and administration of the staff. In the teacher dimension, it was found that teachers' education backgrounds did not match the subject they taught. There was an insufficient number of hired teachers in some areas which has effects on quality education. The education reform in the second decade (2009-2018), identified to develop a new trend in administration by the decentralization of education institutes, education zone and local administration offices. It further suggested that there should be participation of parents, communities, private sector

and other stakeholders; good governance, transparent, justice and detectable service system; and, application of the new trends in the administration system to develop teachers.

Peter Senge, a professor at Massachusetts Institute of Technology (MIT), USA, has worked with his colleagues on a research to develop a guideline for many business companies in United States which failed in their operations to recover. He found that the concept to able for business to recover was Learning Organization (LO). According to Senge (1990), the learning organization is *the organization which includes all level employees to coordinate and to develop each other and the overall company potential for as the leverage for operation performance to reach their desired goals.* [1]. The same concept was applied in this study with the education organizations and institutes to “*Learning Organization*”. Lo is the place that has an atmosphere and culture of learning. Teachers exchange knowledge and experience with each other, and create new knowledge and innovation for quality education.

This study applied Peter Senge’s 5 disciplines in learning organization to develop the small schools to become a Learning Organization. This will save as a model to develop quality teachers, quality education and educational administration which are include in the education reform in the National Education Act.

MATERIALS AND METHODS

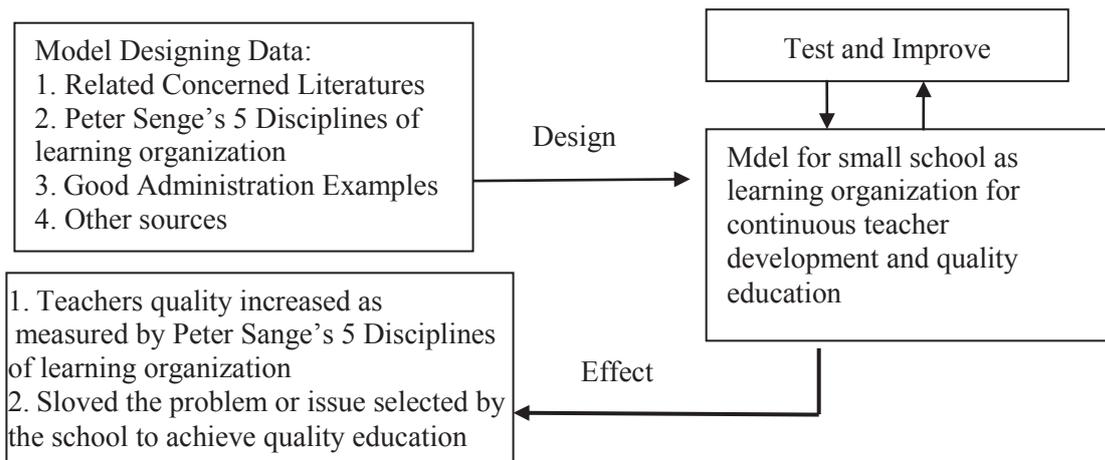
Research Objectives

1. Analyze Develop a model of learning organization in small schools based on Peter Senge’s 5 Disciplines to continuously develop teachers and quality education.
2. Compare the solutions on quality education problems and issue identified by the schools.
3. Compare the Learning Organization level of the selected schools.
4. Determine the satisfaction of the school staff on the developed model of the school as a Learning Organization.

Definitions

1. Learning Organization (LO): the organization that employees continuously learn and develop to maximize their potential. They also learn to develop each other and based on the organization’s potential reach the desired quality of operating performance.
2. Personal Mastery: the employee of the organization has personal vision, good will and seeks knowledge to continuously develop and maximize his potential and create innovative ideas to share with the operation for quality performance.
3. Mental Models: the awareness to clarify what is right, see the image of the world, situations and phenomena, with a clear mental picture of idea, belief, point of view and personal values that conform to the organization.
4. Shared Vision: the organization staff participate in the ideas and procedures of the organization, and cooperate to create the organization vision, and develop teams to achieve the vision. It also means the organization have committed staff to work and to be committed in actualizing the vision.
5. Team Learning: the organization employees exchange skill and experience through any channel such as informal conversations during working and break time, to as formal as training, seminar, operation meeting and further studies, to develop each other and the team potential.
6. Systems Thinking: the method of thinking and understanding the cause and effect relationship that shape the behavior of the system which it can be replicated to produce new results. It will be easy

Research Concept Framework



Research tools included Learning Organization level evaluation forms and the satisfaction on the school development form for Learning Organization questionnaires. These tools have the same creating procedure that is: studying the concerned research document evaluation form and questionnaire drafting. Then, they were sent to the 5 experts to check the consistency between the questions and objectives. The index of consistency in Cronbach's alpha was calculated by testing with 32 educational staff in Plubpla School, Muang, Chanthaburi and the results were 0.82 and 0.95, respectively.

Methods

The method was divided in 2 periods:

The First Period: Studying and Designing

Concerned documents and researches has been studied, the problem condition and the management concept was studied through an interview with 9 executives from successful small schools. The result of the interview was used to make a draft form to be discussed with the focus group and executives. This lead to the development of the ID steps to be a learning organization.

The Second Period: Testing, Evaluation and Improvement

The identification of the school was clone by coordinating with the education zone to recruit the executive who is willing to find and apply a new administration method in his/her school. The researcher arranged a meeting with the executive and teachers in the school to provide information about the research. There were 4 schools qualified to partiapate.

1) Wat Tao Kote Municipal School in Muang, Nakorn Si Thammarat has 550 students and 35 teachers. This school was selected because it was the least famous compared to the other 8 municipal schools. This school is under pressure and with high expectations from the local administration executive, parents and community.

2) Wat Kwian Hak (Sombat Radnukoon) School in Khlung, Chanthaburi is under the supervision of the Office of Basic Education Committee. It has 124 students and 11 teachers. The school director is a dedicated woman. The students came from the local family with poor financial status and lacked readiness for schooling. This school also lacked teachers with specialization in Science, Mathematics and Foreign Languages.

3) Baan Nong Bon School in Pong Ron, Chanthaburi is under the supervision of the Office of Basic Education Committee. It has approximately 90 students and 7 teachers. The schools executive is changed and transferred every year and there are some periods that the school did not have director.

4) Tar Khlaeng High School in Na Yai Arm, Chanthaburi. It has approximately 120 students and 25 teachers. This school had lacked many things and has many problems. The four schools have to select 1-2 of the education quality issue they want to improve or develop using the 10 steps. Wat Tao Kote Municipal School selected the learning achievement and 8 desirable properties development issues; Wat Kwian Hak School selected the learning achievement and 3 desirable properties development issues; Baan Nong Bon School and Tar Khlaeng High school selected 3 desire properties development issue.

RESULTS AND DISCUSSION

1. Results from the forms provided to the schools was developed from the Peter Sange's 5 Disciplines of a learning organization for teachers development and quality education with 10 steps as shown in Figure 1.

The method used in each step can be optimized within the context of each school making sure that all teachers have maximum participation. The detail for each steps are these followings:

Step 1: Giving an orientation about the definition, rationale and characteristics of a Learning Organization to staff and the necessity and benefits that teachers and students can obtain. Teacher created vision. They identified and selected problems and issue in achieving quality education they need to resolve and developed criteria to evaluate the consistency of the solution to the school's and individual teacher's vision.

Step 2: Teachers created visions and selected the education quality issue wanted to solve or develop and assigned the criteria or the evaluation by assigning the school overall vision, working group vision and individual vision to be consistent. For example, if they to develop selected School's ONET to be not below 50%, the working group or the whole school and the teachers in each subject should assign ONET results of $\geq 50\%$.

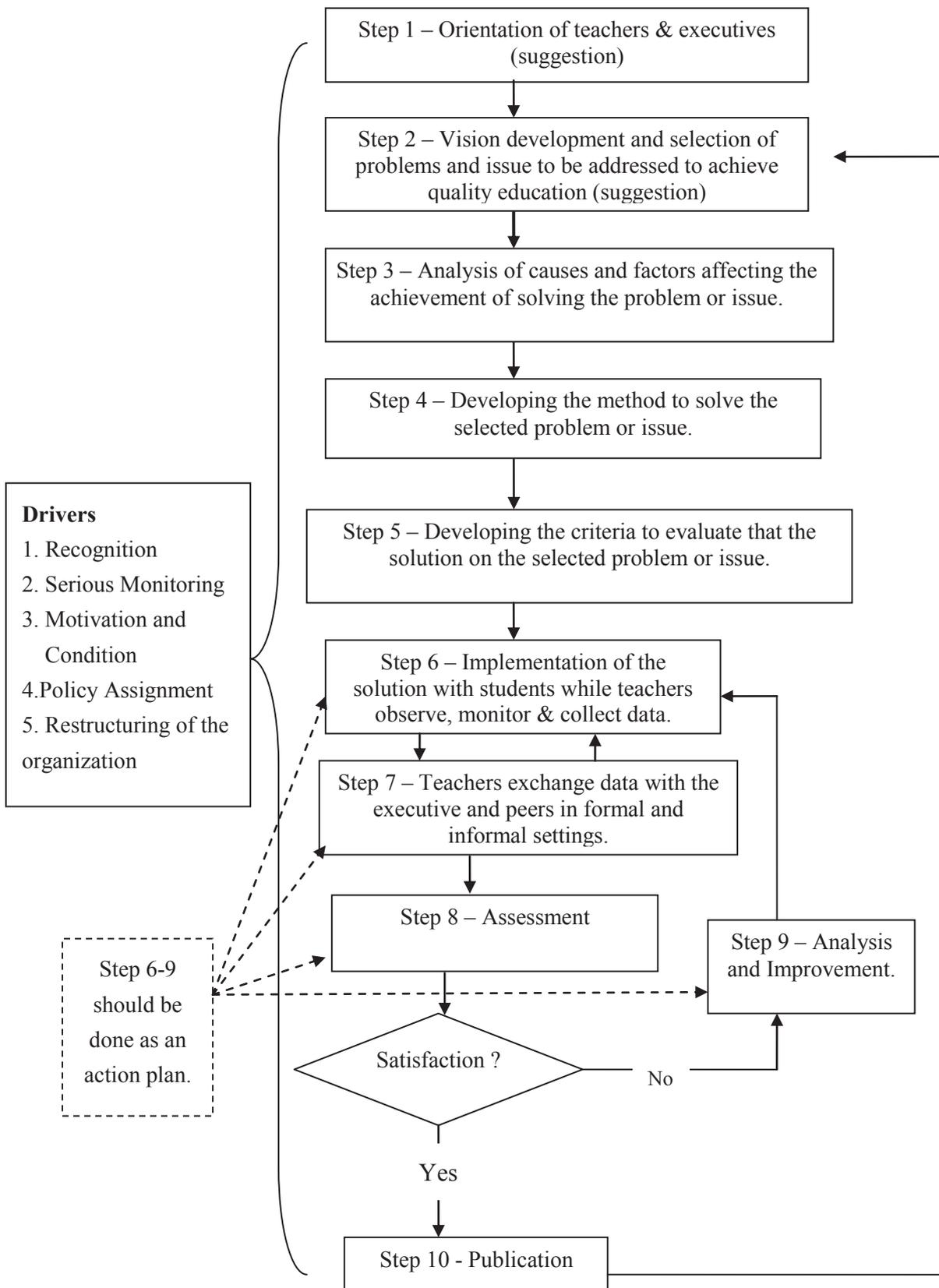


Figure 1 The Small School Development for Learning Organization as Peter Sange’s 5 Disciplines to continuously develop and education quality.

Step 3: Teachers analyze the causes and factors affecting the success in solving the selected problem or issue (From step 2). The use of analysis method that is focused on system thinking as the Cause and Effect Diagram should be done.

Step 4: Teachers develop a principled and clear method to solve the selected problem or issue (From Step 2).

Step 5: Teachers or representative group develop criteria to evaluate the solution to the problem or issue. It should obtain data to show improvement after solutions were employed.

Step 6: Implementation of the solution with students. During this step, teachers should monitor and collect data. This is an important step and takes much time because all teachers have to coordinate with the monitoring executive for and advising.

Step 7: Teachers exchange collected data with each other and with the executive in formal (eg. teacher's meeting) and informal (eg. chat during break time) settings.

Step 8: After a specific period (eg. one month), assessment should be done to check the progress and effectiveness of the solution.

Step 9: After the assessment, the data analyzed and revised method must be tested and re-implemented going back to steps 6 to 8 until a satisfying result is achieved.

Step 10: If the result were satisfactory, it will be published to boost the morale of the teachers. This will create a more united work force to improve the school and make the program more sustainable. If results are unsatisfactory it will go back to step 9.

Another problem or issue will be selected and follow the same procedure.

This cycle based on Sange's LO will have outstanding effects on the development of teachers and quality education.

Drivers: The 10 process had to depend on the driver to be optimize the methods, strategies and techniques within the context of the school. These drivers include Recognition, Serious and Continuous monitoring, Motivation and Condition, Policy Assignment and Restructuring of the organization.

2. Comparisson of the pre-test and post-test result of the identified problem and issue to achive education quality in the 4 schools selected are as follows:

2.1 Wat Tao Kote Municipal School in 2009-2010 selected the learning achievement leverage to be in between the rank 1-5 and 8 desirable properties of students. The result found that the learning achievement of this school was in between the rank 3-5 and the 8 desirable properties of students were leveraged with satisfaction from the teachers.

2.2 Wat Kwian Hak (Sombat Radnukoon) School in 2009-2010 selected 3 desirable properties of students which include discipline, respect and reading, and average ONET score of Mathayomsueksa 6 (Grade 12) students to be higher than 50% for all academic subject. The result has found that students have the desired properties that satisfied the teachers. However, ONET result in 2011 for some academic subjects was below 50% which was analyzed by the teacher to identify the reason. After the model was implemented in 2012, it was found that ONET result for almost every academic subject was above 50%.

2.3 Baan Nong Bon School in the second semester of 2010 selected 3 desirable properties which included discipline, reading and public mind. The result found that students had better desirable properties at the teachers satisfaction level.

2.4 Tar Khlaeng High School in second semester of 2012 selected 3 desirable properties of students which include discipline, knowledge seeking and public mind. The result found that teachers were not satisfied on the desirable properties evaluation. After the analysis, teachers improved the method and implemented it again on the first semester of 2013.

3. Comparing the result for the Learning Organization levels of the 4 schools, between was found that Wat Tao Kote School increased from “Medium” level ($\bar{X} = 3.31; SD. = 0.12$) to “Highest” level ($\bar{X} = 4.80; SD. = 0.40$), Wat Kwian Hak School increased from “Medium” level ($\bar{X} = 2.64; SD. = 0.57$) to “High” level ($\bar{X} = 4.47; SD. = 0.50$), and Baan Nong Bon School increased from “Medium” level ($\bar{X} = 2.98; SD. = 0.77$) to “High” level ($\bar{X} = 4.45; SD. = 0.80$). While, Tar Khlaeng School is still on the re-implementation process.

4. Teachers satisfaction found that teachers in Wat Tao Kote School, Wat Kwian Hak School and Baan Nong Bon School were satisfied on the form at the “High” level evaluation ($\bar{X} \geq 4.00$). While, Tar Khlaeng High School is still on the re-implementation process.

CONCLUSION

This research has designed a model for small as learning organization for continuous development of teachers and quality education based on Peter Sange’s 5 Disciplines of a Learning Organization tested and improved with 4 schools in 2009 – 2012. The model included 10 steps and depended on 5 drivers. In the analysis of this model, it has been found that:

1. This model is based on Peter Senge’s 5 Disciplines of LO, the concept believed as becoming the role model of other Learning Organizations. This concept believes that if the staff’s quality is continuously developed, it will have an effect on management efficiency and the product and service quality. Therefore, applying this concept to develop teachers, it will have an effect on quality.

2. The model boked into the potential and quality development of teachers by asking them to identify problems and issues that can be solved though the 10 steps such as learning achievement, the desirable properties, etc. For these issues, teachers already know that they have on important role in providing quality education. The model designed in this research is flexible and can serve the working context of teachers from different schools. It was found that there was little problem model was applied in each school. Teachers felt their participation and were willing to slove, improve and develop the selected issue. They did not feel that it an additional duty. Everyone was satisfied to solve the problem based on facts. In addition, it is a model that can be gradually and continuously integrated with the teachers’ real working condition. The model implementation resulted to teachers’ and students’ development.

3. After an academic term, it was found that the model enabled teachers to practice systematic think on problem solving. They followed the process which includes sufficient data collection, hypothesizing, apply statistical tools in the data evaluation, resourcefulness in finding a possible and efficient way for implementation, trial and error in learning and actual, experience. The model also made clear the school vision, and the teachers’ individual visions. These visions were linked to each other to be able to have the same understanding, direction, expectation and coordination to achieve the goals. This model also served as a learning process for Action Learning, for the executive staffs, and teachers, in their workplace one school. It is consistent with Marquardt & Reynolds (1996) finding [2] that the model enabled teachers to discuss and exchange ideas with each other, which provided the learning atmosphere with in the individual and the group. Everyone is free to express his/her opinion, which is consistent with Karson et. Al. (2000), Hull (1996) and Louis (1994). The model enabled teachers to be creativitive in generating new knowledge. This knowledge started form an individual and then transferred to others throughout the organization becoming a new knowledge for the workplace. This is consistent with Marquardt & Reynolds (1996),

Appelbaurn & Rechant (1977), Mumford (1995), Peter & Waterman (1993) and Hull (1996). In addition, this model supported the leadership to decentralize responsibility and decision-making to staff.

The Application of this Research

1. The application of this research is to serve the educational strategy 2013-2015. The model of this research has actually been applied for the following: teachers development, school administration system development and students' development by implementing in the schools. Therefore, it consistent with issue 3 of the educational strategy 2013-2015 to reform the teaching profession as a high class occupation. It is also consistent with issue number 4 that – the education system and teachers training should be continuous.

2. Other applications. The model obtained from this research can be applied with any education institutes at all levels and contexts. However, the operation needs other support components such as the school executive and other mechanisms.

ACKNOWLEDGEMENTS

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Saving Our Heritage: An International Approach to Historic Architectural and Cultural Conservation-An Investigation of International Charters and Their Influences and Implications

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Abstract: This paper will investigate and discuss the importance, the relationship, the process, the influence and the implication of saving historic architectural and cultural heritage through two Charters-the Venice Charter and the Burra Charter. The investigation of these two Charters reveals that internationally accepted standards of conservation principles and practices offer effective guidelines of cultural heritage conservation and practices for culturally significant places. This article will also cover the Charter' s outreach influence on how the international community' s adaptation of the Charters for their own regional historic architectural and cultural conservation. Further, the opinions and reflections of scholars and professionals were reviewed and the advantages, disadvantages, and future trends were discussed for the development of new conservation Charters in different cultural context and varieties of circumstances. The principles, guidelines and methods of the Venice and the Burra Charters have helped successfully on saving cultural heritage in global stage. Nevertheless, due to complicated cultural contexts, different regional issues, and national legislations, there are difficulties in developing new Charters to fit to specific approaches and regions.

Keywords: Heritage architectural conservation, Cultural conservation, Charters

INTRODUCTION

“One of the man’s basic instincts seems to be his desire to leave to future generation traces of his passage on earth... This suggests that the interest in monument originates with the beginning of the humanity” [6]. Early in the 1933, a group of architects and planners joined with artists, art critics, scientists from around the world for fourth meetings of the International Congresses for Modern Architecture (CIAM) or the Athens conference, it primarily deal with cities in a new and unorthodox way. The principles outlined by this charter have considerable influence on urban design; it serves as a starting point for the formation of a “Charter of Urban Rights” [5]. The idea of saving historic architectural heritage and properties has gradually become more coordinated international efforts in the

post war period. It brought about the increasing awareness of protecting cultural properties from national to international level. As a result, UNESCO makes a list of heritage significant places in danger each year in order to create the awareness of protection of heritage. More importantly, it provides the Charters, documentation and recommendation for heritage conservation as a standard as well as guidelines.

These two Charters and their offshoot international charters on historic architectural and cultural conservation are good and useful tools for national and international conservation practices incorporated by UNESCO and member organizations. “Saving our heritages is a function of the custodians of our treasures which Tilden calls it Interpretation. Thousands of naturalists, historians, archeologists, and specialists are engaging in variety of saving heritage practices to unveil and reveal the beauty, wonder, spiritual meaning, and inspiration for visitors to see” [11].

The Venice Charters provides principles to guide the preservation and restoration of the historic buildings and ancient buildings while the Burra Charter offers a standard of practice for those who provide advice, make decisions about, or undertake works to places of cultural significance, including owners, managers and custodians [12]. The charters operational guidelines have been adapted and implemented by various world heritage conservation projects especially in Southeast Asia region as shown in the following section. Although these Charters provide a blueprint of conservation, however they also have disadvantages in implementing real conservation practice in different regions: and the scholars and professionals had extensive discussion based on their experience encountered. Thus the new conservation movements should pay attention not only to the architectural heritage character but also to their surroundings and lives of the human beings who inhabit them. This paper will discuss the importance of saving historic architectural and cultural heritage through two Charters—the Venice Charter and the Burra Charter.

THE IDEA OF SAVING HISTORIC ARCHITECTURAL HERITAGE

Since after World War II in 1942, the world heritage was introduced the grand idea of making culture a key component in the protection and restoration of architectural heritage conservation. The primary idea is that architectural heritage has been exploited in three ways: as a representation of common world culture, as a world asset, treasure and social identity, and as a key aspect of development [10]. The interplay of these functions drives as a dynamic force to insert the ‘idea of saving historic architectural heritage’ throughout the world. The notion of heritage conservation in international level remains one of the most important priorities because heritage are meaningful to all people, regardless of cultural, social, political and economic differences.

Historic architectural conservation is concerned with the protection of historic and ancient architectural buildings from loss and damage. People have recognized and have advocated for heritage conservation because objects and places have important information, associations,

and meaning and because they embody social and cultural memory [10]. The movement of studies in conservation has long begun in Europe when restorer and the scientist had been emerging during the 1930s with a focal point in the Art museum. As a result in 1945, UNESCO was founded. UNESCO has always taken a positive role in conservation and the foundation under the auspice of International Centre for the Study of the Preservation and Restoration of Cultural Property (ICCROM), and International Council on Monuments and Sites (ICOMOS) to promote a culture of peace and unity and understanding [16]. UNESCO, ICCROM, ICOMOS and many other international organizations have the main important mission and role to support, promote, protect and contribute the conservation process for cultural and historic heritage places around the world. They provide quality of conservation practice as well as raise awareness about the importance of preserving cultural heritage in the world today and for the future through various charters. This article focuses on two international Charters: the Venice Charter and the Burra Charter; their issues, relationships, importance and influence on the architectural heritage conservation are discussed.

ESTABLISHMENT OF CHARTERS, MISSION, APPROACH AND METHODS

The Venice Charter

The development of conservation and restoration techniques required qualified specialists, but at the same time specialists grew aware of a new fact: the sole listing and safeguarding of major historic buildings were not enough. It was essential to place the architectural heritage in its real context and the historic buildings in their environment. At the Second congress of Architects and Specialists of Historic Buildings held in Venice in 1964, 13 resolutions were adopted. The first resolution is known as the International Restoration Charter or the Venice Charter [13]. The mission of the Venice Charter for the Conservation and Restoration of Monuments and Sites is to provide professional standards which give an international framework for the preservation and restoration especially for ancient buildings. It sets forth principles of conservation based on the concept of authenticity and the importance of maintaining the historical and physical context of monuments, buildings and sites. It also sets the principles of preservation, which relate to restoration of buildings with work from different periods [13].

In his article ‘Cultural Heritage of Southeast Asia: Preservation of World Recognition’, Dr. A Ghafar Ahmad stated, “The Venice Charter emphasizes the importance of respect for original building fabric, precise documentation of intervention, the significance of contributions from all periods to the building character, and the maintenance of historic buildings. Other standards, charters, recommendations and conventions had followed suit in the interest of protecting and enhancing the historic and cultural environment” [2]. The Venice Charter provides the principles guiding the preservation and restoration of ancient buildings on an international basis, with each country being responsible for applying the plan within the framework of its own culture and traditions [13]. For example, it defines not only

the historic monument for single architectural work but also the urban or rural setting; it defines the preservation as a contribution to the study and safeguarding of the architectural heritage and as work of art. The Charter also set general guidelines for conservation of architectural buildings to be maintained on a permanent basis, to offer socially useful purpose while preserving a setting which is not out of scale and to preserve sculpture, painting or decoration as an integral part of the monument. It clarifies the restoration methods such as to preserve and reveal the aesthetic and historic value, to apply modern techniques if traditional techniques prove inadequate, to respect all periods to the building of a monument, to replace missing parts harmoniously integrated with the whole and to allow no additions. Finally, it sets the principles for excavations which should be carried out in accordance with scientific standards of archaeological excavation adopted by UNESCO in 1956.

In the real conservation practice, architects make careful decision of detail restoration, assess historical importance and safety, and apply traditional and modern techniques in reversible way. These specific knowledge and technical skills are never outlined in the Venice Charter, it is upon each country to learn and refine their own procedures. However, The Venice Charter continues to be the most influential approaches to save the past and the present for the future heritage sites or buildings legacy by giving principles to guide the preservation and restoration of the ancient buildings and historic sites.

The Burra Charter

In 1977 Australia ICOMOS reviewed the Venice Charter in relation to Australian practice and accepted the philosophy and concepts of the ICOMOS Venice Charter. In 1979 the Charter for the Conservation of Places of Cultural Significance was first adopted at a meeting in the historic mining town of Burra, South Australia. Since then the document was commonly known as the 'Burra Charter'. The Burra Charter, the Australian ICOMOS Charter for the Conservation of Places of Cultural Significance introduced the concept of cultural significance relating to the aesthetic, historic, scientific or social value for past, present and future generations; it sets standards of practices for those who provide advice, make decisions about, or undertake work to places of cultural significance, including owners, managers and custodians [1]. The Burra Charter mission is to improve and lead cultural heritage conservation and practice for culturally significant places. The Charter advocates a cautious approach to changing a place. It recommends the work necessary to repair, to secure and to function so the history of the place can be continually recognized.

The Charter standards and guidance can be applied to all types of places of cultural significance including natural, indigenous and historic places with cultural values [1]. For the Charter's purposes, it defines meaning of place, cultural significance, fabric, conservation, maintenance, preservation, restoration, reconstruction, adaptation, use, compatible, setting, related place and object, associations, meanings and interpretation. These thirteen definitions give standards and guidelines for understanding of cultural significance and their elements. It provides conservation principles of the aim of conservation and management as to retain the

cultural significance of a place; to proceed with cautious approach for changed place which should not distort the physical or other evidence nor be based on conjecture; to introduce knowledge, skills and techniques with traditional techniques and materials for the conservation of significant fabric; to interpret values, use, setting, location, contents, related place and object, participation, co-existence of cultural values. The Burra Charter guides the process of setting the policy development for managing a place based on understanding of its cultural significance. The Burra Charter also provides advices by giving clear concepts and principles of conservation process, change, maintenance, preservation, restoration, reconstruction, adaptation, new work, conserving use, retaining associations, and interpretation. Lastly, the Charter clarifies and guides conservation practice as sequence of investigations, decisions and actions to be implemented and applied on cultural heritage in any field. Conservation Practice in the Burra Charter also includes managing change, disturbance of fabric, responsibility for decision, direction, supervision and implementation and it also guides the processes of documenting evidence and decisions, record keeping, and cataloguing of removed fabric and resources. The Burra Charter and its guidelines are considered the best practice standard for cultural heritage management in Australia and it is influential for cultural and architectural heritage conservation adapted by Pacific regions/countries such Japan, China, Southeast Asia countries and many more around the world.

THE INTERNATIONAL INFLUENCES OF CHARTERS

During the latter half of the 20th century, the number of international charters dealing with the conservation and preservation of cultural heritage expanded from a handful to literally dozens. This includes new Charters formed and considerable documents being published. Especially, the Venice Charter has a huge influence on master principle Charter as stated by Cevat Erder, “the Venice Charter is actually an European charter, but from the moment it was declared, we find a certain adaptation of the charter to North American attitudes and then, of course, to Australia” [7]. Professionals, scientists and conservation experts are regularly referring their studies and practices to the principles contained in the Venice Charter and the Burra Charter.

The UNESCO, ICOMOS and their members in different regions around the world, they have established and provided many other Charters with universal selection criteria and methods which are necessary for new strategy, flexible purpose, and multiple-disciplinary approach for various heritage conservation projects. For example, influenced by the Venice Charter, ICOMOS Charter for the Conservation of Historic Towns and Urban Areas was established also known as the Washington Charter, adopted by UNESCO. The influence of the Venice Charter and the Burra Charter has far reached to Pacific regions. Regional standards of best conservation practice, Hoi An Protocols for Best Conservation Practice in

Asia, professional guidelines for assuring and preserving the authenticity of heritage sites in the context of the cultures of Asia, was documented in 2005 by UNESCO Bangkok.

The conservation Charter of principles for the conservation of heritage sites in China was published in 2000 by China ICOMOS to provide a methodological approach to the conservation of heritage site in China. Looking closer to ICOMOS in Southeast Asia, a region of immense and rich cultural diversity such as Thailand, Cambodia, Indonesia and other seven country-members, ICOMOS Thailand has tremendously provided the architectural and cultural heritage conservation and management charters in SEA context such as Thailand Charter on culture heritage management and conservation, management of archaeological resources and cultural heritage places and International Charter for the conservation of historic and vernacular places [8]. Additionally, in ASEAN declaration cultural heritage at joint communiqué of the thirty third ASEAN ministerial meeting Bangkok, Thailand in 2000, the principles and approaches of international Charters have influentially guided the Southeast Asia the protecting of cultural heritage, maintaining of rich cultural heritage, enhancing of inter-cultural appreciation cultural heritage and promoting of identity in the ASEAN region.

Following the current outstanding world heritage conservation projects in SEA countries, many world heritage places were helped by UNESCO and non-international organizations to restore and conserve architectural, archeological and cultural heritage. A total of 14 cultural properties in Southeast Asia have been listed in the WHL by January 2001 in six countries including Cambodia, the Philippines, Indonesia, Lao People's Democratic Republic, Thailand and Vietnam [15]. These world heritage conservation projects all received supports and efforts from UNESCO and NGOs with remarkably well implemented Charters and techniques for architectural and cultural heritage conservation. The well-recognized examples of historic architectural conservation projects are Angkor in Cambodia, Borobudur Temple Compounds in Indonesia, Town of Luang Prabang in Lao People's Democratic Republic, Hoi An Ancient Town in Vietnam, Historic Town of Sukhothai, Associated Historic Towns and Historic City of Ayutthaya in Thailand [15].

REFLECTIONS AND OPINIONS FROM SCHOLARS AND PROFESSIONALS

There are different views and reflections from professional and expert of concerns in the international Charters on architectural and cultural heritage conservation. During the course of evolvement of the Venice Charter and the Burra Charter, there exhibits advantage and disadvantage when comes to the reality of heritage conservation practice. As suggested by Erder [7]., “the Charters very important effect on education and on the use of terminology. They provided the facility for explaining international attitudes”, it is useful for all regions to adapt and use the Charter principles for a cohesive transnational approach to the appropriate integration of different culture context and technology with existing infrastructure. On the other hand, there are modifications and adaptations in conservation principles in order to fit

into conservation aspect and context of different regions. The principles and guidelines developed ought to be dynamic and flexible to meet the reality of change and continuous learning. According to Jane Lennon, she stated that “we tried to use the Venice Charter, but we found that it concentrated on aesthetic and historic values. That was a problem for us in addressing living cultural significance, especially because we have only 200 years of European settlement and 40,000 years of indigenous settlement. We obviously took the principles of the Venice Charter, but we developed our own—the Burra Charter—which for us is very much a living document because of the need to ensure the continual education of our practitioners” [7]. These two charters set guidelines and procedure that may hinder the development of new progress due to the lack of education and difference in the nature of conservation. Lennon suggested that “proliferation of charters has in some way prevented progress within certain organization structures” [7]. François LeBlance stated that “in the real world, it's architects who deal with historic buildings, engineers who deal with historic roads and bridges and structures, archaeologists who deal with irreplaceable sites, planners who deal with historic cities and landscape architects who deal with historic cultural landscapes. Yet during undergraduate training, very few of these professionals are exposed to the international instruments that we've been discussing” [7]. To have an effective historic conservation, I believe that the Charter should be wisely adapted within its own culture and condition. A good undergraduate educational programs or interdisciplinary projects that could educate the young professionals in training and expose them to the international instruments of the Charters' fundamental principles are essential for future success. To reinforce the idea of Tilden's Interpretation, Professor Ken Taylor suggested that Interpretive Education Management would play a role in saving the heritage because it informs and enlightens us on social history, promote the feeling of a sense of place, create links with the past; it is an understanding of where things have occurred, what has occurred, when they occurred, who was involved and why things occurred. It embodies the feeling of participation and results to sustainable conservation through interpretive value.

SUMMARY

In the field of conservation, conflicts of values on aesthetic, historical and technical grounds are often inevitable. The international Charters guidelines and principles may be positive at forefront but may not always be practical; the core of these differences and deficiency of technical knowledge are to be explored. Saving historic architectural heritage has become coordinated international efforts in the post war period with international approaches, sharing successful conservation methods and connections from around the world as an effective mechanism. There are good examples of the global efforts and methods on the evolving guidelines of new Charters. In today's dynamic world the conservation of heritages evolves from the cultural heritage, architectural heritage, built environment, air and water, the natural environment to sustainability of design.

Saving our heritages carry the responsibility of presenting the real site to the visitors. As Tilden said, “ for here he meets the Thing itself – whether it be wonder of Nature’s work, or the act or the work of Man; to pay a personal visit to a historic shrine is to receive a concept just as no book can supply”. Interpretation is an effective tool which contributes to heritage conservation and is worthy of further study and research. The past heritage conservation approach is focused on the ancient monument and historic building including significant cultural places. The urbanization and the effects of the industrial revolution has become a big part of current society, thus the study and focus area has expanded to concern not just only in the cultural heritage but also to the pressing changes of our built environment. “The concept of cultural heritage has been broadened from historic monument and works of art to include ethnographic collections, historic gardens, towns, villages, and landscapes.”

One of the main important roles of saving heritage that the Charters has little guidelines is the involvement of local community participation in continuity of its traditions and in cultural heritage that leads to sustainable conservation. The linkage of green architecture to a nation’s traditional design heritage and the eco-tourism that integrate the local people, economy and vernacular landscape into a successful living community are interesting topics for the future research. Nonetheless, the Charters language was deliberately written in such broad, general terms that it can be used in the variety of circumstances. It should not be used as a prescription and rule of interpretation but a process by which an appropriate adaptation can be derived.

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The military sharing as an asean strategy to counter terrorism in indonesia

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Abstract: This paper offers insights into how ASEAN (The Association of Southeast Asian Nations) tackle global issues of terrorism within the international system. The global war on terrorism, to a certain degree, has influenced the ASEAN leaders to securitize terrorism as a critical threat to ASEAN. However, it's difficult to separate Indonesia and ASEAN in countering terrorism because as ASEAN member states are always together with other ASEAN states in maintaining peace and stability in the region and together in overcoming the problem of incorporating nontraditional issues. The ASEAN's assistance to Indonesia in fighting terrorism in the country, such as, military sharing. The organization of terrorists transferred money, weapons, information and personnel across border with ease. Trans border organization terrorist activities indicated a border security was too weak. Therefore, the situation stressed the importance of multinational intelligence-sharing. By using these strategies, we attempt to examine to what extent the ASEAN strategies are more promising.

Keywords: ASEAN, Countering terrorism, Military sharing, strategy.

INTRODUCTION

Southeast Asia is becoming an international terrorist hub following the Bali bombings in October 2002 that killed 202 people. In fighting the international terrorists, ASEAN countries need to collaborate with each other and settle their differences especially the security sector. As terrorism pose a major threat to ASEAN's society, ASEAN members have adopted joint declarations on counter terrorism. They are working together to hold capacity-building activities in fighting terrorism.

Development Assistance from ASEAN to Indonesia

Indonesia and ASEAN members have worked together in fighting terrorism in accordance with the ASEAN Declaration in November 2001. For example, Prime Minister Goh Chok Tong of Singapore said that his country has supported the United States General War on Terrorism (USA's GWOT). Mahatir issued a statement condemning the terrorist attacks. Following the 9/11 attacks, President Megawati visited United States to support counter terrorism[1]. Following the 2002 Bali bombings, Indonesia and ASEAN states issued a declaration during the Eight ASEAN Summit in November 2002. The declaration has supported the action in countering terrorism in the region [2]. The Indonesian President Megawati states:

“ the September 11 attacks on the United States, last October's Bali bombing, and the deadly car bombing in Jakarta on Tuesday have shown that regional plans of

action to tackle terrorism and cross-border crimes like drug smuggling are inadequate....It became clear that no single country or group of countries could overcome this threat alone. In Indonesia's view, which is shared by the rest of the ASEAN members, it would take a global coalition involving all nations, all societies, religions and cultures to defeat this threat. ” [3]

This section discusses ASEAN's assistance to Indonesia in fighting terrorism in the country. However, it's difficult to separate Indonesia and ASEAN in countering terrorism because member states always work together to maintain peace and stability. The importance of the strategy in combating terrorism needs further elaboration.

Military Sharing

The organization of terrorists transferred money, weapons, information and personnel across borders with ease. Transborder organization terrorist activities indicated border security was weak. Therefore, the situation stressed the importance of international intelligence-sharing and extradition agreements. Furthermore, Indonesia and other ASEAN members highlighted a regional Mutual Legal Assistance Agreement, especially information exchange, such as intelligence information, modus operandi, and serious or minor offenses by the terrorist organizations. Indonesia and other ASEAN governments also cooperate to prevent trafficking in small arms that is suspected terrorist activities.

Based on the 2001 ASEAN Declaration on Joint Action to Counter Terrorism[4], Indonesia and other ASEAN countries information and exchange intelligence about terrorist activities including the movement and funding of terrorist organizations. This action aims to secure all modes of travel and to protect lives and properties of people against terrorist attack. In investigating, detecting, monitoring and reporting on terrorist acts, the Indonesian government has cooperated with other ASEAN members in enhancing their military capabilities to develop regional capacity building programmes.

ASEAN focal points on counter-terrorism were set up to carry out several activities related to military sharing, for example, military training programmes especially for law enforcement authorities such as psychological operation or psychological warfare courses; they managed to procure intelligent equipment; they arranged courses early bomb or explosives; detection police investigated post-blast scenes to find out the truth; to secure airport; and regular inspections of passport or important documents were also carried. Meanwhile, Indonesia and other ASEAN member established the ASEAN Regional Forum (ARF) Inter-session Meeting on Counter-terrorism and Transnational Crime (ISM-CTTC) in Sabah in March 2003. This program developed military cooperation to secure transportation on the road, the air and the sea and it focused on the movement of people and goods, and document security.

Furthermore, under the ASEAN Security Community (ASC), the Indonesian government and other ASEAN members have shared military information to facilitate political and security cooperation particularly in countering terrorism in the region. Multilateral cooperation in defense was approved at the ASEAN Defense Ministers' Meeting (ADMM) in Cebu, the Philippines in January 2007. The ASEAN Security Community Plan of Action in 2004 has six programmes, namely, 1) developing political cooperation of ASEAN members, 2) shaping and sharing of ASEAN countries norms, 3) preventing conflicts in ASEAN region, 4) giving a resolution to the conflict, 5) trying to create peace on post-conflicts, and 6) implementing the ASC agreement. As the main advocate of the ASC, Indonesia highlights cooperation between members to ensure peace in the region. The other ASC members also have motivated Indonesia to counter terrorism in the country with sharing military information; enhancing cooperation between security and intelligence agencies to

secure borders and immigration control; and improving intelligence sharing to freeze terrorist groups' assets among national police forces.

In August 2002, Indonesia and other ASEAN immigration authorities have enhanced border coordination to prevent the movement of terrorists by setting up intelligence units and ASEAN focal point directories as noted above to exchange information. Indonesian and other ASEAN police and law enforcement officials established an anti-terrorism task force, called ASEAN Collaboration on Post Terrorist Attack in June 2003 in Ha Noi, Viet Nam. This aims to help ASEAN members after a terrorist attack; to identify, pursue, and apprehend suspects, examine witnesses; search for facts; and treat meat of person attacked, injured or killed as the result of terrorist attacks. In 2004, there was a regional ministerial meeting in Bali [5] to deal with counter terrorism. This meeting aimed to enhance cooperation involving the police and the military in improving maritime security and preventing terrorist funding.

The results of cooperation between Indonesia and other ASEAN members are bearing fruition such as, the arrest of Fathur Rohman Al-Ghozi by the Philippine National Police on January 15, 2002. He comes from Indonesia and took an active part in Jemaah Islamiyah (JI). Based on instructions from Al Qaeda's Afghan bases, he trained JI members in making bomb at the Moro Islamic Liberation Front (MILF) camps in Mindanao, Philippines. Based on information from Singapore and Malaysia, the Indonesian police arrested Agus Dwikarna, Tamsil Linrung, and Abdul Jamal Belfas who had cooperation with Al-Ghozi and had bomb making ingredients in their suitcase in March 2002. In February 2003, Mas Selamat Kastari, a JI leader in Singapore was arrested in the Indonesian Riau islands. In August 2003, the JI operations chief, Hambali was caught by the Thai police. In early 2008, (2) senior JI member were caught in Kuala Lumpur by Malaysian police. In September 2009, the police shot a key JI organizer, Noordin Mohamad Top; in February 2010, a training camp in Aceh was disrupted by the Indonesian police. This camp was set-up by Dulmatin who joined in JI organization in the Philippines and was implicated in the 2002 Bali bombings. Finally, since 2002 until 2010, more than 300 suspected terrorists were caught.

CONCLUSION

This paper emphasizes the relevance of ASEAN in countering terrorism in the region especially in Indonesia. ASEAN as a regional international organization helps Indonesia to combat terrorism through military sharing. ASEAN members and Indonesia have done efforts in fighting terrorism and have made successes in arresting suspected terrorists.

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Conceptual Framework of Computer Act Development under Political Issue of Thailand

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Abstract: Politician relies on computer act to avoid from criticism on internet channel and used an act for harm a person who has a difference ideology. Conceptual framework of computer act development under political issue of Thailand is used for recommend government agency for enhancing developing a computer act according with modern direct democracy concept that responds to true requirement of voter. Moreover, this development keeps a CIA triad which is direction of computer policy providing.

Keywords: Computer act development, Political issue and modern direct democracy.

INTRODUCTION

Before certain political conflicts happened in Thailand, the government under the leadership of former prime minister Taksin Shinawatra, established a ministry of information and communication technology (MICT) in order to provide an ICT infrastructure in the dimensions of economic, culture and social [4]. The origin of MICT brings about drafting a computer act in order to control and protect the Thai people from criminals who relies on computer devices or the internet. Even though the computer act is employed to protect Thai people in various viewpoints such as commercial, privacy and threat, this act is enforcead to harm the differences in ideology of politicians since the time of former prime ministers Surayut Chulanont, Samak Sundaravej, Somchai Wongsawat until Abhisit Vejjajiva [6]. Moreover, the government under the leadership of Yingluck Shinawatra, aggravated the political issue by announcing a new policy which protects a politician from criticisms on the internet that is in contrast with the demarcated regimen which is the foundation of Thailand [5]. This phenomenon shows that the computer act is not responding to resolve political conflicts in Thailand. Therefore, the Thai government should develop a new computer act that can respond to democracy and provide a protection mechanism from politicians who rely on the act to harm each other. However, this act should protect the Thai people from criminals as before [7].

In order to overcome the problem, this paper recommends a conceptual framework that can be used to create guidelines for the computer act development based on democracy, create a protection mechanism on the employment for political achievement and create guidelines which covers on security including integrity, confidentiality and availability. This paper reviewed an original model to respond to the objectives. This can be used to recommend to the Thai government to draft a new computer act which covers the conflict of difference in political ideology.

LITUREATURES REVIEW

In order to construct the conceptual framework, this paper reviews an original model including modern direct democracy theory, act drafting regulation and Confidentiality-integrity - availability triad (C-I-A) as explained below:

- The modern direct democracy theory states that a politician is a representative of the people. They can vote or discuss regarding public policy which have impacts to people in Thailand [1]. There are 4 components which direct democracy is enforceable to driving a policy as shown below:

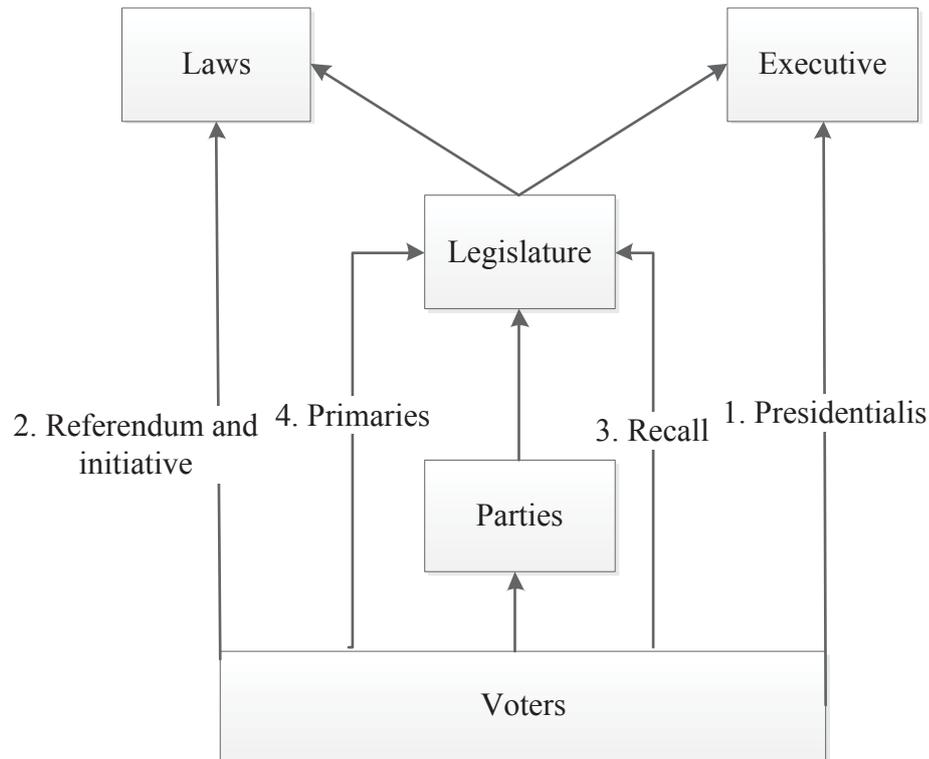


Figure 1 Modern direct democracy [1]

Figure 1 shows the components are compromised to democracy mechanism creation. The government is voted via the power of voters called presidential. Even though, this process improves a democracy or the power of the administrative section, there is conflict between them with the legislation section that tries to control an administrative section that is a voter representative. Then, the administrative section relies on popular referendum which transfers a law founding power to voters that replaces a legislation section. Moreover, voter can recall a politician who does not respond with their duty by a petition from a group of voters. It is an important mechanism for voters under democracy. The last component is direct primaries elections that voter selects for a candidate from a party that they are a member of.

- The act drafting regulation begins from the initiatives by the cabinet or member of the house of representatives [3]. Secondly, there are 3 periods for act consideration including; enact, amendment and voting. Then, this drafted act will be considered by the senate to accept or reject. Once the act is accepted from congress, it will be presented to His Majesty the King who signs the act to law as a response to the behest by the prime minister. In order to propose an original model, this paper illustrated the relational process on figure 2.



Figure 2 Act drafting regulation

From figure 2, this process is useable to draft and announce an act in Thailand that begins with the member of the house of representatives. After considered, the act is approved by the senate.

- C-I-A triad is the direction of providing internet security [2]. Confidentiality is used to protect data or information which is created on a computer or the internet. Therefore, an electronic transaction relies on confidentiality in order to protect the user from disclosing data to computer criminals. Integrity is used to confirm data exchange on the internet or keep on a storage not allowed for editing from other persons. Availability is employed to confirm once there is an audit trial, to find and approve available data. Therefore, this concept operates together in order to improve the security on the internet system as shown figure 3.

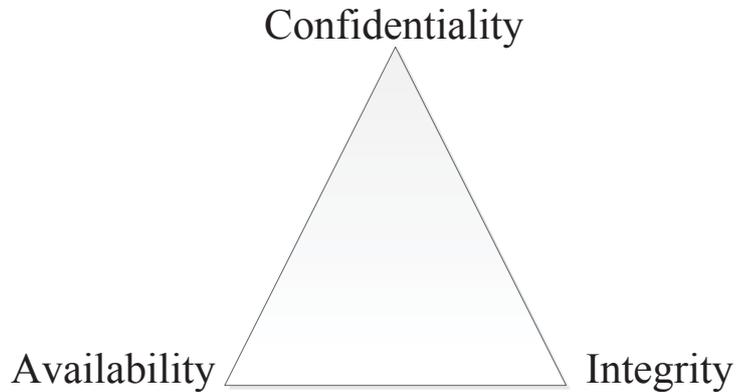


Figure 3 C I A triad

Figure 3 shows that internet security relies on the C-I-A triad in order to provide security system to internet and computer users from crimes.

This paper is composed of 3 literatures in order to create a conceptual framework for the computer act development in political issues in Thailand that will be proposed in the next section.

THE CONCEPTUAL FREAMWORK

In order to respond with the objective to create a protected mechanism in the computer act for political achievement, this paper constructed a new component which can be used to protect a politician who uses the act to harm each other. Moreover, this model comes from the modern direct democracy theory, C I A triad and act drafting regulation as show below:

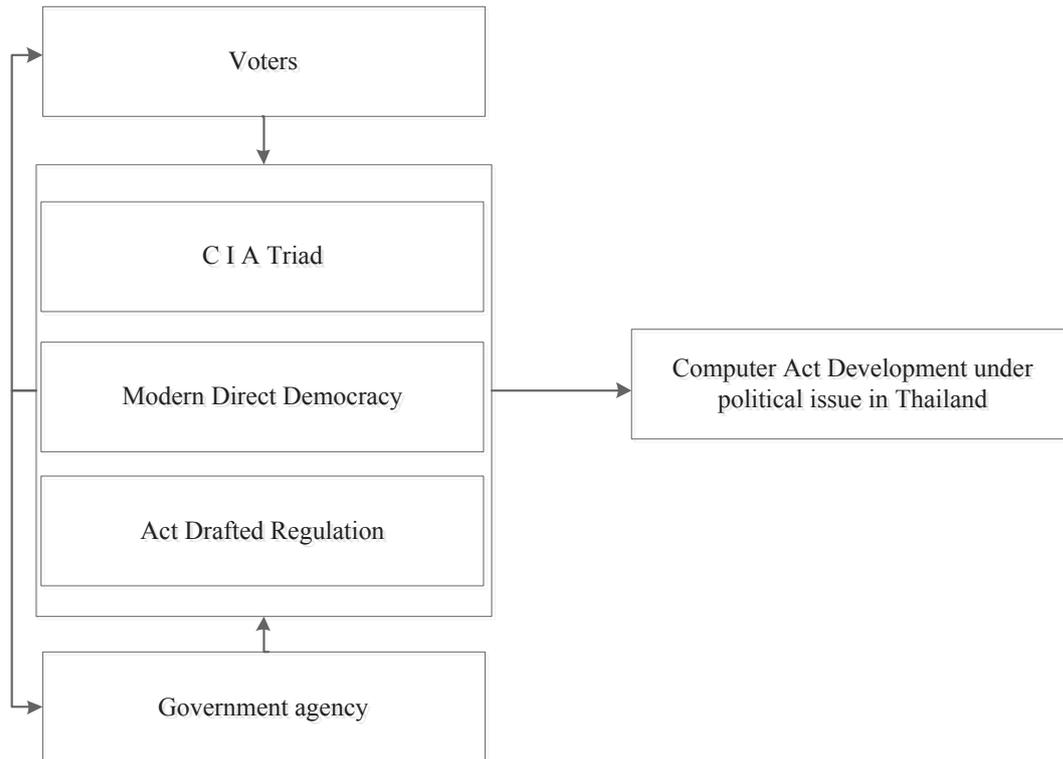


Figure 4 Conceptual framework of computer act development under political issue in Thailand

This framework tries to respond with voters and the government by drafting a computer act under the modern direct democracy concept. In order to protect a politician against the computer act usage to harm differences in ideology, this act is collected, combined and drafted by the constituent assembly that is selected by the voters. It shows that an act will be drafted under voters requirements because it is developed by the representatives. For control on ethics and morals of politicians according to the conceptual framework there is a recall process which relieves a politician by the strong power of voters. In the past, recall process in Thailand cannot respond with the true requirements of Thai voters [8]. Therefore, it is an important mechanism for voters who criticizes a politician on the internet and protects a politician who harms other persons because of the computer act. In addition, this act should be developed under the C-I-A triad including confidentiality, integrity and availability which covers computer storage, information flow on the internet and security. This, conceptual framework can be used to recommend to the government in order to develop a computer act under political issues in Thailand by modern direct democracy concept which truly responds to voters' need.

This paper hopes that the model can be used to respond to creation of guidelines for computer act development according to democracy. The second objective is the creation of protection mechanism from the computer act employed for political achievement. This objective is responded by cooperation concerning the drafting of a computer act between voters and the government as part of the conceptual framework. The last objective is the creation of guidelines for the computer act development which covers on security confidentiality, integrity and availability. This objective is responded by the C-I-A triad model. Moreover, this conceptual framework relies on the mechanics of the congress system on developing an act.

CONCLUSION

This paper proposed a conceptual framework of computer act development under political issue in Thailand which is used to recommend to the government in order to draft a computer act. This development process relies on modern direct democracy in order to respond with the true-requirement of voters from politician a representative of the people. Moreover, this framework keeps strong efficiency to confidentiality, integrity and availability or the C-I-A triad. Even though this model responds with the objectives, it should be proven by statistical method such as structure equation modeling (SEM) in order to display that it is suitable with the actual data set. Moreover, the problem is there is a conflict about political ideology that impact the design with the differences in voters and the government. Therefore, this paper can be used to guide the government and further import the model later.

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Potential Impacts of Weather on Rice Production and Evaluation of Agro-Adaptation Measure for Northern Thailand

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Abstract: Climate change poses a significant threat to agriculture and global food supply. The purpose of this study was to evaluate the potential impacts of weather on rain-fed rice production and agro-adaptation measure to mitigate its impacts in Northern Thailand. Based on the rice production and weather data from 17 provinces during 1989-2012, the unit root tests and feasible generalized least squares involving a panel data model are explored to obtain reliable estimates. Stochastic production function in the context of current observed productions was applied and then simulated the impact of altered planting dates on mean and variance of rice production. It was shown that weather variables had a major impact on rice production. Increase in temperature decrease mean rice production and increased its variance. The precipitation increases were found to increase production levels and variability. To explore the potential effect of changing the growing season in the year by altering planting date, this study simulated later planting dates by shifting the planting date later in one to three month increments. At each increment, a new weather dataset was constructed for the time windows corresponding to the new growing period. Simulations of changing the growing season showed that the impacts of temperature and precipitation on mean rice production would decrease from 1.52 to 1.42% in response to shifting the planting date later to one month increment. The rice production variance would decrease from 0.18 to 0.15% due to this altering planting date. These simulation results revealed that the decrease in impact of weather on rice production could be mitigated significantly using proper management practices in terms of altering planting dates. It could prevent the crop from harmful effect of weather during growing period.

Keywords: Rice production, Weather, Panel data, Agro-adaptation, Altering planting date

INTRODUCTION

Thailand is one of the world's biggest rice producers with about 11 million hectares of area harvested and with paddy output of about 31.5 million tons in 2009. Thailand is also the world's biggest rice exporter with an annual shipment worth more than 4,321 million USD and reached 6.9 million tons in 2009 (FAO, 2009). These data present that rice production in Thailand is a significant proportion of the Thai economy, labor force, and world rice market. In Northern Thailand, rice production represents a significant portion of the regional economy and labor force. It has the second-largest area of rice fields of (after Northeast) about 15 million rai with paddy output of around 7.8 million tons in 2012.

Weather is an important factor affecting the agricultural sector, especially the rain-fed system. As climate change harms rice yields, and as continuous growing population threaten food security, rice producers and the Thai government will be forced to further address rice production's contribution to global climate change (Climate Institute, 2008). The previous

study on climate change and agriculture in Thailand is based on the crop simulation model. Nevertheless, understanding of the environmental variables that affects regional rice yield is limited and econometric estimation of production functions to identify rice production average and variability have received little attention in Thailand, especially in the regional level.

This study aims to answer the following open questions based on the methodologies applied. First, how does the change in weather variables affect the mean production and its variability? This study applied the econometric approaches to estimate statistical relationship between rice productions and weather conditions. Second, how is change in rice production affected by agro-adaptation measure? This study simulates the empirical result to the evaluation of adaptation scenarios that predict the effect of change in planting date on rice production. This study contributes to the literature by developing an econometric model to determine the potential impacts of weather conditions on the mean and variance of rice production, and by examining the implications of the agro-adaptation on agriculture. These results have important implications for adaptation patterns to mitigate the effects of climate change on food security in the future.

MATERIALS AND METHODS

There are different approaches that have been under taken to estimate the effect of climate on crop yield. Hertel and Rosch (2010) group the approaches into three categories; crop growth simulation model, hedonic approach, and a statistical or econometric approach. For the previous study in Thailand, a number of studies on climate change and crop yield predominantly applied the crop simulation model. An example of the early works was done by Matthews et al. (1997), Felkner, Tazhibayeva, and Townsend (2009), and Babel et. al. (2011). The hedonic approach and econometric approach have received little attention in Thailand although it has been used by Chen, McCarl, and Schimmelpfennig (2004), Mendelson (2009), and Wang et al.(2009) among others.

Just and Pope Production Function Estimation

In order to examine the effect of weather variables on both average and variability of rice production under heteroscedastic disturbances, a stochastic production function approach of the type proposed by Just and Pope (1979) is applied as given in equation (1).

$$y_{it} = f(x_{itk}, \beta_k) + u_{it} = f(x_{itk}, \beta_k) + h(x_{itk}, \alpha_k)\varepsilon_{it} \quad (1)$$

where y_{it} is rice production, x_{itk} is a vector of K explanatory variables, $f(x_{itk}, \beta_k)$ is the deterministic term of production (or mean function) with β representing the vector of estimated coefficients, u_{it} is the heteroscedastic disturbance term; $h(x_{itk}, \alpha_k)$ is the stochastic term of production (or variance function) with α representing the vector of estimated coefficients, and ε_{it} is a random error term with zero mean and variance of σ^2 . This specification allows explanatory variables such as weather to influence both mean and the variance of crop production. Thus, the advantage of this Just and Pope specification is the proposed estimation method is fit for heteroscedasticity.

The stochastic production function given by equation (1) can be estimated using maximum likelihood estimation (MLE) or a feasible generalized least squares (FGLS) under heteroscedastic disturbances. MLE is more efficient and unbiased than FGLS estimation in the case of small sample (Saha et al. 1997). Given the large sample in this study, the FGLS is used. To estimate production function, the procedure proposed by Just and Pope (1979) is used and adapted to the case of panel data by assuming that rice production and explanatory

variables have relationship in form of log-linear model or the Cobb-Douglas Production. This procedure consists of three steps. The first step, regress y_{it} on x_{itk} by OLS and obtain the residuals, u_{it} . The fact that production variance appear as heteroscedasticity in the Just-Pope formula, the OLS regression coefficient estimates of the mean production function are still unbiased and consistent, but not asymptotically efficient (Asche and Tveteras, 1999). The second step, use the OLS residual from the first step as a dependent variable to estimate the marginal effect of x_{itk} of the variance of production. The third and final step, perform FGLS by re-estimating the mean production in the first step using the predicted value from the variance function in the second step as weights for generating the FGLS estimators.

Estimate the Mean Production Model

The econometric estimations of this study applied the panel data model, the production equation estimated for rice in the form of one-way error component model was constructed as equation (2).

$$Prod_{it} = \beta_0 + \beta_1 Parea_{it} + \beta_2 Atem_{it} + \beta_3 Train_{it} + \beta_5 T_{it} + \mu_i + v_{it} \quad (2)$$

where $Prod_{it}$ is the natural logarithm of rice production (tons), $Parea_{it}$ is the natural logarithm of planted area, $Atem_{it}$ is the natural logarithm of seasonal mean of monthly average temperature for growing season (in degree celsius), $Train_{it}$ is the natural logarithm of seasonal mean of monthly total rainfall for growing season (mm.), T_{it} is the time-trend variable to represent the effect of technological progress during the sample period, μ_i is the unobservable individual-specific effect, and v_{it} is the remainder disturbance.

Estimate the Variance Production Model

This step can use the OLS residuals from equation (2) as a consistent estimator of u_{it} . Then, $\ln(u_{it}^2)$ is regress on explanatory variables the same as the explanatory variables used in equation (2). Then, apply the OLS to estimate the following non-linear regression:

$$\ln(u_{it}^2) = \alpha_0 + \alpha_1 Parea_{it} + \alpha_2 Atem_{it} + \alpha_3 Train_{it} + \alpha_5 T_{it} + e_{it} \quad (3)$$

Panel Data Set

This study obtains panel data of rice production in 17 provinces over a 24 year period (1989-2012) including 408 observations. Rice in Thailand is mostly grown under rain-fed conditions, accounting for over 80 percent of the total rice area. Therefore, rain-fed rice production data was used in this study. Rice production and planted area are obtained from Office of Agricultural Economics (OAE) reports (2012). Climate variables were taken from the Meteorological Department of Thailand (2012). Monthly data on temperature and precipitation for each province measures for rice growing season (May to October) based on values from a representative weather station located centrally within the province. For the sample period, the average production is 338,423 ton/province/year. The mean temperature is 28.28 °C. Total precipitation is about 1,100 mm. The summary statistics are presented in Table 1.

Table 1 Descriptive statistics of the data used in the estimations

	Production (tons)	Planted area (rai*)	Average temperature (°C)	Total precipitation (mm.)
Mean	338,423.30	757,565.70	28.28	1,086.02
Std. Dev	257,845.30	585,720.90	0.79	260.99
Maximum	1,261,079.00	2,541,989.00	30.12	2,137.00
Minimum	29,889.00	80,051.00	26.22	522.60

Note: * 6.25 rais = 1 hectare

RESULTS AND DISCUSSION

Pre-estimation Specification Test

In order to construct the efficiently estimated parameters in the error component model with cross-section heteroscedasticity, panel unit root test and heteroscedasticity test were performed. In order to prevent the issue of spurious correlation, the test for the presence of unit root for each variable is a necessary step prior to process the FGLS estimation. This study employed two kinds of panel unit root test which fit the balanced panel data set; the Levin, Lin and Chu (LLC) test that assumes common unit root process and Im, Pesaran and Shin (IPS) test that assumes individual unit root process. The result shows that using different test specifications, the rice production, planted area, and weather variables passed both tests and are thus stationary (I(0)). Therefore, there is no need for a different data before the FGLS estimation. In order to confirm that the existence of the variance component of production function is reflected in the presence of heteroscedasticity in the production function, the Breusch-Pagan-Godfrey (B-P-G) test was applied which regresses the squared residuals on the original regressors. The White's test was applied which regresses the squared residuals on the original regressors, the square of regressors, and interaction effects. Results of these tests firmly reject the null hypothesis of homoscedasticity at all conventional significance level.

Rice Production Function Estimates

The final estimates of the parameters of the proposed production functions are presented in Table 2, where the Cobb-Douglas functional form was applied for both average and variance of rice production. The parameters listed in Table 2 are the estimated elasticities for rice production scenarios in Northern Thailand. Model North was the original scenario without altering planting date, whereas North-LPD1, North-LPD2, and North-LPD3 were the agro-adaptation scenarios with later planting date in one to three months, respectively.

Table 2 Estimated parameters for rice production, mean function and production variability

	North	North-LPD1	North-LPD2	North-LPD3
Mean function				
Planted area	0.969294*** (0.002026)	0.973249*** (0.001965)	0.975307*** (0.001954)	0.979669*** (0.002054)
Average temperature	-1.534399*** (0.093076)	-1.444816*** (0.098126)	-1.155561*** (0.100605)	-1.029620*** (0.095794)
Total precipitation	0.017073*** (0.004978)	0.020012*** (0.004655)	-0.005199 (0.004712)	-0.014038*** (0.005066)
Time trend	0.120296*** (0.005396)	0.125706*** (0.006498)	0.131886*** (0.006610)	0.132340*** (0.006881)
Constant	4.337737*** (0.327465)	3.924506*** (0.343059)	3.056453*** (0.348475)	2.610556*** (0.331333)
Adjusted R-squared	0.998420	0.998474	0.998441	0.998226
F-statistic	64317.99***	66583.15***	65179.13***	57266.44***
Variance function				
Planted area	0.000204 (0.002844)	3.48E-05 (0.002964)	0.000630 (0.003078)	0.000234 (0.003084)
Average temperature	0.174180* (0.093582)	0.141356 (0.089299)	0.088157 (0.073787)	0.075781 (0.058488)
Total precipitation	0.011725 (0.010710)	0.006891 (0.009804)	0.007407 (0.009317)	0.010634 (0.008581)
Time trend	-0.024968*** (0.002923)	-0.026634*** (0.002949)	-0.027665*** (0.002970)	-0.027919*** (0.002935)
constant	-0.579715* (0.338646)	-0.425739 (0.309262)	-0.253735 (0.253393)	-0.224245 (0.196068)
Adjusted R-squared	0.17075	0.174699	0.173859	0.179202
F-statistic	21.95***	22.54***	22.41***	23.21***

Note: Numbers in parentheses are standard errors.

*, **, and *** indicate 1%, 5%, and 10% level of significance.

For the results of the mean production function, Table 2 shows that the *time trend* coefficients are all positive and statistically significant for all four scenarios. Therefore, technological progress such as improved agronomic practices has induced rice yield improvement during the sample period. As expected, the *planted area* elasticities are all positive. This indicated that an increase in planted area induced an increase in rice production is statistically significant. For the effect of climate variables, the overall effect of increase in temperature is negative on the mean rice production, whereas the effect of increase in precipitation is dependent on specific scenarios. The effect of change in temperature is found to be very significantly. Thus, estimated elasticity for *average temperature* in production mean regression is consistently negative for all four scenarios suggesting an inverse effect of an increase in average temperature on the mean rice production. The statistical results implied that one percent increase in average temperature leads to decrease in rice production account for 1.53, 1.44, 1.15, and 1.03 percent for North, North-LPD1, North-LPD2, and North-LPD3 scenarios, respectively. The effect of change in *total precipitation* is found to vary significantly across various rice production scenarios. North and North-LPD1 scenarios consistently showed a positive impact of an increase in total precipitation on the rice production with high statistical significance. This result implied that one percent increase in total precipitation is induced an increase in rice production between 0.01 to 0.02 percent for these two scenarios.

For the result of variance function, the interpretation of a positive coefficient indicates that an increase in the associated variables induced a higher production variance. As expected, the technological progress, as denoted by *time trend* induced a decrease on rice production variance with high statistical significance. The rice production variability is likely

to increase with the increase in planted area for all four scenarios. A higher average in temperature implies a consistently increase in rice production variability for all four scenarios. Finally, the effect of changes in precipitation on production variability was generally positive. Higher amount of total precipitation seems to be increasing the variation in rice production.

The Evaluation of Agro-Adaptation Measure

To explore the potential effect of changing the growing season in the year by altering planting date, this study simulated later planting dates (LPD) by shifting the planting date later in one to three months increments (LPD1, LPD2, and LPD3). At each increment, a new weather dataset was constructed for the time panels corresponding to the new growing period. Table 2 shows the impacts of temperature and precipitation on mean rice production decreased from 1.52 to 1.42, 1.15, and 1.03 percent in response to the shift in planting date. The rice production variance would decreased from 0.18 to 0.15, 0.09, and 0.08 percent due to these altered planting dates.

CONCLUSION

This study used an econometric model to estimate stochastic production function with cross-section heteroscedasticity and simulated the impact of agro-adaptation by altering planting date. The results from the error component model showed that the acreage of crops whose mean rice production and variability increased. The trend has positive impact on the mean rice production and tends to reduce the variance of production. The results implied that an increase in temperature suggested an inverse effect on the mean production and consistently induced more variability of rice production. The impacts of precipitation on rice production vary across different models. Simulation results for agro-adaptation indicated that the impacts of weather on rice production decreased by shifting the planting date. The simulation results revealed that the appropriate adaptation measure can reduce rice production uncertainties in Northern Thailand. The results of this study suggested that it is necessary to take immediate adaptive actions to mitigate the decreases in rice production. In particular, the case of rice production in Northern Thailand, decreased in production under future weather condition can be mitigated significantly using proper management practices in terms of altering planting dates.

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Post-Occupancy Performance of LEED Certified Buildings in Thailand: Case Study International School of Bangkok

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Abstract: This study was designed to measure the post-occupancy performance of LEED certified buildings in Thailand. LEED buildings are certified based on predicted performance, estimated by the project team, rather than actual performance. Green design is marketed on two predominate platforms i.e., an environmental benefit and a financial benefit, both of which are achieved through the same mean, energy reduction. With very little research to date, further post-occupancy performance studies are needed in order to effectively analyze the regional post-occupancy performance of LEED certified buildings. At the start of this study, there were five LEED certified buildings in Thailand; however, due to various reasons such as insufficient data or an inability to provide necessary data, not all of the buildings were eligible to participate. Accordingly, the International School of Bangkok (ISB) Cultural Center was used as an intensive case study. This post-occupancy performance study includes analyses of ISB energy consumption, emissions, and Energy Use Intensity (EUI), in comparison to the modeled baseline and predicted estimate i.e., actual performance compared to predicted performance. Further, the Cultural Center EUI was compared with national average EUI, as well as sector-based EUI, in order to determine if there was any benefit over the national average performance of non-certified buildings. Lastly, additional perceived performance benefits such as increased comfort and satisfaction, health, and productivity were evaluated

Keywords: Post-occupancy, Performance, Energy use intensity (EUI), LEED, Value

INTRODUCTION

Leadership in Energy & Environmental Design (LEED), part of the green movement, was implemented to offer a solution to a problem. The trend toward green technology has been driven by two main factors. First, environmental concerns have increased the urgency to preserve our natural resources as climate change, deforestation, and biodiversity loss pose critical risks to the well-being of mankind [1]. In turn, these concerns have driven policies resulting in more stringent environmental regulations. Environmental regulations increase operating cost and reduce competitiveness, resulting in billions of dollars in increased compliance costs and lost profits every year [2]. Subsequently, businesses begin to look for ways in they can meet environmental objectives while reducing compliance, production, or operating cost. Green design has increasingly been seen as a way to meet those objectives. Many businesses operating in developed, highly regulated countries have chosen to outsource productions to less developed countries, increasing their competitive advantage by lowering regulatory and labor costs. However, the Environmental Kuznets Curve (EKC) theory, developed by Grossman and Kruger, suggests that this is only a temporary solution. Grossman and Kruger analyzed air quality metrics in relationship to GDP and found that, "...an inverted U-shaped relationship appears: at relatively low levels of income per capita,

growth leads to greater environmental damage, until it levels off at an intermediate level of income, between 5,000 and 6,000 USD.”[3] The idea behind the EKC is that, although growth is bad for environmental quality at the initial stages of industrialization, later on it reduces pollution, as countries become wealthy enough to pay to clean up their environment [4]. Grossman and Kruger believed that as countries got richer, citizens began to assert pressure on their governments for cleaner environments [5]. Several subsequent studies produced the same results.

Therefore, as GDP increases, the financial burden of regulations will increase, and Thailand will face the same problem. After analyzing the EKC relationship in Thailand, results showed that all air quality metrics revealed a decreasing trend, while GDP showed the reciprocal. The trend towards increased environmental preservation and energy efficiency is evident. The Thai court recently ruled in favor of local green activists, placing environmental concerns over business agenda. As a result, the Thai government suspended \$12 billion in investments to Map Ta Phut [6].

LEED certification was established by the United States Green Building Council (USGBC) in order to verify the sustainability of built projects. To date, there have been numerous studies designed to compare and evaluate the costs and benefits of green design. Studies have shown green design to be a financially viable investment, where benefits typically outweigh associated costs. One of the earliest studies, conducted for the city of Portland, revealed a lifecycle savings of 15 percent [7]. A prominent 2002 study found that short-term costs increased with the level of sustainability; however, long-term costs decreased significantly [8]. Similarly, a cost benefit analysis of 33 California based buildings found that the benefits, which include a cost savings derived from reduced energy, water, and waste lowered operations and maintenance costs, increased occupant productivity and health, resulting in a financial benefit that outweighed the initial investment by ten times [9]. A 2007 study presented at the National Conference on Building Commissioning found that in 9 of 11 projects, energy savings offset all of LEED associated soft and hard costs [10]. *The Green Trend Outlook 2011* shows benefits for new construction and retrofits, resulting in an 8.5 to 13.6 percent reduction in operating cost, with an increase in building value between 6.8 to 10.9 percent. Further, improvements to ROI ranged from 9.9 to 19.2 percent, with an increased occupancy of 2.5 to 6.4 percent. Additionally, rental value was increased from 1 to 6.1 percent [11]. Typically, green buildings are noted as having a higher initial cost, or a green premium, arising from requirements such as energy modeling, documentation and certification fees, commissioning, and increased design and construction fees [12]. Although the green premium associated with sustainable design varies from study to study, it typically ranges between 1 and 6 percent, with the 1 to 3 percent range most commonly accepted. While most research studies show average green premiums that fall within this range, the predominant consensus is that the costs of buildings vary greatly both in LEED and non-LEED certified buildings.

Although numerous studies have focused on LEED buildings, until recently there has not been a broad assessment of LEED post-occupancy performance. In 2007, the New Building Institute (NBI) conducted research that analyzed 121 LEED-NC (new construction) buildings. The study analyzed the post-occupancy performance of buildings certified through 2006. The basic benchmark of the study compared the EUI of LEED buildings to that of national stock (non-certified buildings). The report concluded that on average, LEED buildings are living up to their predicted performance. The study showed that the LEED buildings provided an energy savings between 25 and 30 percent, with Gold and Platinum buildings averaging the best performance. Despite the overall positive results, the wide scatter indicates that there are areas that need improvement. The large range of variability in EUI must be reduced in order to provide precise quantification of overall energy savings [13].

The “Regional Building Case Study Project” (RBCSP) published in 2009, is the only other post occupancy study of LEED certified performance [14]. The LEED standard of certifying projects based on predicted energy savings, rather than the actual energy savings has attracted criticism. Further, critics propose that findings were intentionally presented in a manner designed to portray more favorable results. Analysts’ frequent use of the median LEED, EUI data in comparison to the Commercial Building Energy Consumption Survey’s (CBECS) national average EUI is cited as an unrepresentative and meaningless comparison, as a mean to mean comparison gives a more accurate portrayal [15].

In addition, several studies have found that there are additional or perceived benefits to LEED, such as increased health, comfort, satisfaction, and productivity. Research has suggested that improved indoor air quality, day-lighting, lighting control, temperature control, increased ventilation, and indoor environmental quality of LEED buildings can increase productivity and result in long term financial savings. One of the most commonly cited research studies is an early study conducted by Greg Kats in 2003. After analyzing a wide range of variables that contribute to perceived or additional LEED added value from 33 LEED certified buildings, Kats concluded that even at the low end of the range there was a 1 percent productivity gain for Certified and Silver buildings, equivalent to \$665 per employee per year, or \$2.96/ft² per year. Additionally, Gold and Platinum buildings saw a 1.5 percent increase in productivity, resulting in gains of \$998 per employee per year, or \$4.44/ft² per year. Additionally it has been noted, that there is a large range in potential productivity and health gains from improved indoor environmental quality.”[16] A similar study published in *Forthcoming in the Journal of Sustainable Real Estate*, estimated PV of productivity gains for LEED certified buildings at \$153.61 per ft² in comparison to Kats’ low estimate range of \$37 to \$55[17]. Since Kats’ research, there have been numerous studies that have highlighted additional positive benefits of green design. For instance, researchers have found that buildings with improved indoor environmental quality (IEQ) have shown a 40 percent reduction in absenteeism and a 5 percent increase in productivity.

The sustainable building idea asserts that buildings which are LEED certified offer two main benefits. First, they lower operating cost by reducing energy consumption. Secondly, there is simultaneous reduction in emissions due to the direct correlation of energy consumption and emission levels. In order to analyze performance and determine if there is indeed a reduction in energy consumption as well as emissions, actual post-occupancy performance data, including energy consumption, must be evaluated and compared to the baseline model and national averages. Since energy consumption directly correlates to emission levels, emissions are estimated using site energy consumption data. Further, the financial benefit can be estimated only when an actual reduction of energy consumption is exhibited over the baseline model and national average. Additionally, it is suggested that LEED certified buildings may have additional perceived benefits, such as increased occupant comfort and satisfaction, resulting in increased productivity. Improved indoor air quality and day-lighting may improve occupants’ health. Perceived benefits are therefore measured through the use of a questionnaire designed to identify key metrics of user satisfaction.

MATERIALS AND METHODS

This research uses a mixed method and has been divided into 3 categories for analysis: the Environmental Kuznets Curve analysis, the post-occupancy performance analysis, and the additional perceived benefit analysis. The EKC analysis uses a quantitative method in which secondary data was gathered through a government database. The EKC is analyzed in order to establish a correlated trend between air quality and GDP. The Thai Meteorological Department, Bangna and the Thonburi Power Substation were utilized, as

they provided the most complete data sets spanning from 1996 to 2010. The post-occupancy performance analysis (POP) uses a mixed method in which primary data was gathered through an in-depth interview in order to identify the driving factors that encouraged ISB's decision to invest in LEED. The in-depth interview was used to identify ISB's perception of LEED and expected value. Additionally, it was used to gather company documents detailing energy and water consumption. A general building survey was conducted to provide general project information including location, square meters, primary building activity, date of full occupancy, LEED certification level, sustainable features, and project team. Energy consumption, water consumption, and the general building survey are used to derive financial and environmental performance. Secondary data was collected from the project team and government agencies to be used as comparison data. Lastly, the additional perceived performance benefit analysis (APB) uses a mixed method. The quantitative analysis utilizes a five point Likert scale survey to analyze eight key comfort and satisfaction metrics including: overall physical environment, air quality, temperature comfort, lighting comfort, noise level, privacy, health, and productivity. Additionally, the survey includes a secondary qualitative analysis generating data through the use of open-ended, questions in which occupants were given an opportunity to identify any additional areas of satisfaction/dissatisfaction that were not already addressed in the survey allowing participants to more fully describe perceived performance.

RESULTS AND DISCUSSION

The EKC analysis revealed that all air quality measures show a decreasing trend, while GDP shows the reciprocal, that is, as GDP increases, air pollution consistently decreases. Results support the research theory that once the critical level of wealth is achieved, governments begin the process of environmental clean-up; thus, resulting in increased environmental regulations and enforcement. This suggests that naturally, as Thailand continues towards first world status, environmental regulations and enforcement will continue to increase, thus increasing the financial burden associated with environmental regulations. As regulatory costs increase, the trend in green building is predicted to increase. Further, evidence shows that the green building trend is increasing in Thailand. At the start of this study, there were 5 LEED certified buildings and 8 registered buildings. In just a few years' time, these figures increased dramatically; today there are 13 certified buildings and 43 registered projects [18]. This represents a 160 percent increase in the number of LEED certified buildings and a 600 percent increase in the number of registered projects.

The post-occupancy performance analysis shows that the International School of Bangkok's (ISB) baseline and predicted estimates were projected at 1,083,441 and 751,713 kilowatt hours per annum respectively [19]. This represents a 31 percent decrease in energy consumption for the predicted estimate over the baseline. The actual kilowatt hours consumed were measured at 647,734, which indicates that the building is performing better than predicted, represented by a 14 percent decrease over the predicted estimate and a 40 percent decrease over the baseline [20]. In terms of financial benefit, this equates to an additional annual savings of 338,760 baht above the predicted estimate and 1,403,561 baht over the baseline. Using the baseline modeled energy consumption of 1,083 MWh, emissions are estimated at 548 tCO₂ per annum with the predicted estimate decreasing CO₂ emissions by 31 percent. Actual measured energy consumption (327.5 tCO₂) reduced emissions over the baseline by 40 percent and was 14 percent lower than the modeled prediction (380 tCO₂). As environmental performance and energy performance are closely correlated, we can see that environmental performance is higher than the initial estimates. National average EUI was calculated at 176.58 kWh/m² with the education sector-based EUI at 105.1 kWh/m². EUI for

ISB's cultural center, which is categorized as an education facility, has been calculated at 65.99 kWh/m², which represents a 63 percent decrease over the national average, and a 37 percent decrease over average EUI for education facilities. These results show a significant reduction in energy consumption and closely mirror the 40 percent decrease over the estimated baseline shown in the energy performance analysis.

The actual billed water consumption in 2011 was much higher than both the modeled baseline and predicted estimate. It is important to mention that occupancy is variable and can range from 470 to 730 occupants [21]. Moreover, the facility is used after hours and the theater holds additional events, none of which are accounted for in the minimum modeled estimates. Furthermore, it must be noted that a water leak has been acknowledged somewhere in the pre-existing buildings and because the plumbing infrastructure is interconnected, with much of it running underneath the pre-existing buildings, the leak has been difficult to resolve. Although the leak is not directly related to the Cultural Center, it has skewed the water consumption data. Therefore, water consumption performance cannot be accurately estimated at this time and is not included in the overall financial analysis[22].

CONCLUSION

ISB exhibits a performance benefit over non-LEED buildings. The largest post-occupancy performance study conducted by New Building Institute estimated energy savings between 25 and 30 percent [23], which is much higher than the subsequent study. The "Regional Green Building Case Study Project" estimated energy savings at 5 percent [24]. Both of the previous studies found a large range in performance variability when comparing measured performance to modeled performance and in measured EUI. The analysis of ISB's Cultural Center is presented as a case study; therefore, performance variability cannot be expressed; however, it must be noted that in multiple sample scenarios, performance variability should be expected. When examining LEED performance, it is important to remember that LEED accreditation is not a one design fits all process, and there are many different design features used to optimize performance. While some designs may meet or exceed their predicted performance, others may fall drastically short, as identified in the previous studies. Furthermore, energy efficiency will fluctuate over the life span of a building due to a multitude of variables, such as temperature, energy cost fluctuation, life span and maintenance of mechanical features, specifications of replacements and deterioration of building components, etc. As a building's mechanical equipment ages, it becomes less energy efficient, and therefore affects overall building performance. Numerous variables can significantly affect overall performance, showing that variability of building deterioration and maintenance play a critical role. The combined results of post-occupancy performance studies have indicated there is an overall performance benefit when comparing LEED to non-LEED performance. It must be noted that ISB exhibited a measured EUI that was much higher than the previous studies estimated. As it has been discussed, there are many variables that affect individual building performance. ISB's increased performance suggests there is an additional, regional benefit. As climate and temperature can significantly affect performance, regions which exhibit less seasonal fluctuation may experience a greater performance benefit. In regions where buildings must be designed for both hot and cold weather, energy efficient designs present greater difficulty. In regions where seasonal extremes are a factor, overhangs designed to reduce the energy needed to cool a building in the summer months, may result in higher energy consumption used to heat the building during winter months. Additionally, on-site energy generation, such as photovoltaic energy, will be more productive in regions that exhibit consistently, sunnier weather patterns. Clearly, ISB's increased EUI measurement indicates the probable existence of an additional, regional benefit.

In conclusion, ISB exhibits both significant financial and environmental benefits. Measured performance has exceeded the predicted performance, signifying that in this case, the measured value is higher than expected investment value. After combining all post-occupancy performance research results, it is determined that there is an overall performance benefit of LEED to non-LEED buildings; however, individual building performance is widely variable. The additional perceived performance benefit analysis revealed that overall satisfaction ranked in the 92nd percentile. Seventy-five percent of participants noted that they are more productive at work when their physical surroundings are comfortable. It has often been suggested that the physical environment contributes to productivity and the participants themselves perceive this relationship, however more research into this topic is needed, but in this instance overall comfort and satisfaction can be viewed as an additional benefit to sustainable design [25]. Research studies designed to quantify the value of perceived benefits have demonstrated significant financial gains. Expected benefits include customer retention and attraction, decreased operation and maintenance cost, greater productivity, employee retention and recruitment, and increased tenancy and rental values. Research shows that LEED certification increases customer retention and attraction by an estimated 73 percent. Additionally, studies have indicated that LEED certification exhibits an increase in tenant demand [26]. Additional perception benefits associated with increased demand and differentiation premiums are applicable to ISB. These benefits could potentially result in higher future enrollment and increased tuition prices. In this case study, evidence supports the existence of additional financial benefits resulting from ISB's LEED investment. Additional benefits could significantly increase the overall performance value of ISB's Cultural Center.

Green building certification has increased worldwide and this trend, mirrored by the rapid growth of LEED certification in Thailand, is clearly shown. Building construction and operation account for a significant amount of energy consumption and GHG emissions worldwide. The increased interest in green building presents an opportunity for the Thai government to minimize environmental risks, while shifting some of the burden to the non-government sector. Furthermore, Thailand's CO₂ emissions from fuel combustion have increased by 202.4 percent between 1990 and 2008. Thailand has the fourth highest CO₂ emissions out of the eighteen referenced Asian countries, excluding China [27]. The current worldwide emphasis to reduce energy consumption has resulted in international collaborations designed to address environmental concerns, and carbon credit permit systems have long been underway. The adoption of international environmental agreements could have a significant impact on the future of multilateral trade. It is pertinent for governments to encourage efforts and adopt standards that are designed to reduce energy consumption and emissions. Significantly reducing national emission levels and energy consumption provides substantial economic gains and risk avoidance. Many countries already offer tax incentives designed to encourage green investment, and tax incentives are shown to increase the expected benefit of LEED by 39 percent [28]. It is recommended that Thailand's government adopt an incentive program to promote green building, as there are significant environmental and economic benefits. As previous research has indicated a wide variability in individual performance, it is recommended that further research be conducted to establish the areas which exhibit maximum and minimum performance benefits. Evidence indicates the existence of perceived performance benefits, which have been shown to increase productivity, health, and occupant comfort and satisfaction. This research should be expanded upon to include a regional, post-occupancy performance analysis of the financial gains in terms of net present value. The additional perceived benefit analysis highlights areas which may be used to improve occupant comfort and satisfaction. Lastly, as this research is limited by the small population, further research is recommended. As the population of Thai LEED

certified buildings grow, longer and more abundant data sets will provide stakeholders with a definitive picture of overall performance.

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Understanding of ASEAN Economic Community (AEC): Scale Development and Validation across Singapore, Thailand and Vietnam

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Abstract: This study develops and validates a new scale to explore the understanding of ASEAN economic community (AEC) among citizens of Singapore, Thailand, and Vietnam, three ASEAN member nations with contrasting levels of economic development and histories. Data were collected via self-administered questionnaires in three official languages (English, Thai and Vietnamese). The final usable samples include 857 Singaporeans, 2,275 Thais, and 265 Vietnamese. The findings reveal both similarities and differences in the way people from these three nations understand AEC. From an initial pool of 14 items, the results from exploratory factor analysis suggested the elimination of four items that were not similarly perceived by people of these national groups. The remaining ten items that were consistently loaded into two similar factors across the three nationals revealed two underlying concepts. The first concept consists of five items, which reflect ‘Regional Competitive Integration’ (RCI), and the second concept comprises a group of five items indicating ‘Regional Economic Cooperation’ (REC). To assess scale reliability, validity, and measurement equivalence of these two concepts, a multiple group confirmatory factor analysis was conducted. The results show that both five-item scales of RCI and REC are reliable and valid as well as possess factorial equivalence or metric invariance. Therefore, future research can incorporate these two concepts into study related to the understanding of regional economic integration by adopting these newly developed scales and perform cross-cultural comparisons.

Keywords: Understanding of AEC, Regional Competitive Integration, Regional Economic Cooperation, Measurement Equivalence, Multiple-group confirmatory factor analysis

INTRODUCTION

Regional economic integration refers to a process by which countries in geographic proximity collaborate to encourage free flows of goods, services, human and capital resources [1]. The ASEAN Economic Community (AEC) represents one such integration with ten member nations, including Brunei Darussalam, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam. Although these countries are pursuing a similar economic goal of having ‘one vision’ or ‘one identity’ by being ‘one community’ by 2015, they greatly differ from one another with respect to market size (population), economic development (GDP), and international trade (exports-imports). Table 1 summarizes the characteristics of these key indicators and compares the ten ASEAN Nations.

Table 1 Key Indicators of ASEAN Members

	Population (July 2013 est.)	GDP (PPP) USD (2012 est.)	Exports (USD billion-2011 est.)	Imports (USD billion-2011 est.)
Brunei	415,717	50,500	12.75	3.02
Cambodia	15,205,539	2,400	6.155	8.213
Indonesia	251,160,124	5,000	201.5	166.1
Laos	6,695,166	3,000	2.131	2.336
Malaysia	29,628,392	16,900	227.5	202.4
Myanmar	55,167,330	1,400	8.196	5.982
Philippine s	105,720,644	4,300	47.49	63.01
Singapore	5,460,302	60,900	409.2	365.4
Thailand	67,448,120	10,000	219.1	202.1
Vietnam	92,477,857	3,500	96.91	97.36

Source: CIA The World Factbook

In order to achieve the goal of being a single regional economic community, a uniform understanding of AEC should be clearly communicated to the citizens of all member states. Therefore, this study explores how nationals of Thailand, Singapore and Vietnam understand the AEC. These countries were selected based on their contrasting characteristics, with Singapore and Vietnam representing ASEAN members situated at the two extremes of economic development and Thailand in the middle. More specifically, with respect to economic development, Singapore leads the other two nations while Vietnam is among the bottom four economies of the ten ASEAN members. In terms of market size, Singapore is the second smallest economy while Vietnam is the third largest in the region. As for international trade, Singapore has the highest volume, whereas Thailand and Vietnam rank third and fifth, respectively.

LITERATURE REVIEW AND RESEARCH OBJECTIVES

Building on Podok and Thoumrungroje's [2] study which explored the understanding of AEC among citizens of Singaporeans and Thais, this study included a third nation, Vietnam, to investigate the uniform understanding of AEC among people of these three economies. Unlike Podok and Thoumrungroje [2] who only examined the pattern of factor loadings of the scale measuring people's understanding of AEC with exploratory factor analysis, this paper aims to test the metric equivalence, by means of a multiple-group confirmatory factor analysis using structural equation modeling (SEM), of the scale across three contrasting economies of three member nations of ASEAN.

METHODOLOGY

Singapore, Thailand and Vietnam provide interesting and contrasting contexts for testing the performance of a scale to measure understanding of AEC due to their different economic developments and histories. To best assess the understanding of AEC among citizens of these countries, a self-administered survey was used to collect data.

Sample and Data Collection

In order to ensure that the samples can represent the population of interest, purposive and quota sampling techniques were applied to select the respondents. According to the CIA World Factbook [3], the median age in years of Singaporeans, Thais, and Vietnamese are 33.6, 35.1, and 28.7, respectively. The sex ratios are almost equally divided across three nations. Therefore, respondents were approached based on the age and sex criteria. In Thailand, data were collected using an intercept technique while electronic mail was used to collect data from Singaporeans and Vietnamese. The final sample sizes yielded 857 Singaporeans, 2,275 Thais, and 265 Vietnamese. Although these sample sizes are not proportionate to the actual populations of the three nations, the samples possess the age and sex divisions that approximate the national statistics. Specifically, the median age and sex ratio of the three samples are similar to those of the nations.

Measures and Scale Assessment

From a review of what AEC aims to achieve by 2015, fourteen items reflecting the understanding of AEC were generated and rated on 6-point Likert scales (1 = ‘strongly disagree’ and 6 = ‘strongly agree’).

Table 2 Scale Items*

UND1. The AEC will be a single market by 2015.
UND2. The AEC aims to be a single production base for the region.
UND3. The AEC attempts to be a highly competitive economic region.
UND4. The AEC wants to be a region with equitable economic development among member nations.
UND5. The AEC attempts to be a region that will be fully integrated into global economy.
UND6. The AEC members will cooperate in developing human resources.
UND7. The AEC members will help one another build capacity.
UND8. The AEC members will closely consult one another on macroeconomic and financial policies.
UND9. The AEC members will cooperate in enhancing infrastructure and communication connectivity.
UND10. The AEC members will develop electronic transactions through e-ASEAN.
UND11. The AEC members will work together to integrate industries across the region so that regional sourcing can be achieved.
UND12. The AEC will be a region with free movement of goods and services.
UND13. By 2015, skilled laborers will be freely moved across member nations of AEC.
UND14. Capitals and investments will be moved more freely within the AEC region.

* **Bolded items were eliminated from further analysis due to their inconsistent pattern of factor loadings across nations.**

Table 2 shows the list of the items used. The results from exploratory factor analysis (EFA) indicate that four items (UND4, UND5, UND10, and UND12) were not consistently loaded with the same factors across three countries so they were removed from further analysis. The remaining ten items form two distinct concepts: 1) Regional Competitive Integration (RCI); and, 2) Regional Economic Cooperation (REC). Five items that constitute RCI are UND1, UND2, UND3, UND13, and UND14 while the other five items (UND6, UND7, UND8, UND9 and UND11) reflect REC.

Item reliability was assessed using squared multiple correlations (R^2) [4] while scale reliability and construct reliability were assessed by means of Cronbach’s alpha (α) and composite reliability (ρ_c) [5, 6], respectively. Scale validity was evaluated by standardized

factor loadings (λ) and the significance levels of the factor loadings [4]. In order to assess metric equivalence in the scale, a multiple-group confirmatory factor analysis was conducted by means of structural equation modeling. Following the procedures outlined in Bensaou, Coyne and Venkatraman [7], Singh [8], and Steenkamp and Baumgartner [9], several models were compared to evaluate the extent of scale equivalence.

RESULTS AND DISCUSSION

Table 3 presents the results from a scale assessment. All factor loadings are significant at $p < .01$ with standardized loadings ranging from .512 to .927, which indicate substantial relationships between each item and the designated construct [4]. This result confirms construct validity. As for item reliability, all, except one (i.e., UND7 in Singaporean sample), squared multiple correlations are above 0.4, suggesting that most items are reliable. Although item UND7 in the Singaporean sample shows a low R^2 , the factor loading is still significant at $p < .01$. Therefore, the item is still a valid measure of REC. To assess the reliability of the construct, all composite reliabilities are above a minimum threshold of 0.6 [5] while all Cronbach's alphas are between .847 and .974, which are beyond the minimum acceptable level of 0.6 [10]. Hence, the constructs and scales were proven reliable.

Table 3 Scale Assessment

Items	Singapore				Thailand				Vietnam			
	λ	R^2	ρ_c	α	λ	R^2	ρ_c	α	λ	R^2	ρ_c	α
UND1	.716	.513			.637	.406			.762	.581		
UND2	.729	.532			.703	.494			.845	.715		
UND3	.742	.551	.650	.884	.772	.596	.654	.848	.868	.753	.668	.907
UND13	.822	.675			.744	.553			.740	.547		
UND14	.853	.728			.772	.596			.860	.740		
UND6	.821	.674			.812	.660			.873	.762		
UND7	.512	.262			.846	.716			.898	.806		
UND8	.875	.766	.574	.847	.817	.667	.811	.913	.927	.860	.839	.974
UND9	.886	.785			.825	.681			.887	.787		
UND11	.852	.725			.817	.668			.843	.710		

As discussed in great detail in previous literature on measurement equivalence [7, 8, 9], three fundamental levels of scale equivalence (from least-to-most rigorous forms) include: 1) same form [7] or factorial similarity [8] or configural invariance [9]; 2) factorial equivalence [7, 8] or metric invariance [9]; and, 3) error variance equivalence [7] or measurement equivalence [8] or error variance invariance [9]. While the first level ensures that similar items constitute the same designated factor, the second and third levels require uniform factor loadings, and error variances across cultural groups, respectively. In this study, both RCI and REC scales were proved to have factorial equivalence or metric invariance, whereby equivalent factor loading of each item to its designated construct is achieved across three cultural groups. As shown in Table 4, Model 1 is unconstrained, Model 2 is a model where factor loadings were constrained to be the same across three subgroups, and Model 3 represents a fully restricted model in which both factor loadings and error variances were constrained to be equivalent across three groups. Since the change in χ^2 ($\Delta\chi^2 = 21.732$, d.f. = 16) is not significant (p-value = .152) in Model 2, but significant (p-value < .000) in Model 3 ($\Delta\chi^2 = 21.732$, d.f. = 16), these results indicate that the RCI and REC scale possess factorial equivalence or metric invariance.

Table 4 Results of Testing Scale Equivalence

Model 1		Model 2				Model 3			
χ^2 (d.f.)	p-value	χ^2 (d.f.)	p-value	$\Delta\chi^2$ (d.f.)	p-value	χ^2 (d.f.)	p-value	$\Delta\chi^2$ (d.f.)	p-value
938.010 (96)	.000	959.742 (112)	.000	21.732 (16)	.152	4105.097 (158)	.000	3167.087 (62)	.000

Although the model χ^2 of 959.742 with 112 degree of freedom is significant ($p = .000$), which does not indicate good fit, the chi-square statistic has been documented to be sensitive to sample size; therefore, other fit indices should be used to assess the model [6]. The comparative fit index (CFI) is .964, the non-normed fit index (NNFI) or Tucker-Lewis index (TLI) is .956, and the root mean square error of approximation (RMSEA) is .047. These indices reveal good fit, i.e., $CFI \geq .95$, $NNFI \geq .95$ and $RMSEA \leq .06$, based on the suggestions of Hu and Bentler [11, 12]. Hence, the model fits the data well.

CONCLUSION, IMPLICATIONS AND SUGGESTIONS FOR FUTURE RESEARCH

Conclusion

This study provides empirical evidence of how citizens of three ASEAN countries with contrasting levels of economic development understand the essence of the ASEAN Economic Community (AEC). From the results, the understanding towards AEC is similar across Singapore, Thailand and Vietnam. The first common understanding is that AEC reflects ‘regional competitive integration’ (RCI) where member nations become a single market and production base with free resource mobility to enhance the competitiveness of the region. The second underlying factor emphasizes ‘regional economic cooperation’ (REC) the cross-border collaboration among member nations in order to promote economic development. Both RCI and REC scales consist of five items that manifest the underlying concepts. The scales were proved to be reliable, valid, and equivalent across the three economies. This implies that the authorities responsible for promoting a uniform understanding of AEC among nationals of member states have achieved this objective.

Implications and Suggestions for Future Research

Given the cross-cultural equivalence nature of both RCI and REC scales, future research may adopt these two concepts in order to examine their antecedents and consequences. On the one hand, policy makers may search for strategies or policies that help enhance regional competitive integration and regional economic cooperation among members. This is deemed necessary so that national and regional endeavors can be tailored to help member nations achieve the AEC’s goal of being a single regional economic community. On the other hand, the outcomes of the RCI and REC in terms of national and regional economic developments as well as improvements in business performances should be investigated.

Future research may also validate the scales across other ASEAN nations. This study only selects three countries, each of which represents an economy at different stages of development. Furthermore, an application of institutional theory to explain the role of regulatory, normative and cognitive institutions in shaping both individuals and organizations to become regional citizens is also worth conducting. Based on Dimaggio and Powell [13] and Busenitz, Gómez and Spencer [14], a country institutional environment, which includes regulatory, normative, and cognitive entities can assert pressures on the members—both organizations and individuals—to ensure that homogeneity in the belief and behavior is institutionalized and legitimacy is attained. Therefore, research studies that investigate the

influence of a country institutional profile on a uniform understanding and cooperation for the achievement of a common goal among citizens are warranted. This application of institutional theory also represents an extension of the theory to study a phenomenon at the individual level. Moreover, the results from such studies will potentially enable government and related authorities to identify which institution is more or less influential in shaping the member organizations and individuals so that relevant policies can be designed.

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Use of Blog, Web-based Lessons and Electronic Feedback in Language Teaching: Readiness of ASEAN Teachers and Students for 21st Century Classroom

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Abstract: The approaching ASEAN Economic Community (AEC) would certainly demand a tremendous explosion of English-related work in ASEAN members. Need for proficient English workforce has made the study of English more important than ever. This paper identifies and discussed the effectiveness of the three instructional tools, namely, blog, Web-based lesson and electronic feedback in EFL writing classes in university teaching. The present studies aimed at developing student's writing competence partially in the cultures and English of ASEAN countries which considered very important. The results from incorporating these three tools into EFL writing classes for University student are presented and these in relation to students' participation and learning outcomes are discussed. Beside students' learning performance, it is also argued that teachers and their roles are significantly crucial and that their engagement with technology in education is closely related to success in ICT integration in language teaching. It is concluded that a more evidence-based model for deriving the positioning would allow the teaching professionals to move from a framework to a genuine taxonomy.

Keywords: Blog, Web-based lesson, Electronic feedback, Teacher professional development, Educational technology

INTRODUCTION

English is as important to Association of Southeast Asian Nations or ASEAN region as it is to the globe. Universities in this region aim at helping their students to be knowledgeable in English language to be eligible employees in AEC market. Even though English is one of the greatest main concerns, it is one of the least successful subjects in many ASEAN countries including in Thailand. To enhance the positive outcomes of language learning, technology is used as a teaching tool. It has become part of our life and increasingly affects our life. The increasing connection between English and technology leads to the integration of various types of technology into language classrooms. Technology makes classrooms which were used to rely on chalk and blackboard more interesting.

The fast growing of information and communication technology (ICT) has led to changes in class management. The Internet has accelerated the use of computers for education and has created critical changes on English language teaching and learning in several aspects. A variety of emerging technological tools are changing perceptions and process in pedagogy and optimizing the learning culture. The technological tools become a powerful instructional means in the 21st Century language classrooms. To language classrooms, these can be effective tools for improving communication skills, for example, reading can be enhanced with ICT-integrated materials. Segers and Verhoeven [1] found that using technology to make interactive storybooks helped learners to expand their vocabulary

and gain insight into the structure of narrative texts. Birmingham and Davies [2] used technology to enable learners to understand, visualize and interpret difficult texts and found that these technologies helped to develop students' understanding of language and their own critical literacy skills. This paper analyzes and discusses the values and problems of collaborative blogging, Web-based lessons and electronic feedback in the EFL classroom. In addition, it reviews problems in teachers' engagement with technology.

Roles of Educational Technology in Language Classrooms

It has become a necessity for teachers to respond to the demands of the modern global workforce requirements. Teachers need to keep in pace with 21st century technologies. First of all, teachers must understand the characteristics of their students. For example, Rodgers [3] shares that these new generation learners are likely to be keen at using sounds and images to convey contents whenever possible. They perform better when given multi-learning stimuli. Therefore, for example, teachers of writing skills need to consider accompanying the written tasks with visual and sound materials. These learners then, also crave interactivity, are good at reading visual images, have strong visual-spatial skills, tend toward parallel processing and inductive discovery, look for fast response times which leads to short attention spans.

For several decades, technology has contributed as teaching tools in the language and second language classrooms [4]. The Internet, particularly, has become a useful tool for communication, a venue for experiencing different cultures and a mediator in diverse political, social and economical situations. The four skills in language learning (listening, speaking, reading and writing) have recently been taught using various methods and technology. Technology has achieved satisfactory outcomes in language learning. Of these four skills, it is quite agreed among EFL teachers that writing is the skill with which many teachers have the least success. Many teachers, although realizing the importance of teaching writing skills to students, also think writing tasks are time-consuming and difficult to teach. Several research studies have confirmed that Thai learners have poor performance in writing [5-7]. Similarly, Wongsothorn et al. [8] declared that pre-tertiary students produced very poor writing pieces in the national assessment. Some teachers [9] blamed the lack of experience in writing as the main barrier to quality of students' written products.

It is observed that technology advantages us in several ways [10, 11]. Many of these tools can be used by teachers for language learning purposes. Of these, weblog, Web-based lessons and some Web tools (e.g., email, chat rooms and social media) are currently familiar and recognized by many. Obviously, integrating technology into the classroom especially for English as foreign language (EFL) promotes positive learning outcomes as well as learners' motivation.

Use of Web-Based Course, Class Blogging and Electronic Feedback in EFL Writing

Today's students write much more via computer than they otherwise would with pen and paper, computer-based collaborative activities are likely to effectively enhance their writing ability and are critical for students' mastery of language. Technology also helps students integrate issues of language and culture and that they become active users of the language. It has enormously influenced the way teachers and students organize classes. Computer technology alleviates issues of access to information and learning resources. Due to this fascination, technology has become an educational tool supporting the strong belief that it could improve students' attention and interest in learning. Technology also makes the lesson more efficient when used appropriately in the classroom. Several kinds of technology have been successfully used in the EFL classroom; however, this paper focuses on blogging, Web-based lessons and electronic feedback for improving the writing skills of EFL students.

Class Blogging

Blogs have existed on the Internet since 1998. Later, in August 1999, Blogger, a free blog hosting service, was launched. This fostered the rapid growth of blog sites [12]. A blog is an online personal journal that can be updated as frequently as the author wishes. Blogs are popular in several areas and therefore it is no wonder that education cannot afford to ignore this development. As blogs provide space and tools for writing, EFL writing can employ blogs as a powerful teaching tool.

Blogs could be a replacement for the traditional cycle used to manage a writing class. The traditional writing classroom normally involves the lodgment, marking and return of student assessment. These procedures have been done manually and require a great deal of effort by the instructor to manage the papers. Moreover, the teacher needs to be aware of the turnaround time. The worst problems are accountability, and assignment tracking and security. It is also worth mentioning that this way of managing a writing class requires a lot of paper for the drafting, writing and feedback.

Bloggng, similarly to online chain discussion groups, is an easy way to engage with students' writing in the classroom. It is an effective way to manage the lodgment, marking and return of student assessment with no fuss [13, 14]. Blogging using Google's Blogger.com, LiveJournal.com and WordPress.com is free and easy to set up, manage and update without additional support. As many students are active users of Facebook, Twitter or hi5, they have become familiar with blogging [13].

It was found that blogs allowed a user to check the changes that was made to his/her blog with no fuss. While with other tools, a user needed to "check in" occasionally to see if there is any new content posted, blogs made use of a "publish-subscribe" model in which the subscribers received notifications when new content was posted. In the writing classroom, therefore, blogs were qualified as a pedagogical tool [15].

In addition, blogging in the writing class could replace the cycle of steps in developing an essay: brainstorming, writing, submitting, receiving feedback, revising writing and resubmitting. Blogs clearly benefit the writing classroom. They enabled the instructor and students to communicate through and about writing. Both sides could easily update online writing.

These findings are in accordance with several recent works. For example, due to its ease of management, blogging in the EFL writing class enables students to exchange feedback. This is a characteristic of collaborative writing [16]. Both students and teacher learn how to negotiate [17-19] through blogs on the extent of student control and teacher intervention. In comparison with the traditional EFL class, it has been found that blogging promotes peer response activities [20] and that student's develop autonomous language learning ability [21]. Students have the opportunity to learn complexity and lexical diversity through feedback [22]. As noted by Bloch [23] and Pennington [24], it has been observed that students are highly motivated to write and to write well as a result of the nature of the online writing context.

To promote collaborative writing in class, the teacher is recommended to consider the activities involving with social media such as Facebook or blog. Students may be asked to do a project work in which they are required to work collaboratively in group with others.

Web-Based Lessons

Use of web-based instruction has expanded due to the fact that this enables access with no limitations on place and time [25, 26]. In education, the availability of the form of Web-

based instruction or technology in education provides useful information to help students gain knowledge. According to Khan [27], Web-based instruction is an innovation which transfers instruction to audiences living in other places by using the Web as a transferring tool. It creates education on the Web by using the Web as a medium in learning and contact [28]. In addition, it combines today's technology and instructional design methodology to increase learning effectiveness and solve problems of time and place [29, 30]. Moreover, Web-based instruction was defined as "the application of a repertoire of cognitively oriented instructional strategies implemented within a constructivist theory" by Perkin [31]. In other words, Web-based instruction is based on constructivist theory. In addition, Web-based instruction implements collaborative learning in which information and resources are utilized from the Web [25]. Web-based instruction is also known as a hypermedia-based instructional program creating a learning environment which encourages and develops people's knowledge by using the Web to access resources and information Khan [32].

Due to the fascinating characteristics of Web-based instruction, it is considered a powerful tool for promoting the teaching of writing in EFL classroom. The integration of Web-based instruction in learning and teaching is one effective teaching method [27] which is expected to help students to improve their use of conjunctions. The recommendations below are issues gathered from the study related to the application of Web-based lessons from Chomchiawchan and Khampusaen [33]:

- a. **Commitment:** There should be strong commitment between teachers and students. Since there is no coercion from teachers, students should be convinced or encouraged to join the Web-based lesson. Teachers should inform and lead students to believe that learning through a Web-based lesson also affects their learning. Teachers might emphasize the extra points that students would gain or the improved learning outcomes achieved through using this material as it would help them to develop their understanding of language use.
- b. **Characteristics of a Web-based lesson:** The activities in a Web-based lesson should be made attractive to increase students' motivation. The Web-based lesson should provide students with interaction. The Web-based lesson should also provide activities in which students can interact with their friends. These activities might come in the form of an online discussion or peer review. Teachers might raise some topics and encourage students to respond to. Students should be explicitly informed about both intrinsic and extrinsic motivation. For example, they should be directly tested on what they had learned in the Web-based lesson. This would intrinsically motivate their desire to learn through the Web-based lesson. Furthermore, extra points should be separately allocated without being included within other grading criteria. This could lead to students giving precedence to learning through the Web-based lesson. Since the design of the Web-based lesson could attract students' attention, the Web-based lesson should be well designed. Sound, animation or stimulating activities could be added to the Web-based lesson to gain students' attention.
- c. **Motivation in learning with Web-based instruction:** Students studying under a learner-centred approach need more intrinsic motivation. On this issue, Weimer [34] also gave an example of intrinsic motivation. Students being intrinsically motivated if they were tested on what they had learned on the course. Thus learner-centred

approach may actively engage students to all activities and could raise their level of motivation in learning.

- d. Web-based instruction and social media: The Web-based lesson should be applied within well-known social networking services such as Facebook or Twitter in order to provide easy access to students. These services are attractive and widely used by many people. With Facebook or Twitter, teachers and students would be able to easily connect to each other. They can both share interesting information and comment on their friends' status. Therefore, if the accounts for these subjects are registered with these social networking services, teachers would be able to reach their students and also to use these services as a medium for learning.

Electronic Feedback

Electronic feedback is a method in which teachers apply technology to give feedback [35]. Reviewing literature, it was believed that electronic feedback had potential to improve students' writing and to be capable of addressing the limitations of traditional feedback. In fact, a number of researchers have made critiques of strategies for teaching writing [36]. Strategies applied in the teaching of EFL writing mainly focus on grammar and the writing content [37]. Nevertheless, this usual strategy might not be effective enough for developing students' writing abilities. This might relate to providing feedback which is a main process in writing teaching strategies [38]. Hand-written and individual oral feedback which are the main methods in the EFL context have limitations in improving students' writing abilities. For example, students might correct the errors according to feedback given by the instructor without learning the issues behind the errors [39]. Moreover, written feedback was related to cultural issues [40]. In Thai culture for example, students may be afraid of losing face when they are given feedback in writing. In some strategies, teachers might give both written and oral feedback to students individually. These strategies might make students feel embarrassed. In addition, traditional feedback takes time. Students have to wait for their teacher's feedback before they rewrite their compositions. The process of giving feedback might also be problematic in terms of the amount of time consumed. Moreover, if students are not clear about the feedback provided, they may have to wait for a week to meet their lecturers again in order to discuss the unclear. Hand-written feedback might not be clear because of the limited space available in traditional written feedback. These problems might cause misunderstandings between the feedback givers and receivers. Therefore, the traditional way of giving feedback in the EFL context could be considered as a potential cause of problems in the EFL students' writing performance.

The advantages of electronic feedback are noted in Un-udom and Khampusaen [41]. Firstly, after receiving feedback, students were able to review their feedback and to make the decision about whether they wanted to accept it. Secondly, the process of electronic feedback was done online. Students felt more comfortable receiving comments without losing face which might be the case with classroom feedback. Moreover, the electronic method saved time because students could check the feedback online, and they could ask for more information by phone or email. In addition, teachers could more easily check whether students had copied their work from the Internet by searching for doubtful phrases or sentences using a search engine to trace the original sources. Therefore, plagiarism was greatly reduced. In addition, the function of the Review tab of Microsoft (MS) Office programs allowed additional comments on students' compositions to be made easily at New comment button. The clarity of feedback was found positively affected students' writing of compositions. Electronic feedback was therefore found helpful in improving writing skills in the EFL context.

The following section discusses findings that are of interest and recommendations on the application of electronic feedback to improve EFL students' writing [41]:

- a. Giving electronic feedback on students' writing allows students to see their mistakes and guides them on how to solve their errors. This might help them to improve their writing skill in both grammatical structure and composition content. Technological support in the EFL classroom has been discussed by studies such as those by Albirini [42]. These studies explained that technological support might contribute to an effective EFL classroom as teachers and students interact with each other more comfortably and teaching techniques such as the giving of feedback are supported. Therefore, this could explain why electronic feedback is effective in improving students' writing abilities.
- b. Giving feedback to students electronically plays an important role in the improvement of students' writing ability. At the very least, it is helpful in supporting the EFL writing classroom as confirmed by Yeh and Lo [43].
- c. Technology is a possible method for supporting the giving of feedback in Thai teaching of EFL writing. Furthermore, electronic feedback might be a good alternative method for solving problems such as students' copying habits since students have to consider the feedback before they accept it. In addition, posted links and PDF files guide them in learning how to solve their problems in writing. Moreover, as this method uses MS Word 2007 to give feedback to students, the software functions support the giving of feedback. Consequently, students can more clearly see their feedback, and the limitations of traditional feedback in terms of limited feedback space would be solved. Furthermore, the whole process is done online: students do not have to make an appointment to receive feedback which is what was usually done with traditional feedback. Therefore, the problem of the amount of time consumed could be solved. The use of this method is therefore recommended to address issues related to strict rules, for example, grammar and organization. In fact, it is an effective alternative method for solving writing errors in the Thai EFL context. This method seems to address the limitations of traditional feedback, dealing with errors in strict grammatical rules and organization.

Teachers' Engagement with Information Technological Tools

No matter how powerful and useful of computers, technology and the latest advances applicable to language teaching such as specialized websites, blogs, wikis, language teaching methodology, journals, and so in language teaching are, to some teachers these tools are still a source of fears and insecurity [4]. Although many educational institutions have done institutional efforts to prepare their personnel and equipment by spending large amounts in technology to prove the positive effects of integrating computers in language learning [44] and so, a lot of teachers still miss the proper attention, will to learn and appropriate attitude towards teaching with technologies. Many reasons (e. g., the lack of time for training) lead to low utility in using. One major concern commonly shown by both teachers and education boards is how to motivate and instruct teachers to integrate computers and ICT into their classes. It is stated that the quality of instructors who teach online courses cannot be guaranteed since anyone can put a course online [4, 45]. Prior to its effective and routine use, teachers need time to learn about technology in addition to the time required for course preparation. With regard to producing teaching materials, teachers definitely need more time and ongoing training. Cuban, Kirkpatrick and Peck [46] also found that, although the

increasing availability of computer equipment in schools offers easy access to computer resources, many teachers fail to alter their existing patterns of teaching.

Adding the challenge to the context, the demands on teachers and their delivery needs are usually ignored [4]. Therefore, in reality, not many teachers are actually using computers with their classes. The fact is that technology is both concerned with the means for change and is a change in itself. Reviewing the literature particularly on Thai ICT policy, the main emphasis of the training is on ICT skills and management efficiency, with little application to pedagogic purposes. This might be one reason why many Thai teachers do not use technology in their everyday practice.

Teachers' Technology Skills

As technology is itself complicated, users (i.e. teachers and students) are unavoidably required to learn about technology before they can move forward to learn to teach/to learn with technology. Undeniably, as technology delivers both the subject and itself as a tool to learners, a teacher must be made knowledgeable and comfortable with the tools to ensure that they can effectively use them.

Teachers begin teaching with a certain knowledge base [47, 48]. Throughout their careers, they need to build on pedagogical theories and develop their practice [49], for example, by learning about technology and how to evaluate its potential in their teaching. Teachers can engage with technology in a variety of ways. Typically, courses are designed to assist teachers to become proficient in using the hardware and software that can support their teaching.

Therefore, the nature of technology as a subject is not the only consideration in designing professional development for teachers. Teachers' demographic and biographical characteristics are just as important in determining the success or otherwise of professional development provision in this area.

Engaging Teachers in Technology Training

Obstacles to the use of technology in teaching and learning can be classified into four related categories: lack of supervision and technical assistance; attitude and perception regarding the use of technology; workload issues; and technology management and infrastructure. These are addressed in the following five sections.

- a. Lack of ICT knowledge and skills: Teachers should learn how to use technology: Palloff and Pratt [50] added that the instructor must be trained both to use technology and also to shift the way in which they organize and deliver material in technology environment [51]. This is absolutely the case when using technology in teaching as it requires teachers to have more skills than the traditional teaching skills in the classroom. Effective use of these tools means teachers have to cope with transformation.
- b. Workload issues: Workload issues are also significant problems when there is a high teaching load. UNESCO [52] stated that teachers who attempt to use technology in classrooms must be provided with appropriate and sufficient time for training and practicing opportunities [11]. According to some teachers, the training is time consuming and increases their workload. On the other hand, it is claimed that effective integration of technology in lessons is time saving, and preferred to blame increased workload on poor technology skills and strategies in the classroom [53].

- c. **Unreliable and obsolete ICT equipment:** The use of technology in higher educational institutions is also found to be unsatisfactory due to inadequate, unreliable and obsolete technology equipment, both software and hardware. Such problems are caused by lack of support from organisations. Preston and others [54] remarked that these factors prevent teachers from integrating technology into teaching. Similarly, a deficiency in administrative support in implementing change (through leadership, planning and the involvement of teachers as well as managers) is a barrier to using technology in education [55].
- d. **Pedagogical use of technology:** One difficulty with integrating technology in the language classroom is that despite its amazing memory capacity and processing speed, it is still no match for the intricacy of natural language. It is generally thought that authentic language – language used by people in real contexts for real purposes – is the best model for learning. Richards and Rodgers [56] as well as Atagi [57] argued that integrating technology into instruction may not lead to success in EFL classrooms if teachers have no pedagogical knowledge. Thus, they advised teachers to carefully study the subject matter into which they are going to integrate technology and make the right match.
- e. **Participation in technology training programs:** Professional developers of technology need to prepare for obstacles which may lead to failure of the program[4]. Timetabling is a significant issue for ensuring adequate participation, and it is suggested that teachers need technology training program which matches their schedule. Thus, a big challenge in organizing technology training program occurs when some teachers cannot attend technology training sessions due to their high teaching load [4]. Another significant issue is the link between technology training activities and real practice in the classroom. Waddoups, Wentworth and Earle [58] found that an technology training program can be spoiled if the emphasis is put on training in the use of technology rather than on linking this technology to real-life situations. Failures in technology training programs may occur when participants are not given anything to refer back to when find themselves struggling to generalize the skills gained from training in their everyday practice [59].

The integration of ICT into foreign language teaching depends largely on teachers who, due to limitations in their skills and knowledge, may design programs poorly and be unable to use them efficiently. The successful delivery of lessons largely depends on both the instructional design and how it is used [11].

CONCLUSION

These modern educational tools not only engage students with their own learning, but also prepare them for their future professional lives. Students developed their collaborative working and high-quality writing pieces that directly the impact from engagement opportunities. As supported by Kolb [60], learning is "the process whereby knowledge is created through the transformation of experience." These emerging technological tools have transformed learners from receivers of knowledge, skills and dispositions. The learners tend to become active learners who involve in doing things and thinking about what they are doing. They were more engaged in reading, writing, discussions and problem-solving. They took part in learning activities more because their learning activities are combined with an action such as giving feedback to others. Class activities have

moved these learners from the learning from faculty presentation to understanding, applying, analyzing, synthesizing

In this paper, insight into the wealth of educational technologies and their power in language teaching and learning has been offered. As presented, a great deal of the success in language classroom comes from preparing teachers to use technology that encourages interaction from learners in this online environment. If technology is effectively integrated in our teaching, our new, refocused approach to teaching will drive us a long way to making technology a more rewarding tool in the teaching and learning process. This paper has examined that these educational tools have been used and have confirmed their potential particularly in improving EFL writing skills. The author expects that, at the very least, the paper will raise awareness of the need to reflect upon new ways of language teaching and learning.

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Academic Achievement from learning about Social Network via E-Book

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Abstract: E-Book is currently widely used in most academic institutions. To assess E-Book's efficiency, this research applied Presentation Slides and E-Book as teaching tools for learning about Social Network. The test scores from learning via both teaching tools were compared. Besides, students also participated in the attitude survey towards learning via E-Book. The result revealed that learning via E-Book obtained better academic performance and students were satisfied with learning via E-Book.

Keywords: E-Book; Social Network; learning tool

INTRODUCTION

The Social Network has been increasingly popular in our daily life and business. Social Network creates new service opportunities for various industries [6]. Learning how to adopt Social Network efficiently drives achievement of business objectives [2]. The researcher has been assigned to instruct the Web Based Programming course and has foreseen that the Social Network is interrelated to the Web Based Programming. Therefore, the researcher has included the Social Network topic in course. Moreover, the past researches concluded that learning via E-Book could better attract the learners to focus on the course. Ming Nie et al. [7] reported that E-Book promoted changes to study strategies and enhanced student learning experience. As a result, E-Book creates better learning efficiency. So E-Books have been envisioned to be a preferred and common choice of teaching and learning tool in the very near future [3]. Hence, the researcher applied E-Book as tool for teaching the Social Network. In order to assess the learning efficiency and effectiveness of learning via E-Book, the research about academic achievement from learning about Social Network via E-Book was established.

MATERIALS AND METHODS

The research goal were to see if learning via E-Book enabled students achieve better academic result and students were satisfied with learning via E-Book. The students were distributed the course material about Social Network in both Presentation Slides (prepared by using presentation software) and E-Book formats at the beginning of the course. The Social Network materials were separated into two parts. The first part was about the history and the concept of Social Network prepared in Presentation Slides format. The second part was about the Social Network development prepared in E-Book format. The Social Network topic was taught in seventh week later and took 4 hours for the whole course-length. Students involved in this study were all 21 students enrolled in the Web Based Programming course. The test was given to all students after finishing the course. The test was designed to cover all contents of the Social Network course having 50 multiple choice questions. The first 25 questions and

the latter 25 questions were from learning contents taught via Presentation Slides and E-Book respectively. The test scores were not included in determining the official Web Based Programming course grade. In addition, students were given the opportunity to complete a survey regarding their experience in learning about Social Network via E-Book at the conclusion of the course. The key variables were analyzed using the descriptive statistics. The Paired Samples Test was used to compare between the mean test scores that students obtained from learning via Presentation Slides and E-Book. The level of statistical significance of the study was 0.05.

RESULTS AND DISCUSSION

There are 17 (80.95%) of the 21 enrolled students involved in the study. The remaining four students did not participate due to their personal and medical absence. The findings are as below.

Academic Achievement

The academic achievement in this research was determined by the test scores. The mean test score for the 17 students was 40.59 (SD = 5.80). The average test scores from learning via Presentation Slides and E-Book were 18.24 (SD = 4.54) and 22.35 (SD = 2.32) respectively. The correlation between the test scores of two learning approaches was 0.37 with Sig. = .148, indicating that the test scores of both learning approaches were not related. The Paired Samples Test revealed that the average test score from learning via E-Book was higher than that of the Presentation Slides ($t = -3.976$; Sig. (2-tailed) = .001) (See Table 1).

Table 1 : Paired Samples Test

1 Paired	t	df	Sig. (2-tailed)
Presentation Slides Test Scores VS E-Book Test Scores	-3.976	16	0.001

Survey Result

All 17 students who participated in this research completed the survey regarding their experience in learning about Social Network via E-Book. The following is the summary of their responses (See Table 2): Seventeen (100%) of the respondents indicated that they had experience in learning via E-Book. Seventeen (100%) respondents agreed that E-Book should be used in teaching and learning in place of Presentation Slides. Five (29.4%) respondents agreed that E-Book attracted learning, ten (58.8%) respondents strongly agreed and two (11.8%) respondents very strongly agreed. Six (35.3%) respondents agreed that they could quickly and easily learn how to use E-Book, five (29.4%) strongly agreed and six (35.3%) very strongly agreed. The average level of opinions that students could quickly and easily learn how to use E-Book was 3 out of 4 (SD = 0.866). Two (11.8%) respondents disagreed that students focused on learning would enhance academic performance, three (17.6%) agreed, eight (47.1%) strongly agreed and four (23.5%) very strongly agreed. Besides, the overall respondents' opinion about learning via E-Book was rather positive (average level of opinions was 2.91 out of 4).

Table 2 : Respondents' opinions

	Disagree	Agree	Strongly Agree	Very Strongly Agree
E-Book attracted learning.	0 (0.00%)	5 (29.40%)	10 (58.80%)	2 (11.80%)
Easy and quick to learn using E-Book.	0 (0.00%)	6 (35.30%)	5 (29.40%)	6 (35.30%)
Focus on learning enhanced academic performance.	2 (11.80%)	3 (17.60%)	8 (47.10%)	4 (23.50%)

CONCLUSION

The learning Social Network via E-Book enhanced student academic performance, compared to learning via Presentation Slides and students were contented with learning via E-Book. There are a number of explanations for these findings.

Firstly, E-Book users did not require technical skills so it was very easy to use [7]. The average level of opinions that students could quickly and easily learn how to use E-Book (mean = 3 out of 4; SD = 0.866) supported this point of view. Students felt convenient when using the E-Book. The most useful features were adjustable text size and word searching [5,8]. Further researches should therefore explore the E-Book's design that encourages students' learning.

Secondly, there were several studies about consequence of learning via E-Book. It was found that students who read E-Book having visual-syntactic text formatting (VSTF) could improve their academic performance [10-11]. It could be that the design attracted learners and helped improve reading proficiency. According to the study, it was found that the average test score from learning via E-Book was statistically higher than the average test score from learning via Presentation Slides. Additional study would help to better clarify the impact of E-Book's design on the students' academic achievement.

The researcher feels that the current study contributes to the popularity of using E-Book in education. It is very interesting to study about the possibility of using E-Book instead of paper-based learning materials as it has begun to be widely implemented in major universities in America [4]. In addition, the E-Book can be used as a better teaching tool than other general presentation software. Most students preferred to obtain the E-Book before the lecture so that they could follow along during the class lecture [9]. Therefore, it is imperative that we continue to explore the relationship between the students' perceptions in learning via E-Book and their academic achievement [1]. Furthermore, it will be more practical if E-Book is applied in teaching the whole course and students are assessed their academic results thereafter.

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Physical, Chemical and Sensory Properties of Purple Rice-Based Ice Cream

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Abstract: The objective of this study was to determine effect of rice: water dilution ratios (1:2, 1:4 and 1:10 w/w) on the properties of both rice solutions and purple rice-based ice cream prepared from these solutions. Ice cream mix contents (w/w) were 55 % rice solution, 30 % coconut milk and 15 % sugar. Processing of the ice cream was carried out under laboratory scale. Experimental results indicated that dilution ratio significantly affected properties of the milk solution and consequently the final product. The physical properties of the ice cream especially overrun play a major role in sensory acceptability of panelists. The rice solution prepared from 1: 4 ratios provided the ice cream of highest overrun of 25.85 % and overall sensory scored of 7.36

Keywords: Leum Pua rice, purple rice solution, rice based-ice cream, ice cream processing

INTRODUCTION

Purple rice is distinguished by the rice grain having red brown or dark purple color in its covering layers. Pigments in the rice, which are located in the aleurone layer of rice grain, have been reported as a mixture of anthocyanin compounds and belong to the family of flavonoids. [1] It is well known that phenolic compounds are major active component for antioxidation [2]. In the grain of purple rice, anthocyanins have been reported as the main substance of phenolic compounds [3]. The anthocyanins in purple rice were identified as cyanidin-3-glucoside. [4]. A number of studies revealed that these water soluble compounds can reduce low-density lipoprotein cholesterol (LDL), improve lipid profiles, have anti-inflammatory and antioxidative activities. According to these properties, they are one possibility to fight against heart disease and also preventing diabetes [5].

Ice cream is a frozen dessert that is delicious, nutritious and relatively cheap. It is made from dairy products such as cream (or substituted ingredients), combined with flavorings and sweeteners such as sugar [6]. Ice cream structure determines several important sensorial parameters in the final product such as stiffness, dryness, melt resistance and texture. The setting up of ice cream structure comes from the manufacturing process that includes the steps of preheating, homogenization, pasteurization, ageing, freezing and hardening, as well as from the various components used in the formulation. [7][8]. However, ice cream contains high fat and calories which directly affected consumer's health. Dairy products are allergic for some consumer and vegetarian are also avoided consuming the dairy product. Therefore, grain-based ice cream formula has been developed. The purple rice has been used as raw material for traditional Thai dessert for a long time. Purple rice based ice cream developments are therefore interesting especially their antioxidant properties point of view. However, as compared with milk, different in composition may affect the overall qualities of final products. Besides, during

the process of making ice cream in particularly preparation of rice solution the deviation of main active composition may occur. Unfortunately, a limit number of such information is available.

In this study, properties of the purple rice solutions affected by dilution ratio were investigated. Effect of the ratio on the physical, chemical and sensory qualities of the purple rice-based ice cream was also studied. The information obtained may help improving the formulation of the ice cream mix and appropriate process design.

MATERIALS AND METHODS

Materials

Purple rice (*Oryza sativa* L.) cv. Luem Pua grain used in this study was obtained from Faculty of Pharmacy, Chiang Mai University, Chiang Mai, Thailand. The grain was milled with laboratory scale miller without polished to obtain milled rice. The rice was then packed in a polypropylene bag and kept at 4°C until used.

Preparation of purple rice solutions

The purple rice was cleaned with clean water twice and soaked in clean water with various ratios (w/w) of the purple rice to water of 1:2, 1:4 and 1:10 at ambient temperature for 4 hours. The mixtures were then blended and mixed with home kitchen blender (Philips, HR2068, Netherlands). After that, the mixtures were filtered with cheese cloth. The obtained rice solutions were then subjected to analysis for their physical and chemical properties.

Purple rice-based ice cream preparation

The ice cream mix formulations were based on 55% purple rice solution, 30% coconut milk and 15% sugar. All ingredients were mixed at 70 °C for 30 min. The mixture was homogenized using rotor stator homogenizer (VELP scientific, OV5, Italy), pasteurized at 80 °C for 2 min using water bath (Memmert, WNB29, Germany), cooled down by cold water and immediately stored at 4 °C in refrigerator overnight. A batch of aged ice cream mix (500 ml) was frozen in a continuous freezer (Gelatino Pro 3K; Italy) at – 6°C for 15 min. Then the soft ice cream was hardened and stored in freezer at -20 °C. For each recipe, at least two different batches were prepared.

Chemical properties analysis

The purple rice solution and ice cream samples were analyzed for fat content by Roesel-Gottlieb method and total solid contents by method in accordance with AOAC [9]. Total phenolic content was analyzed by Folin–Ciocalteu reagent [9]. Anthocyanins as cyanidin-3-glucoside was analyzed by pH Differential method [10] and pH was measured by pH-meter, (Sartorius: Model PB10, Germany)

Physical properties analysis

Samples of both the rice solution and ice cream were evaluated for their color using Minolta Chroma Meter (Model CR 400, Japan) and viscosities by Brookfield Viscometer (Model LVDV-II+, USA). Overrun [11], Melting rate [12] and hardness [13] of the ice cream samples were also determined.

Sensory evaluation

Acceptance testing was used to evaluate the sensory properties of the purple rice-based ice cream samples. The method was based on a 9 point hedonic scale where 9 = like extremely and 1 = dislike extremely. The duplicate tests were carried out for 20 panelists.

Statistical analysis

Experimental data were analyzed using the SPSS software version 16.0 (SPSS Inc., USA). Duncan's new multiple range tests was used to detect differences amongst treatment means. Statistical significance was tested at the 95% confidence level. All experiments were carried out for 3 replicates.

RESULTS AND DISCUSSION

Properties of purple rice solutions

The chemical properties of purple rice solutions (Table 1) prepared from three different dilution ratios were significantly difference ($p < 0.05$). Dilution with water reduced concentration of solutes in the solutions. This also affected the physical properties of the solutions as shown in Table 2. Viscosity of the solution decreased significantly ($p < 0.05$) while brightness and red color of the solution tended to increase.

Table 1. Chemical properties of purple rice solutions affected by dilution ratios

rice: water ratio (w/w)	pH	% total solid	%total oil	cyanidin-3-glucoside (mg/l)	total phenolic compound (mg/l)
1:2	6.45±0.01 ^c	7.58±0.06 ^a	1.10±0.05 ^a	88.73±1.79 ^a	0.25±0.01 ^a
1:4	6.56±0.00 ^b	2.72±0.01 ^b	0.39±0.01 ^b	49.04±0.56 ^b	0.18±0.01 ^b
1:10	6.86±0.01 ^a	1.28±0.03 ^c	0.16±0.00 ^c	33.40±0.58 ^c	0.09±0.01 ^c

Value presented is mean ± standard deviation from 3 replications.

Mean values with different letters in the same column are significantly different ($p < 0.05$).

Table 2. Physical properties of purple rice solutions affected by dilution ratios

rice: water ratio (w/w)	L*	a*	b*	viscosity (cP)
1:2	42.53±0.19 ^c	+9.45±0.12 ^c	-0.21±0.05 ^c	3.09±0.14 ^a
1:4	46.55±0.73 ^a	+11.30±0.69 ^b	-0.11±0.06 ^b	2.43±0.08 ^b
1:10	45.48±0.30 ^b	+12.63±0.21 ^a	-1.38±0.01 ^a	1.26±0.08 ^c

Value presented is mean ± standard deviation from 3 replications.

Mean values with different letters in the same column are significantly different ($p < 0.05$).

Chemical properties of purple rice-based ice cream

Table 3 illustrated the chemical qualities of purple rice-based ice cream prepared from different purple rice solutions. Generally, due to the purple rice solution was the main ingredient of the ice cream mix (more than 50 %) effect of the dilution on the ice cream's properties were similar to those of the rice solution. Besides, addition of others ice cream ingredients further decreased the concentration of the active components in the ice cream. However, added-sugar and coconut milk resulted in higher percentage of total solid and oil, respectively.

Table 3. Effect of dilution ratios on chemical properties of purple rice-based ice cream

rice: water ratio (w/w)	pH	% total solid	%total oil	cyanidin-3-glucoside (mg/l)	total phenolic compound (mg/l)
1:2	6.18±0.01 ^c	28.85±1.15 ^a	5.70±0.02 ^a	128.48±4.39 ^a	0.12±0.04 ^a
1:4	6.21±0.04 ^b	25.39±2.57 ^b	4.69±0.01 ^b	42.00±2.91 ^b	0.10±0.03 ^b
1:10	6.24±0.01 ^a	26.71±2.70 ^c	4.46±0.01 ^c	14.37±0.16 ^c	0.05±0.01 ^c

Value presented is mean ± standard deviation from 3 replications. Mean values with different letters in the same column are significantly different ($p < 0.05$).

Physical properties of purple rice-based ice cream

Table 4. Effect of dilution ratios on physical properties of purple rice-based ice cream

rice: water (w/w)	viscosity(cP)	Overrun (%)	L*	a*	b*	Melting rate (g/min)	texture (kg)
1:2	384.78±1.01 ^a	16.78±2.52 ^b	36.66±8.46 ^c	15.82±2.04 ^a	2.47±1.72 ^c	0.281±0.001 ^c	6.633±0.095 ^a
1:4	65.82±5.30 ^b	25.85±1.17 ^a	42.35±6.79 ^b	13.27±1.83 ^b	3.19±2.02 ^b	0.319±0.010 ^b	4.498±0.130 ^b
1:10	36.32±4.31 ^c	6.96±0.06 ^c	56.39±6.44 ^a	7.39±2.20 ^c	5.34±0.45 ^a	0.410±0.019 ^a	2.913±0.101 ^c

Value presented is mean ± standard deviation from 3 replications. Mean values with different letters in the same column are significantly different ($p < 0.05$).

The physical properties play a major role in ice cream business. The effect of the water dilution on the physical properties of the purple rice-based ice cream was clearly demonstrated in Table 4. The viscosity of the ice cream mix was found to affect both melt down and hardness of the ice cream. High viscosity mix tended to retard drainage of liquid from the ice cream [16] but also provided ice cream of dense and hard texture [17]. For latter cases, it was evidently demonstrated in lower overrun percentage. Highest overrun was 25.85 % obtained from moderated viscosity mix. Generally, bright red purple-color of ice cream was impressive. Addition of the coconut milk brought up the lightness of ice cream dramatically.

Sensory properties of rice-milk ice cream

The sensory evaluation (Table 5) revealed that the physical properties of the ice cream were the key factor. The overrun provided the ice cream of good appearance and structure. This physical parameter may also affect perception of the panelists in terms of flavor. Experimental results indicated that the ice cream prepared from 1:4 dilution ratio-rice solutions was more

preferred by the panelists (overall score point of 7.36) as compared to those of 1:2 and 1:10 ratios.

Table 5. Effect of dilution ratios on sensory properties of purple rice-based ice cream

rice: water ratio (w/w)	color	appearance	hardness	smoothness	sweetness	flavor	overall
1:2	1.8±5.71 12 ^b	6.12±1.596 ^b	5.45±1.383 ^b	5.81±1.366 ^b	5.26±0.964 ^c	5.50±1.254 ^c	5.48±1.194 ^c
1:4	6.95±0.962 ^a	7.29±0.774 ^a	6.90±1.031 ^a	6.98±1.024 ^a	7.10±0.958 ^a	7.29±0.708 ^a	7.36±0.759 ^a
1:10	6.74±1.531 ^a	7.12±1.087 ^a	6.45±1.273 ^a	6.83±1.146 ^a	5.79±1.335 ^b	6.38±1.103 ^b	6.62±0.962 ^b

Value presented is mean ± standard deviation from 2 replications.

Mean values with different letters in the same column are significantly different ($p < 0.05$).

CONCLUSION

The dilution ratio studied significantly affected the properties of the purple rice solution which consequently the properties of the purple rice-based ice cream. Sensory properties of the ice cream were closely correlated with their physical properties. The ice cream of highest overrun was obtained when 1: 4 dilution ratio-rice solution was used. The final ice cream product was accepted from the panelists with overall score of 7.36.

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Antimicrobial activities of Thai herb extracts against *Salmonella* spp.

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Abstract: The *in vitro* antibacterial activities of five herb extracts, including cinnamon (*Cinnamomum cassia*), garlic (*Allium sativum*), lemongrass (*Cymbopogon citratus*), clove (*Eugenia caryophyllus*) and ginger (*Zingiber officinale*) against three species of *Salmonella*, which were *S. typhimurium*, *S. typhi* and *S. enteritidis* were investigated in this study. The antimicrobial compounds of the herbs were extracted from dried ground herbs by simultaneous distillation-extraction in a Likens and Nickerson apparatus using dichloromethane (CH₂Cl₂) for 5 h. The highest yield of the herb extracts was found in the clove extract with a yield of 18.32±1.23%. Using a disc diffusion assay, the cinnamon extract showed the highest inhibition for all *Salmonella* strains, which was 50.07±0.21 mm inhibition zone. The Minimum Inhibitory Concentration (MIC) for garlic, cinnamon, clove and lemongrass extracts against the studied *Salmonella* spp. was 5 µl/ml, while the MIC of ginger extract was 15 µl/ml. For the Minimum Bactericidal Concentration (MBC), the herb extracts could kill the *Salmonella* spp. within the range of 10 and 30 µl, except for the ginger extract that needed a higher concentration than 30 µl. Between the 3 tested species of *Salmonella*, it was found that *S. typhi* was the most sensitive one, while *S. typhimurium* was the most resistant species against different herb extracts. The herb extracts could be useful as a food preservative to control and/or inhibit the growth of *Salmonella* in food products.

Keywords: Thai herb extracts, *Salmonella* spp., Minimum Inhibitory Concentration, Minimum Bactericidal Concentration, Inhibition zone

INTRODUCTION

Salmonella remains a primary cause of food poisoning worldwide, and massive outbreaks have been witnessed in recent years. *Salmonella* spp. are Gram negative, heterotrophic, mesophilic bacteria that present in warm-blooded animal hosts and are an important human pathogen associated with poultry and poultry products. Up to now, *Salmonella* is the most commonly identified bacterial agent causing illnesses, such as typhoid fever in humans [1].

Natural extracts of herbs have been used for many years for different purposes and screened for their potential use as food preservatives. The antibacterial activities of herb extracts and oils can be useful for the preservation of raw and processed food [2]. Clove, cinnamon and garlic are considered as the most common spices and herbs with strong antimicrobial activities. Their essential oils contain chemical compounds, such as carvacrol, cinnamic aldehyde, eugenol and allicin that are identified as the major chemical components responsible for exerting antimicrobial activity [3,4]. Ginger is widely used in food production and oriental medicine. The herb has been investigated to contain several bioactive compounds, including gingerols and shogaols, which have activity against Gram positive and Gram negative bacteria [5].

Extraction of bioactive compounds from herbs can use various procedures, including aqueous systems, alcohol and supercritical fluids [2]. Simultaneous distillation–extraction (SDE) is one of the most widely employed methods to extract herb and spices. This method has been successfully applied in the extraction of essential oils, aroma compounds and other volatile products from different matrices. This technique is less time consuming and allows, due to the continuous recycling, a greater reduction of solvent volumes. Extracts obtained by SDE are free from non-volatile materials, such as cuticular waxes or chlorophylls [6]. The main objective of this study was to determine the *in vitro* antimicrobial activity of different herb extracts, including clove, cinnamon, garlic, ginger and lemongrass, obtained by SDE against *Salmonella* spp.

MATERIALS AND METHODS

Microbial Strains and Culture Maintenance

The microorganisms used in this study were *Salmonella enteritidis* (DMST 16813) and *Salmonella typhi* (DMST 22842) from the culture collection of the Department of Medical Sciences, Ministry of Public Health, Bangkok, Thailand and *Salmonella typhimurium* (TISTR 292) from the culture collection of Thailand Institute of Scientific and Technological Research, Bangkok, Thailand. All the bacteria were maintained as frozen stocks in vials containing Tryptic Soy Broth (TSB) supplemented with 10% (v/v) glycerol at -60°C [7]. During experiments, cultures were grown and maintained on Tryptic Soy Agar (TSA) at 4°C. For the determination of antibacterial activity, each strain was cultivated in 10 ml TSB for 24 h at 37°C [3].

Raw Materials of Dried Herbs

Dried ground cinnamon, garlic, lemongrass, clove and ginger were purchased from a local market in Chiang Mai province. Different dried ground herbs were determined for their moisture content and water activity using a moisture balance (Sartorius MA45, Germany) and an a_w -meter (AquaLab Model CX3CE, USA), respectively. All determination was done in triplicate.

Preparation of Herb Extracts

To extract dried herb components, 40 g of herb samples in 300 ml distilled water were extracted in SDE for 5 h, using a modified Likens and Nickerson apparatus with 40 ml of dichloromethane (CH_2Cl_2) (BDH-Prolabo, France). An amount of 20 ml of dichloromethane was also added to fill the apparatus solvent return loop. After cooling at room temperature for 10 min, the dichloromethane extract was collected and dried over anhydrous sodium sulfate for 12 h. The herb extracts were concentrated at 40°C with a rotary evaporator (BUCHI Labortechnik AG, Switzerland) at atmospheric pressure [8]. The concentrated herb extracts, which was considered as 100% concentration, were collected into dark bottles and stored at 4°C until used.

Antimicrobial Activity of Herb Extracts

Disc diffusion assay

The evaluation of antimicrobial herb extracts using a modified agar disc diffusion method was carried out by employing the procedure of Govaris et al. [9]. For the positive control, Penicillin G (10 µg) (Oxoid, England) was used, while a disc impregnated with 10 µl of sterile distilled water served as a negative control. The experiment was carried out in triplicate.

Minimum Inhibitory Concentration (MIC) And Minimum Bactericidal Concentration (MBC) of herb extracts

The MIC and MBC of herb extracts were evaluated using a microbroth dilution based on the method of Chamdit and Siripermpool [10]. Penicillin G and TSB with 5% Tween 80 were applied as positive and negative controls, respectively. The MIC was defined as the lowest concentration of herb extracts that inhibited visible growth after 24 h of incubation and the MBC was determined from the lowest concentration of herb extract that inhibited the growth of *Salmonella* on TSA. All extracts were prepared and tested in triplicate.

Statistical Analysis

Collected data was statistically analyzed by completely randomized design (CRD) using SPSS version 17.0 software (SPSS Inc, Chicago, IL, USA). Duncan's multiple range tests were used to assess the difference between treatment means. A probability level $P < 0.05$ were used as the statistical significance of the sample treatments.

RESULTS AND DISCUSSION

Chemical Properties of Dried Ground Herbs and Yield Of Herb Extracts

The moisture contents of 5 dried herbs used in this study were in the range of 7.09-8.32% with water activities between 0.61 and 0.65. The highest water activity was found in dried ground clove with a value of 0.65 ± 0.003 . The yield of herb extracts obtained by SDE is displayed in Table 1. Different types of herb significantly affected the yield of the herb extracts ($P < 0.05$). The highest yield of the extract was found in clove, while the lowest one was in garlic.

Table 1 Yield of different herb extracts produced by simultaneous distillation-extraction

Common names	Scientific names	Parts used	Yield (% , v/w)
Lemongrass	<i>Cymbopogon citratus</i>	Stem	2.32 ± 1.05^b
Clove	<i>Eugenia caryophyllus</i>	Flower bud	18.32 ± 1.23^a
Garlic	<i>Allium sativum</i>	Bulb	0.67 ± 0.09^c
Ginger	<i>Zingiber officinale</i>	Rhizome	1.02 ± 0.13^c
Cinnamon	<i>Cinnamomum cassia</i>	Bark	4.34 ± 0.27^b

^{a-c} Different letters in the same column are significantly different ($P < 0.05$).

Antimicrobial Activity of Herb Extracts

Disc diffusion assay

The results of diameter inhibition zones (DIZ) produced by different herb extracts against *Salmonella* spp. are presented in Fig. 1. The cinnamon, garlic and clove extracts strongly inhibited the growth of *Salmonella* spp. Higher amount of the herb extracts produced greater DIZ. For the 3 studied species of *Salmonella*, the relative inhibitory effects of different herb extracts were as followed: cinnamon > garlic > clove > lemongrass > ginger. The DIZ of cinnamon, garlic and clove extracts at the concentration of 30 µl/ml were higher than those of penicillin G. The DIZ of penicillin G against *S. typhi*, *S. enteritidis* and *S. typhimurium* were 20.71±1.18, 20.64±1.00 and 19.90±0.36 mm, respectively. Tajkarimi et al. [11] had reviewed that cinnamic aldehyde and eugenol extracted from cinnamon and clove was effective against *Salmonella* spp.

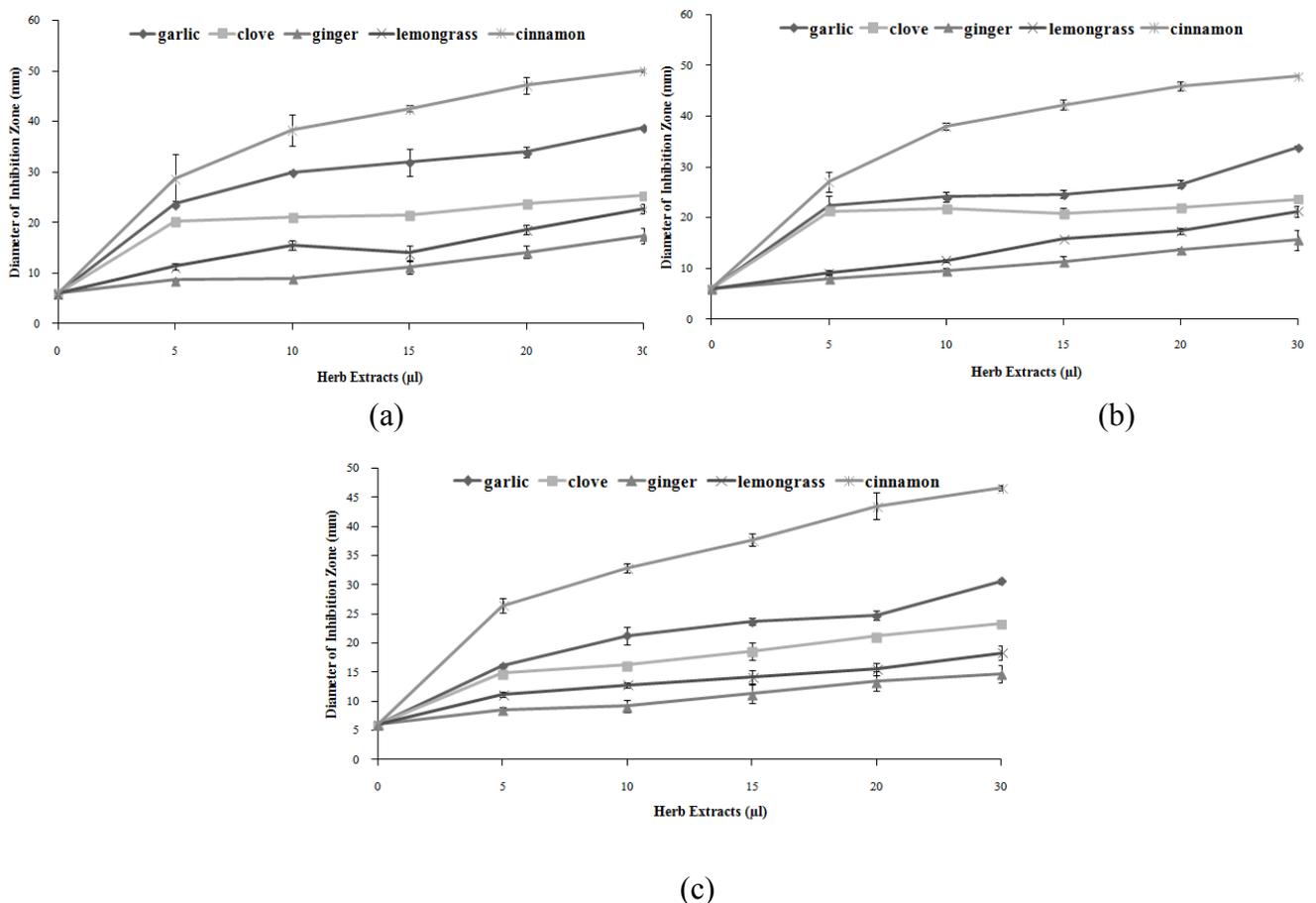


Fig. 1 Diameter inhibition zone (mm) of different herb extracts against *Salmonella typhi* (a), *Salmonella enteritidis* (b) and *Salmonella typhimurium* (c) in the disc diffusion assay

The Minimum Inhibitory Concentration (MIC) and the Minimum Bactericidal Concentration (MBC) of herb extracts

The results of MIC and MBC determination for different herb extracts can be seen in Table 2. The MIC values of the herb extracts were within the range of 5 to 10 µl/ml with garlic, cinnamon, clove and lemongrass extracts could prevent the growth of *Salmonella* spp. at a level of 5 µl/ml. On the other hand, the MBC values of the herb extracts were within the range of 5

to more than 30 µl/ml. The most effective herb extract to inhibit *S. typhi* was cinnamon, while the growth of *S. typhimurium* and *S. enteritidis* could be prevented by 10 µl/ml of the cinnamon extract. The clove and garlic extracts could completely inhibit the growth of *Salmonella* spp. at 15 µl/ml, while the lemongrass extract needed a concentration of 30 µl/ml. Ginger extract could not completely prevent the growth of *Salmonella* spp. at the studied concentrations.

Based on the results of disc diffusion assay and microbroth dilution, it could be clearly seen that the cinnamon extract exhibited the highest antimicrobial activity against *Salmonella* spp., followed by garlic and clove extracts. Fabio et al. [12] reported that the antimicrobial activity of cinnamon was attributed to cinnamic aldehyde (80-90%), which possessed anti-fungal and antibacterial properties. For garlic, the major antimicrobial compound in the herb extract was allicin (allyl 2-propene thiosulphinate) [13]. Chowdhury et al. [14] had reported that the MIC of garlic extract against *Salmonella anatum*, *Shigella dysenteriae* and *Escherichia coli* was 5 µl/ml, which was similar to the finding in this research. It was proposed that the action of allicin was by blocking enzymes that were necessary for bacterial metabolism, interfering with RNA synthesis [15] and inhibiting various thiol-dependent enzymatic systems of bacteria [13]. Feldberg et al. [16] found that the bacteriostatic inhibition of allicin against *S. typhimurium* was due to delayed and partial inhibition of DNA and protein synthesis and an immediate inhibition of RNA synthesis.

Table 2 The Minimum Inhibitory Concentration and Minimum Bactericidal Concentration of different herb extracts against *Salmonella* spp.

Herb extracts	The Minimum Inhibitory Concentration/Minimum Bactericidal Concentration (µl/ml)		
	<i>S. typhimurium</i>	<i>S. enteritidis</i>	<i>S. typhi</i>
Lemongrass	5/30	5/30	5/30
Clove	5/15	5/15	5/15
Garlic	5/15	5/15	5/15
Ginger	15/>30	15/>30	15/>30
Cinnamon	5/10	5/10	5/5

The antibacterial activity of clove was attributed to eugenol (2-methoxy-of 4-allyl phenol), which was present at a high level (70-90%) in clove bud oil. It was reported that the eugenol had a wide spectra of antimicrobial effect, including the growth inhibition of enterobacteria [19]. An additional antimicrobial activity of clove could be due to the presence of tannin (10-19%) [17]. In this study, the ginger extract was found to have the lowest activity to prevent the growth of *Salmonella* spp. Suresh et al. [18] had also reported that ginger extract had a moderate activity against *Salmonella enteritidis*. A similar finding was also described by Sivasothy et al. [5] for the leaf and rhizome oils of *Z. officinale* var. *rubrum* Theilade against *Bacillus licheniformis*, *Bacillus spizizenii*, *Staphylococcus aureus*, *E. coli*, *Klebsiella pneumonia* and *Pseudomonas stutzeri*.

CONCLUSION

Results of this research clearly showed that the herb extracts of cinnamon, garlic, lemongrass, and clove obtained by SDE were effective to inhibit the growth of *Salmonella* spp. in microbiological media. The best herb extract to completely prevent the growth of *Salmonella* spp. was cinnamon extract. This indicated that the herb extracts had a potential to be used as

natural preservative agents in food to increase the safety of the product and/or extend its shelf life.

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The comparison of proteolytic enzymes effective in stabilization and physical characteristic improvement of rice bran (cv. Kam Doi Saket)

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Abstract: The objective of this study was to compare the efficiency of 5 proteolytic enzymes including Bromelain, Papain, Trypsin, Chymotrypsin and Flavozyme® to stabilize and improve physical characteristic of rice bran. The bran was hydrolyzed with the proteolytic enzymes at the concentration of 8.0 mg/ml for 120 min. Degree of hydrolysis (DH), Protein solubility (PS) and Lipase activity (LA) of hydrolyzed rice bran were determined every 15 min interval of hydrolysis. The changes in PS and DH during hydrolysis were found in similar trends for all proteolytic enzymes. In the first 45 min of hydrolysis, PS and DH increased sharply but after this point the increases were slower. LA of rice bran increased within first 45 min of hydrolysis but steeply decreased after this point. The most effective enzymes for hydrolysis rice bran protein were papain, trypsin and chymotrypsin, which showed the highest of PS, DH and lowest LA. After 120 min of hydrolysis, γ -oryzanol and total vitamin E contents were increased by 2.2 and 1.3-folds, respectively.

Keywords: rice bran, lipase activity, proteolytic enzymes.

INTRODUCTION

Rice is the most consumed food in Thailand and many countries in Asia. It is also the main export product of Thailand. About 20 million tons per year of rice are produced in Thailand, which produces about 1.6 million tons of rice bran [1]. Rice bran is rich in nutrients with 14%-16% protein, 12%-23% fat, and 8%-10% crude fiber [2]. Rice bran contains functional ingredients which are interested by many food industries. It contains high level of several phytochemicals, e.g. γ -oryzanol, tocopherols and tocotrienols [3]. γ -Oryzanol showed the lowering cholesterol absorption ability, anti-inflammatory and cholesterol oxidation inhibition [4-6]. Therefore, γ -oryzanol is a potential antioxidant for food, pharmaceutical and cosmetic industries [7].

However, the shelf-life of rice bran is definitely short due to lipid deterioration. The endogenous lipase enzyme in rice bran rapidly hydrolyzes triglyceride to free fatty acids which are susceptible to oxidation. Thermal processes have been used for rice bran stabilization, however rice bran antioxidant are destroyed by heat treatment. Non-thermal processes such as enzymatic process interesting to stabilization of rice bran. [2,8].

Proteolytic enzymatic modification of proteins is a particularly attractive technique, as it can avoid severe operational conditions while enabling ease of control over the reaction to achieve high product yields, reduce by-products, and improve the various functional properties

of the recovered proteins [9]. Moreover, selective enzymatic hydrolysis under controlled conditions could improve food protein functionality from many plant and animal sources [10]. The objective of this study was to compare the efficiency of 5 proteolytic enzymes including Bromelain, Papain, Trypsin, Chymotrypsin and Flavozyne® to stabilize (lipase inactivation) and improve physical characteristic of rice bran.

MATERIALS AND METHODS

Material and chemical

Pigmented rice samples (*cv.* Kam Doi Saket; DSK) was milled with a laboratory rice miller (McGrill type). The bran was collected and sieved through 20 mesh screen to remove broken rice. The bran sample was packed in polyethylene bags and stored at -20 °C until further analysis.

Leucine, 2,4,6-trinitrobenzenesulfonic acid (TNBS), *p*-nitrophenyl laurate (*p*-NPL), Bovine serum albumin (BSA), standard vitamin E, standard γ -oryzanol, trypsin, chymotrypsin and Flavozyne® were purchased from Sigma-Aldrich, USA. Papain, bromelain were purchased from Merk, Germany. HPLC grade methanol, acetonitrile, isopropanol and dichloromethane were purchased from Labscan, Thailand.

Preparation for enzymatic process

Rice bran was added to the mixture of buffer solution and proteolytic enzymes (8.0 mg/ml). The enzymatic hydrolysis was operated under the optimal condition (Table 1). Degree of hydrolysis (DH), protein solubility (PS) and lipase activity (LA) of rice bran were determined every 15 min of hydrolysis. The 1.0 N HCl solution was added in the mixture until pH=3.0 to stop the reaction. Hydrolysis rice bran (RBH) were centrifuged at 6,000 rpm for 30 min and rinsed with DI water until pH=7.0. The supernatant was analyzed for DH and PS.

Table 1 Optimal condition of enzymes

Enzymes	pH	Temperature
Bromelain	6.0	35.5
Papain	6.0	40.0
Trypsin	7.8	25.0
Chymotrypsin	7.6	25.0
Flavozyne	7.0	25.0

Degree of hydrolysis (DH)

DH was determined by the trinitrobenzene-sulphonic acid (TNBS) technique described by Adler-Niessen [11]. The samples (0.25 ml) were transferred to glass test tubes containing 2 ml of 1% SDS. After incubation at 75°C for 15 min, the mixtures (0.25 ml) were transferred to new glass test tubes containing 2 ml of 0.2 M sodium phosphate. TNBS (0.1%, 2 ml) was added in to the tubes which were then incubated at 50°C for 60 min. Stop the reaction by adding 4.0 ml of 0.1 N HCl. Allow samples to reach room temperature and read absorbance at 340 nm.

Protein solubility

The protein solubility of hydrolyzed rice bran was determined using the method described by Lowry et.al. [12]. Briefly, a 5 ml of 2.4 M trichloroacetic acid was added to 10 ml of the sample, the precipitate was removed by centrifugation (6000g, 10 min). Supernatant 1.0 ml was mixed with Folin-Ciocalteu phenol Reagent (0.2 ml). The absorbance at 750 nm was read with spectrophotometric (Model, Genesys 10 UV scanning, Germany). Bovine Serum Albumin (BSA) was used as a standard.

Lipase activity

Lipase activity was determined according to the method reported by Savitha et.al. [13]. It was estimated using a spectrophotometric assay with *p*-nitrophenyl laurate (*p*-NPL) as substrate. One unit of lipase activity was defined as the amount of enzyme that liberated 1 μ mol/min of *p*-nitrophenol under the standard conditions.

γ -Oryzanol and total vitamin E analysis

Rice bran was extracted by hexane (1:10). After shaking in water bath (40 °C) for 1 hr, the mixture was filtered through Whatman No. 4 filter paper. The organic solvent was evaporated under reduced pressure to obtain crude extract which was semi-purified using low-pressure silica (C18) column.

γ -Oryzanol content of the crude extracts was determined according to the method of Chalermpong et.al.[14] with some modification. Reversed-phase HPLC was performed using the Agilent 1100 (USA). The 250 \times 4.6 mm diameter Alltima C18 column was used to separate this compound (Alltech Company Limited, Tokyo). The UV-vis detector was set at 330 nm and the flow rate was 1.0 ml/min. The mobile phase was the mixture of methanol/acetonitrile/dichloromethane (50:47:3). Total vitamin E was determined by using the 250 \times 4.6 mm diameter Alltima C30 column. Fluorescence detector (excitation and emission wavelengths) was set at 290 and 330 nm, respectively. The mobile phase was the mixture of 25:70:5 (A) and 45:45:10 (B) acetonitrile/methanol/isopropanol mixtures (v/v/v) and the flow rate was 0.6 ml/min. To construct the standard curves, standard solutions of γ -oryzanol, and total vitamin E (Sigma-Aldrich, USA) were used.

Data analysis

Data were presented as the means \pm standard deviations (SD) of three replications determination. Analysis of variance (ANOVA) and Duncan's new multiple rang test (DMRT) were applied to determine significant difference at $P\leq 0.05$ using SPSS 13.0 software (SPSS Inc., Chicago, IL, USA).

RESULTS AND DISCUSSION

Effect of enzymatic hydrolysis on degree of hydrolysis and protein solubility

Rice bran was subjected to the mixture of enzyme in buffer solution. Rice bran protein was hydrolyzed by bromelain, papain, trypsin, chymotrypsin and Flavozyme[®] at the optimal condition (Table 1). Fig. 1 shows the ability of proteolytic enzymes to hydrolyze rice bran protein. DH was increased rapidly in the first 45 min and after this point the increase was slower. The slower rate of DH after 45 min was due to the lower substrate concentration by

converting of protein to polypeptide and amino acids. Trypsin, chymotrypsin and papain showed the most effective on DH. At 120 min of hydrolysis, DH of rice bran protein hydrolyzed by trypsin, chymotrypsin, papain, Flavozyme® and bromelain, were 9.79, 9.14, 8.64, 6.64 and 6.43%, respectively. Zhao and co-workers [8] reported that rice bran protein isolate hydrolyzed with trypsin (50.0 °C, pH 8.0) for 4 hours showed 15.35% of DH. Many factors influence hydrolysis rate such as substrate and enzyme concentrations, the presence of activators and inactivators and enzyme specificity [8]. Enzymatic hydrolysis reduces size of protein molecules leading to greater benefit nutritional functionality[8]. Moreover, hydrolyzed rice bran can be used as a food ingredient in value added products.

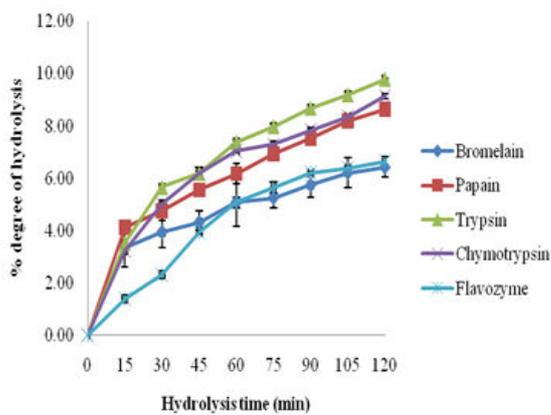


Fig. 1 Degree of hydrolysis of rice bran protein

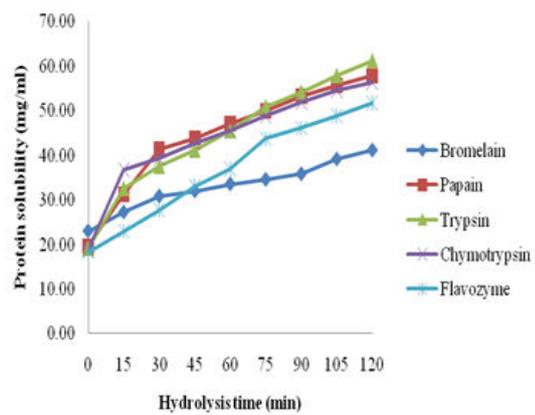


Fig. 2 Protein solubility of rice bran protein during enzyme hydrolysis.

Fig. 2 shows protein solubility of rice bran proteins during enzymatic hydrolysis. It was found that PS of rice bran increased when hydrolysis time was increased. Trypsin, chymotrypsin and papain showed the highest PS which significantly difference from Flavozyms® and bromelain. After 120 min of hydrolysis, rice bran protein showed 68.58, 66.04, 66.65, 54.46 and 44.23% of PS when hydrolyzed with trypsin, chymotrypsin, papain, Flavozyme® and bromelain, respectively. The results were similar to the study of Guo and co-workers [16] which reported that PS of rice protein hydrolyzed with papain (51.5 °C, pH 6.9) for 3 hours and bromelain (56.5 °C, pH 7.3) for 4 hours exhibited high PS as 90.4 and 89.75%, respectively.

Effect of enzymatic hydrolysis on lipase activity in rice bran

Fig. 3 shows the changes of lipase activity in rice bran during the enzymatic hydrolysis. Lipase activity of rice bran hydrolyzed with papain, trypsin and chymotrypsin increased within first 45 min of hydrolysis. The increase of LA might be due to the disruption of rice bran cell by protein hydrolysis leading to the releasing of lipase and lipid which allows lipase enzyme react with its substrate. However, LA steeply decreased after 45 min of hydrolysis. Proteolytic enzymes inhibit LA by hydrolyze lipase enzyme to the smaller fragtions. However, bromelain and Flavozyme® were lack of efficiency for lipase inactivation.

The results showed that trypsin, chymotrypsin and papain were the good proteolytic enzymes which obtained the highest on DH and PS and lowest on LA. However, papain was selected because of its lower price but high activity.

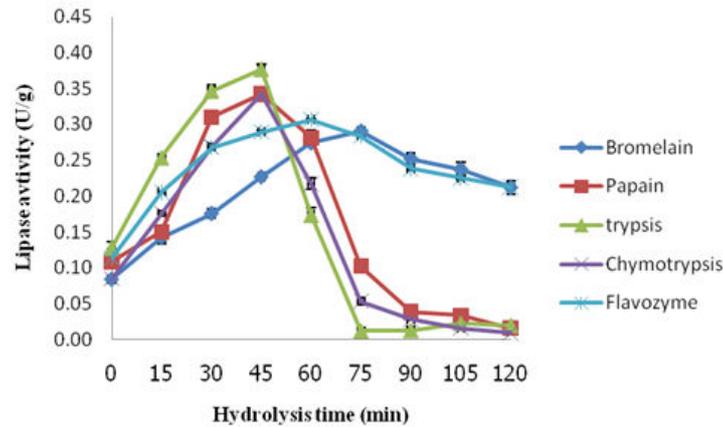


Fig. 3 The change in lipase activity during the enzymatic hydrolysis process.

Effect of enzymatic hydrolysis on total vitamin E and γ -oryzanol in rice bran

Total vitamin E and γ -oryzanol in raw rice bran (RB) and hydrolyzed rice bran (RBH) by papain are shown in Fig. 4 and 5. Total vitamin E and γ -oryzanol contents of RBH were 1.3 and 2.2-folds higher than those contents in RB, respectively. The results indicate that vitamin E and γ -oryzanol are bound with some components in rice bran especially protein and are released after protein hydrolysis.

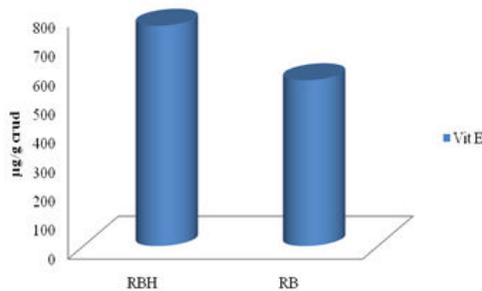


Fig. 4 Total vitamin E in raw rice bran and hydrolysis rice bran.

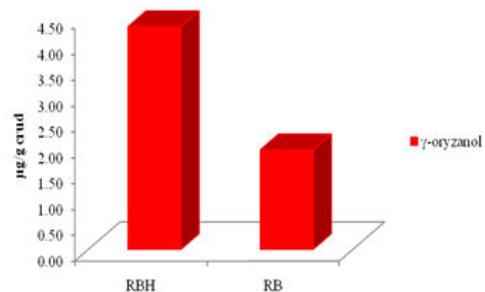


Fig. 5 Gamma-oryzanol in raw rice bran and hydrolysis rice bran.

CONCLUSION

Trypsin, chymotrypsin, and papain were the effective enzymes to inactivate lipase enzyme in rice bran and also showed the highest in DH and PS. For economy reason papain was the most considerable enzyme to be applied for rice stabilization. Moreover, hydrolyzed rice bran contained higher content of vitamin E and γ -oryzanol.

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Effect of Thermal Processing Methods and Polished Rice Mixing Proportions on Bioactive Compound Quantities and Eating Qualities of Pigmented Unpolished Rice from Three Varieties

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Abstract : Kum Phayao, Kum Leumpua and Kum Doisaket are glutinous pigmented rice varieties which were reported about the rich of bioactive compounds and antioxidant properties. Pigmented unpolished rice from these rice varieties had bioactive compounds including total phenolic compounds, tannins, anthocyanins, gamma-oryzanol, gamma-aminobutyric acid (GABA) and tocopherol, which were good for human health. This research studied the effect of some thermal processing methods on the retention of bioactive compounds in each three varieties of cooked pigmented unpolished rice. After various cooking methods such as cooking by rice cooker, steaming and boiling, it was found that rice cooker processing could retain the statistical highest amounts of bioactive compounds (about 48.87-98.95% of uncooked rice depends on each varieties). This method still could retain antioxidant properties (DPPH and ABTS analyzed methods) about 80.95-97.50% of uncooked rice. Steaming and boiling methods decreased some of bioactive compounds and antioxidant properties. After cooking by rice cooker, all cooked pigmented unpolished rice varieties had quite hard texture. This study tried to mix each glutinous pigmented unpolished rice varieties with polished normal rice “Khaw Dawk Mali 105” before cooking by rice cooker. It was found that cooked pigmented unpolished rice from Kum Phayao varieties mixing with Khaw Dawk Mali 105 rice at the ratio 25% had statistical high amount of bioactive compounds and high antioxidant properties. Cooked rice still had statistical good sensory acceptance from the panelist.

Keywords : Pigmented rice, Polished Rice, Thermal processing, Bioactive compounds, Eating Qualities.

INTRODUCTION

In Thailand, there are some glutinous pigmented rice (or black rice) varieties such as Kum Phayao, Kum Leumpua and Kum Doisaket are popular. Some investigators have show that black rice bran or outer layer fraction has functional effects to human health. Black rice outer layer fractions of unpolished grains contain some bioactive compounds such as dietary fiber, flavonoid, polyphenols and anthocyanidins. The major cyanidins fraction are cyaniding-3-glucoside and peonidin-3-glucoside [1]. Bioactive compounds from pigmented unpolished rice can decrease the risk of coronary heart diseases, inflammatory process and atherosclerosis through their antioxidant, anti-platelet and anti-inflammatory activities [2].

Normally, rice is cooked before consumption. Cooking methods (thermal processing) may cause complex physical and chemical changes in bioactive compounds including releasing of bound forms, degradation and oxidation [3]. Few studies have investigated the effect of thermal processing on bioactive compounds during rice cooking preparation. The aim of this study was to assess the effect of thermal processing methods and polished rice mixing proportions on bioactive compound quantities, antioxidant properties and eating qualities of pigmented unpolished rice.

MATERIALS AND METHODS

Materials

Three varieties of paddy glutinous pigmented rice (*Oryza sativa* L.) varieties: Kum Phayao, Kum Leumpua and Kum Doisaket were harvested in November 2012. The first two varieties were obtained from Hong Hin district, Phayao province, Thailand. The last varieties were obtained from Doisaket district, Chiang Mai province, Thailand. All samples were dehulled unpolished pigmented rice by paddy husker (Satake rice machine; Model THU-35A, Japan) and stored in freezer (-18°C) before used.

Study on bioactive compounds and antioxidant properties in three rice varieties.

Three varieties of unpolished pigmented rice were analyzed bioactive compound contents such as total phenol compounds [4], tannins [5], anthocyanins [6], gamma-oryzanal [7], aminobutyric acid [8] and tocopherol [7]. Antioxidant properties were analyzed by DPPH radical scavenging assays [9] and ABTS radical cation decolorization assays [10]. The differences between samples determining by Least – Significant different (LSD) at P=0.05.

Study on the effect of thermal processing methods on bioactive compounds and antioxidant properties

Three thermal processing methods were compared: cooking by rice cooker was performed by using the mixture of 500 g unpolished pigmented rice grain samples and 1,500 mL of water and then cooking by automatic rice cooker (Otto; Model CR-100T, Germany). Steaming method was performed by overnight soaking of unpolished pigmented rice grain samples in water and then steaming by kitchen steamer for 30 min. The last method, was the boiling of unpolished pigmented rice grain samples in boiling water at the ratio of 1:5 (w/v) for 30 min. Unpolished pigmented rice grain from three varieties were treated in all three thermal processing methods. The experimental design will be analyzed using a Randomize Complete Block Design (RCBD). After thermal processing, cooked rice samples were analyzed the bioactive compound contents and antioxidant properties as same as the previous study. The differences between samples determining by Least – Significant different (LSD) at P=0.05.

Study on effect of mixing proportions of pigmented unpolished and polished rice on bioactive compounds, antioxidant properties and eating qualities

High potential of unpolished pigmented rice grain which had high retained in bioactive compound contents after thermal processing was selected to study. The mixture of unpolished pigmented rice and polished rice (Khaw Dawk Mali 105 variety) in different proportion were

cooked by rice cooker. The unpolished pigmented rice grain were mixed in different percentage: 0, 25, 50, 75 and 100%. The experimental design will be analyzed using a Randomize Complete Block Design (RCBD). After cooking, cooked rice samples were analyzed the bioactive compound contents and antioxidant properties as same as the previous study. The differences between samples determining by Least – Significant different (LSD) at P=0.05.

RESULTS AND DISCUSSION

Bioactive compounds and antioxidant properties in three rice varieties

From the analysis of unpolished pigmented rice grain, it was found that in each rice grain varieties had different bioactive compound contents and antioxidant properties. Kum Leumpua had the highest amount of total phenol compounds, tannins and anthocyanin (542.14±6.39, 103.92±32.88 and 777.61±6.04 mg / 100 g db, respectively) (Table 1). In addition, its antioxidant properties were the highest too. It indicated that antioxidant properties were released to the first three bioactive compound contents. Kum Phayao and Kum Doisaket had high gamma-oryzanol and gamma-aminobutyric acid. Tocopherol in three rice varieties had not different.

Table 1 Bioactive compounds and antioxidant properties in three rice varieties.

Quantities	Rice varieties		
	Kum Phayao	Kum Leumpua	Kum Doisaket
Bioactive compounds			
Total phenol compounds (mg / 100 g db.)	168.99±1.69 ^c	542.14±6.39 ^a	223.52±5.41 ^b
Tanins (mg / 100 g db.)	33.76±6.99 ^c	103.92±32.88 ^a	38.49±23.37 ^b
Anthocyanins (mg / 100 g db.)	166.67±7.88 ^c	777.61±6.04 ^a	254.73±5.34 ^b
Gamma-Oryzanol (mg / 100 g db.)	21.54±0.34 ^a	16.57±1.14 ^b	22.84±0.66 ^a
Gamma-Aminobutyric acid (GABA) (mg / 100 g db.)	2.90±0.14 ^a	2.19±1.66 ^b	2.64±0.03 ^a
Tocopherol (mg / 100 g db.) ^{ns}	2.39±0.31	2.30±0.07	2.37±0.34
Antioxidant properties			
DPPH radical scavenging activity (% remaining)	1.00±86.80 ^c	0.74±94.06 ^a	0.74±89.11 ^b
ABTS radical cation decolorization assay [µmol trolox equivalents (TE) / g sample]	0.0045±0.2331 ^b	0.0170±0.3988 ^a	0.0228±0.2067 ^b

^{a-c} Mean values in same row with different letters were significant different (p≤0.05).

^{ns} No statistical difference.

Effect of thermal processing methods on bioactive compounds and antioxidant properties

After thermal processing, all three methods (cooking by rice cooker, steaming by steamer and boiling by boiling water) trended to decreases bioactive compound contents and antioxidant properties in all rice varieties. In Kum Phayao varieties, it was found that cooking could retain highest amount of all bioactive compound contents (77.50-98.96%) (Table 2).

Both steaming and boiling methods could retain lower amount of them than the first method. It was also found the same trends in other two rice varieties (Kum Leumpua and Kum Doisaket). Considering to antioxidant properties, cooking and boiling methods had the higher retaining than steaming one (Fig 1 and Fig 2). Several studies demonstrated of food stuff (in food samples) that the level of temperature and time during thermal processing could decompose some bioactive compound contents [11, 12]. From this study, it could indicate that cooking by rice cooker could conserved some bioactive compounds contents and antioxidant properties than other two thermal processing methods.

Table 2 Bioactive compounds quantities of three rice varieties after cooking different thermal processing.

Quantities	Thermal processing	Relative retention of bioactive compounds from three rice varieties after cooking (% w/w)		
		Kum Phayao	Kum Leumpua	Kum Doisaket
Total phenolic compounds	Cooking	98.96±3.26 ^a	49.66±5.46 ^a	80.70±3.58 ^a
	Steaming	81.24±3.61 ^b	47.88±2.47 ^b	66.30±2.51 ^b
	Boiling	76.16±7.93 ^b	46.37±1.81 ^c	66.83±5.89 ^b
Tannins	Cooking	89.28±8.08 ^a	62.58±3.79 ^a	98.55±1.70 ^a
	Steaming	82.20±4.65 ^b	59.88±5.31 ^b	95.56±5.60 ^c
	Boiling	80.89±5.65 ^b	59.99±12.37 ^b	96.83±5.50 ^{ab}
Anthocyanins	Cooking	83.87±9.53 ^a	58.03±9.92 ^a	48.88±8.64 ^a
	Steaming	63.74±3.11 ^b	39.69±10.64 ^b	43.17±10.71 ^a
	Boiling	77.73±3.63 ^a	57.84±11.94 ^a	43.75±10.12 ^a
Gamma-oryzanol	Cooking	77.50±0.79 ^a	81.89±0.08 ^a	85.16±0.39 ^a
	Steaming	64.76±0.81 ^a	68.62±2.51 ^a	66.16±0.54 ^c
	Boiling	67.08±1.79 ^a	77.13±1.03 ^a	73.29±0.58 ^b
Gamma-aminobutyric acid (GABA) ^{ns}	Cooking	84.83±0.01	97.72±0.39	94.32±0.44
	Steaming	74.83±0.24	93.61±0.01	89.39±0.02
	Boiling	82.76±0.02	94.52±0.01	92.42±0.27
Tocopherol ^{ns}	Cooking	80.33±0.16	88.70±0.29	85.23±0.02
	Steaming	70.29±0.02	83.04±0.11	73.00±0.17
	Boiling	66.11±0.23	85.22±0.05	84.39±0.02

^{a-c} Each bioactive compounds mean values of each process in same column with different letters were significant different ($p \leq 0.05$).

^{ns} No statistical difference.

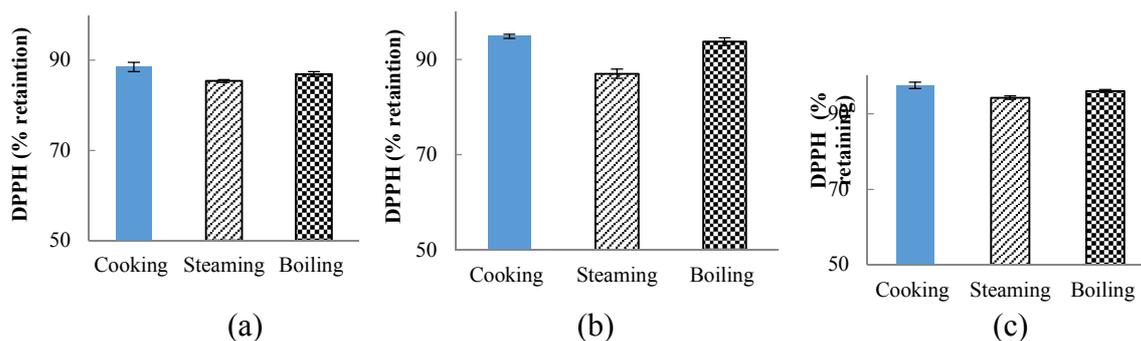


Fig 1 DPPH radical scavenging activity of Kum Phayao (a), Kum Leumpua (b) and Kum Doisaket (c) after cooking by rice cooker, steaming and boiling.

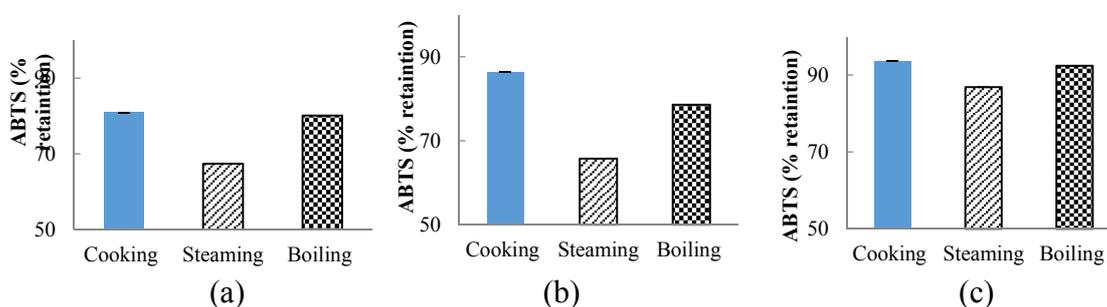


Fig 2 ABTS radical cation decolorization assay of Kum Phayao (a), Kum Leumpua (b) and Kum Doisaket (c) after cooking by rice cooker, steaming and boiling.

Effect of mixing proportions of pigmented unpolished and polished rice on bioactive compounds, antioxidant properties and eating qualities

Kum Leumpua was selected to study because of the high retentions of bioactive compound contents after thermal processing. After cooking by rice cooker, it was found that the higher proportion of pigmented unpolished rice, the higher bioactive compound contents and antioxidant properties (Table 3). When we focused on sensory quality, it indicates that the higher amount of pigmented unpolished rice. The cooked pure pigmented unpolished rice grain had a hard texture, difficult to eat. When we mixed with polished rice grain, the cooked rice had a soft texture, but the rice's fragrant odor was lost. From this study, the recommended proportion of unpolished pigmented rice grain mixing was 25% because of the higher bioactive compound contents and antioxidant properties than cooked pure polished rice and high scores of sensory evaluation.

Table 3 Bioactive compound content, antioxidant properties and sensory qualities of Kum Phayao different proportion in cooked rice.

Quality	Proportion Kum Phayao in cooked rice (%)				
	0	25	50	75	100
Bioactive compound content					
Total phenolic compounds (mg / 100 g db.)	78.76±14.54 ^d	93.53±9.33 ^{cd}	116.10±10.07 ^{bc}	145.33±17.46 ^{ab}	150.89±26.94 ^a
Tanins (mg / 100 g db.)	1.20±0.65 ^d	7.66±0.41 ^c	14.70±0.68 ^b	16.15±1.71 ^b	19.26±1.80 ^a
Anthocyanins (mg / 100 g db.)	ND	19.83±3.31 ^b	51.22±8.57 ^a	57.74±4.68 ^a	64.94±11.94 ^a
Gamma-Oryzanal (mg / 100 g db.) ^{ns}	18.48±1.55	17.21±1.47	20.64±0.48	19.06±1.40	20.97±2.54
Gamma-Aminobutyric acid (GABA) (mg / 100 g db.) ^{ns}	1.57±0.19	1.10±0.25	1.16±0.86	1.12±0.09	1.17±0.33
Tocopherol (mg / 100 g db.)	0.03±0.01 ^c	0.04±0.02 ^c	0.11±0.01 ^b	0.13±0.04 ^b	0.85±0.02 ^a
Antioxidant properties					
DPPH radical scavenging activity (% remaining) ^{ns}	73.30±4.11	73.05±11.45	76.22±2.76	81.93±9.75	83.76±5.22
ABTS radical cation decolorization assay (µmol trolox equivalents (TE)/ g sample)	0.1200±0.01 ^c	0.1593±0.02 ^a	0.1699±0.02 ^a	0.1496±0.02 ^{ab}	0.1464±0.01 ^{ab}
Sensory qualities					
Appearance	7.58±0.78 ^a	5.82±1.04 ^c	5.74±1.54 ^c	5.48±1.11 ^c	6.52±1.22 ^b
Odor	7.08±1.10 ^a	6.54±1.31 ^{ab}	6.76±1.25 ^a	6.10±1.37 ^{bc}	5.92±1.83 ^a
Color	7.34±1.02 ^a	6.00±1.16 ^c	6.14±1.41 ^c	5.90±1.20 ^c	6.70±1.22 ^b
Flavor	7.50±0.89 ^a	6.56±1.18 ^b	6.24±0.89 ^{bc}	5.44±1.13 ^c	5.92±1.21 ^d
Texture	7.60±0.88 ^a	6.70±1.42 ^b	6.16±0.98 ^{bc}	6.30±0.93 ^c	5.12±1.32 ^d
Overall liking	7.74±0.69 ^a	6.64±1.16 ^b	6.50±0.89 ^b	6.04±1.09 ^c	5.86±1.14 ^c

^{a-d} Mean values in same row with different letters are significant different ($p \leq 0.05$).

^{ns} No statistical difference.

CONCLUSION

Cooking by rice cooker could retain higher amount of bioactive compound contents and antioxidant properties than steaming and boiling methods. After cooking, Kum Leumpua varieties had higher retention of bioactive compound contents and antioxidant properties than Kum Leumpua and Kum Doisaket. The mixing of pigmented unpolished rice at 25% proportion with polished rice (Khaw Dawk Mali 105) had high amount of bioactive compound contents and antioxidant and good eating qualities.

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Utilization of Waste Flour during Noodle Production for Biodegradable Film Production

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Abstract: Waste flour gelatinized during noodle processing is a starchy material with low-cost. The objective of this study was to develop biodegradable films based on waste flour and to characterize their mechanical properties. Films from waste flour were prepared by casting technique, with glycerol and sorbitol as plasticizers. Films with sorbitol were more rigid, while films with glycerol are more plasticized and have poorer water vapor barrier properties. The water vapor transmission rate was found to increase with an increase in glycerol content. Plasticized films appeared homogeneous, clear and smooth; in addition, the softness and stickiness of films improved with increasing glycerol concentration. Increasing glycerol content caused increase in tensile strength and improved elongation at break. Therefore, the use of glycerol as plasticizer is alternative to improve the properties of waste flour from noodle production as based films.

Keywords: Biodegradable films, Films, Waste flour, Mechanical properties.

INTRODUCTION

Rice is the most widely consumed basic food and can be used as a raw material in the food industries such as rice noodle industry. The major chemical component of rice grain is starch which comprises around 90% of its dry weight [1]. Rice noodle industry in Thailand has about 600 factories that rice was used around 80% of all raw materials. Therefore, waste flour gelatinized during noodle processing as a starchy material is possible to detect. In recent years, rice flour and starch can be considered a suitable raw material for preparing edible or biodegradable films, which could partly substitute for the traditional non-biodegradable plastic films [2-3]. However, wide application of starch films is limited by its mechanical properties. This limitation has led to improve properties of starch films by addition of plasticizers such as glycerol and sorbitol. Starch-based films plasticized with glycerol and sorbitol were transparent, clear, homogeneous, flexible and easily handled while plasticizers also increase the film's permeability [4-6].

Many studies have been reported on starch-based films made from different types of starches. Therefore starch from waste flour gelatinized during noodle processing could be used to produce biodegradable films to replace plastic polymer because of its low cost and renewability. Also it has not yet been studied in any great details. Therefore, the aim of this study was to develop biodegradable films based on waste flour from rice noodle industry and to characterize their mechanical properties.

MATERIALS AND METHODS

Raw materials

The waste flour gelatinized during noodle processing was obtained from ITSARIYAPHON LTD., PART., Thailand. Food grade glycerol and sorbitol were purchased from Unionscience Co., LTD., Thailand.

Chemical analysis

The moisture, crude protein, total dietary fiber, ash and carbohydrate contents of the waste flour gelatinized during noodle processing were determined using AOAC method [7]. All the analyses were performed in the triplicate.

Film formation

An aqueous solution of 75% (w/v) of flour gelatinized during noodle processing was prepared. Glycerol and sorbitol were used as a plasticizer at the ratio of glycerol:sorbitol; 1:0, 1:1, 2:1, 3:1, 4:1 and put into the solutions to give a final concentration of each plasticizer at 30%, 40% and 50% (w/w) (dry weight based on dried waste flour). All films were heated at 90 °C for 15 min while being stirred continuously. Films prepared by casting technique were by pouring the film-forming solution (90 ml) in a flat 30×30 cm high-density polyethylene plate and allowed to dry overnight at 55 °C prior to evaluate the film properties.

Film thickness

The film thickness was measured with a precision digital hand-held micrometer (Mitutoyo, Tokyo, Japan) to the nearest 0.01 mm at ten random locations on the films.

Color and opacity

Color and opacity were determined according to *Bourtoom* [3], using the CIE colorimeter (Color Quest XE, Fairfax, USA). The color was used to determine the film L^* , a^* and b^* color value and the opacity, represented as color difference (ΔE^*) which was calculated using the following equation:

$$\Delta E^* = \sqrt{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2} \quad (1)$$

The value of ΔL^* , Δa^* and Δb^* were the difference between the color parameter of the samples and the white standard ($L^*= 100$, $a^*=0.00$, $b^*=-0.01$) used as film background.

Water solubility

The water solubility of the films were determined according to *Laohakunjit* and *Noomhorm* [4], one gram strip of the film was immersed and agitated in 10 mL of distilled water for 30 min. The supernatant was then taken out and the unsolubilized film was dried in a hot air oven at 80 °C overnight to determine the weight of dry matter. The solubility was calculated using Equation (2).

$$\text{Water solubility (\%)} = \frac{\text{weight of initial dry matter} - \text{weight of dry matter not solubilized}}{\text{weight of initial dry matter}} \times 100 \quad (2)$$

Water vapor transmission rate

Water vapor transmission rate was determined according to *Bustillos and krochta* [8] and *Ekthamasut* [9]. Film samples were sealed over the circular opening of a permeation cell containing distilled water. The cells were placed in desiccators at 15% RH and heated at 80 °C,

the weight loss of the cells was monitored every 1 hr. for 4 hr. Water vapor transmission rate were calculated using Equation (3).

$$WVTR(g \cdot mm \cdot m^{-2} \cdot d^{-1}) = \frac{(\Delta W) \times (x)}{(A) \times (\Delta t)} \quad (3)$$

which ΔW is weight loss (g), A is area of film (m^2), Δt is time for weight change (day, d), and x is film thickness (mm).

Tensile strength (TS) and Elongation at break (E)

Tensile strength (TS) and elongation at break (E) were analyzed according to *ASTM 882-95* [10]. Film strips (25 mm × 150 mm) were stretched at 25 mm/min (initial grip separation of 100 mm, load cell 1000 N) using Universal Testing Machine H1KS (Hounsfield, England). Film specimens were equilibrated at 65% RH and 27 °c for 24 hr. before testing.

Tensile strength and elongation at break were calculated using Equation (4) and (5), respectively.

$$TS = \frac{F_{\max}}{A_0} \quad (4)$$

$$\% \text{ Elongation} = (\Delta L / L_0) \times 100 \quad (5)$$

which F_{\max} is maximum of force, A_0 is area of film, ΔL is elongation at break, and L_0 is initial gauge length (100 mm).

Statistical analysis

All trials were carried out in triplicate and all data were reported as means±SD (standard deviation). The statistics significance was evaluated using Duncan's New Multiple Range Test and $p \leq 0.05$ was taken as significant.

RESULTS AND DISCUSSION

Chemical analysis

Chemical analysis of waste flour gelatinized during noodle processing showed the rich source of carbohydrates. It is composed of 9.17% of carbohydrate, 2.88% of protein, 0.20% of ash, 0.06% of lipid and 87.69% of moisture.

Mechanic Properties

The mechanical properties of the films which studied were shown in Table 1.

Table 1 Thickness, color and opacity, water solubility, water vapor transmission rate (WVTR), tensile strength (TS) and elongation at break (E) of films plasticized with glycerol and with the combination of glycerol and sorbitol.

Sample Code*	Thickness** (mm)	(L*)**	(a*)**	(b*)**	Opacity (ΔE^*)**	Water solubility** (%)	WVTR** (g·mm·m ⁻² ·d ⁻¹)	TS** (MPa ×10 ⁻⁴)	Elongation** (%)
30%	0.074 ^{abc}	± 99.28 ^c	± 0.61 ^{cd}	± 0.58 ^a	± 0.45 ^a	± 26.602 ^c	± 247.434 ^g	± 6.17 ^b	41.718 ^{bcd}
G:S (1:0)	0.007	0.16	0.03	0.13	0.06	1.17	6.67	± 1.31	± 3.69
40%	0.077 ^{ab}	± 99.64 ^b	± 0.57 ^c	± 0.49 ^{abc}	± 0.29 ^{cde}	± 33.253 ^{ab}	± 298.764 ^d	± 11.68 ^a	48.509 ^{ab}
G:S (1:0)	0.006	0.23	0.02	0.09	0.02	2.19	5.02	± 1.46	± 4.09
40%	0.072 ^{abc}	± 99.84 ^{ab}	± 0.60 ^{cd}	± 0.44 ^{bc}	± 0.30 ^{cde}	± 26.945 ^c	± 256.815 ^f	± 10.37 ^a	57.752 ^a
G:S (2:1)	0.001	0.06	0.01	0.08	0.02	3.12	4.15	± 0.12	9.23
40%	0.071 ^{abc}	± 99.87 ^a	± 0.61 ^{cd}	± 0.38 ^c	± 0.26 ^c	± 30.837 ^b	± 258.331 ^f	± 6.29 ^b	± 55.605 ^a
G:S (3:1)	0.003	0.04	0.01	0.02	0.01	0.71	6.37	0.35	± 5.45
40%	0.070 ^c	± 99.84 ^{ab}	± 0.63 ^{bc}	± 0.38 ^c	± 0.27 ^{dc}	± 31.190 ^{ab}	± 285.875 ^c	± 6.62 ^b	54.794 ^a
G:S (4:1)	0.006	0.10	0.00	0.00	0.01	1.47	6.96	± 1.28	± 1.86
50% G:S	0.079 ^a	± 99.84 ^{ab}	± 0.63 ^{bc}	± 0.51 ^{ab}	± 0.33 ^{bc}	± 34.493 ^a	± 338.210 ^a	± 10.29 ^a	42.264 ^{bcd}
(1:0)	0.001	0.01	0.01	0.06	0.03	2.98	2.83	± 1.05	± 6.30
50%	0.076 ^{abc}	± 99.99 ^a	± 0.64 ^b	± 0.45 ^{bc}	± 0.31 ^{cd}	± 31.602 ^{ab}	± 318.031 ^c	± 6.18 ^b	± 44.459 ^{bc}
G:S (1:1)	0.001	0.11	0.00	0.02	0.01	0.22	0.88	0.67	± 7.52
50%	0.074 ^{abc}	± 99.66 ^b	± 0.66 ^a	± 0.46 ^{abc}	± 0.36 ^b	± 30.986 ^b	± 323.407 ^{bc}	± 7.54 ^b	± 38.180 ^{cd}
G:S (2:1)	0.002	0.04	0.01	0.01	0.01	1.62	2.72	0.37	± 3.05
50%	0.073 ^{abc}	± 99.85 ^{ab}	± 0.63 ^{bc}	± 0.48 ^{abc}	± 0.32 ^{bcd}	± 33.7037 ^{ab}	± 328.585 ^c	± 6.37 ^b	± 34.669 ^d
G:S (3:1)	0.004	0.10	0.01	0.07	0.03	1.10	3.94	1.46	1.59
50%	0.071 ^{bc}	± 99.91 ^a	± 0.64 ^{ab}	± 0.40 ^{bc}	± 0.29 ^{cde}	± 33.951 ^{ab}	± 332.334 ^{ab}	± 6.85 ^b	± 34.493 ^d
G:S (4:1)	± 0.001	± 0.06	± 0.01	± 0.00	± 0.01	± 1.13	± 8.68	± 0.13	± 2.19

*G is Glycerol; S is sorbitol

**Means and standard deviations of the triplicate.

^{a-g} Mean values with same letters at the same column are not different significantly ($p \leq 0.05$).

Film thickness

The thickness of all film samples were not significantly different ($p > 0.05$) as increasing the concentration of glycerol. The thicknesses of films plasticized with the concentration of glycerol at 30%, 40% and 50% (w/w) were 0.074, 0.077 and 0.079 mm, respectively (Table 1). For film samples plasticized with a combination of glycerol and sorbitol, increasing the glycerol content decreased the film thickness.

Color and opacity

Color and opacity of the packaging is an important factor in term of general appearance and consumer acceptance. The results of the measurements which performed on the film's color were expressed using the rectangular coordinates (L^* , a^* and b^*) and total color difference (ΔE^*). The main difference observed was that films with higher content of glycerol had lighter color as indicated by the L^* value and ΔE^* (lower ΔE^*); whereas, yellowness (b^*) had lower (Table 1). This was somewhat expected since color change is attributed to the concentration of glycerol. These results were similar to those achieved by Sobral, Garcia, Habitante, and Monterrey-Quintero [12] who reported that the colorless and transparent of the plasticizer and its concentration effect after its addition to the film solution and agreement with Andrade-Mahecha, Tapia-Blacido and Menegalli [13], who assigned it to the using high plasticizer concentration (20-30%) was low opacity levels of achira flour films.

Water solubility

Water solubility is an important property of biodegradable films because a potential food application may require good water insolubility to enhance product integrity and water resistance. The water solubility of films contains two types of plasticizers which are glycerol and sorbitol. Generally, the solubility of the films should increase with increases in the concentration of plasticizers. In this present study, water solubility was the highest with the use of the highest concentration of glycerol at 50% (w/w). All conditions when glycerol was

combined with sorbitol plasticized films at 50% (w/w) gave a higher water solubility than plasticized films at 40% (w/w). The solubility of films was increased as glycerol concentration increased (Table 1). These results were similar to those achieved by *Bourtoom* [14] who found that film solubility increased about 5% of glycerol-plasticized film and about 7% glycerol-plasticized film when sorbitol, glycerol increased and agreement with *Laohakunjit* and *Noomhorm* [4] who reported that solubility was highest with the use of the highest concentration of glycerol at 35% in rice starch. Increasing glycerol concentrations are able to increase the solubility of the film due to their hydrophilic properties. Glycerol has a higher solubility than sorbitol because it is more hygroscopic.

Water vapor transmission rate (WVTR)

The water vapor transmission rate (WVTR) of films with glycerol and all conditions of the combination of glycerol-sorbitol plasticized films increased with higher content of glycerol and sorbitol ($p \leq 0.05$). Glycerol-plasticized films provided the films with higher WVTR than all conditions of the combination of glycerol-sorbitol plasticized films at each plasticizer concentrations which should be the result of the high hydrophilicity of the glycerol molecule, which is favorable to the adsorption of water molecules and could also contribute to the increase in the film WVTR [4, 15].

Tensile strength (TS) and elongation at break (E)

The mechanical properties of films plasticized with only glycerol and with the combination of glycerol and sorbitol were assessed by measuring their tensile strength (TS) and elongation at break (E). The tensile strength was defined as the maximum tensile stress that the films can sustain. Elongation at break (E) is defined as the maximum change in length of the test specimen before breaking ($p \leq 0.05$). The results showed that the 40% (w/w) glycerol concentration (40% (w/w) G:S (1:0)) gave the highest TS. In addition, the films plasticized with glycerol had a higher TS than that plasticized with combination of glycerol and sorbitol. However, the TS decreased as the sorbitol was added. While the elongation at break (E) of all films, increasing the glycerol concentration from 30% to 40% (w/w) significantly increased the elongation of films which was higher than other film samples. However, the film elongation dropped when the concentration of glycerol increased around 50% (w/w) and the sorbitol was added. The drop in elongation at break was due to a softening of the structure at high glycerol content which means that higher glycerol content could absorb more moisture. The results obtained are in agreement with *Laohakunjit* and *Noomhorm* [4]. They reported that the rice starch films were added 20-30% glycerol (w/w) made a very high the elongation at break but the elongation dropped when the higher glycerol content was used at 35%.

CONCLUSION

The properties of biodegradable films combined with glycerol and sorbitol as the plasticizers were found that increasing glycerol and sorbitol content can increase the thickness and decrease the elongation (E) at break of films. The water solubility and the water vapor transmission rate (WVTR) of biodegradable films increased when increasing glycerol content. Glycerol-plasticized films had a higher WVTR than films were combined with both glycerol and sorbitol. The water solubility and WVTR of films significantly were decreased by adding the sorbitol. Also films plasticized by blends of glycerol and sorbitol had a lower tensile strength than that of only glycerol.

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The physicochemical properties of black glutinous rice yoghurt-liked product affected by rice particle sizes and heating times

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Abstract: Black glutinous rice is a special rice type that contains high anthocyanin compounds. In this research, the rice was utilised to produce a yoghurt-liked product by varying the rice particle sizes, including 300, 212 and 150 microns (50, 70 and 100 meshes, respectively), and boiling times of the rice solutions (30 and 60 min). To make the yoghurt-liked product, rice powder was soaked in distilled water at a ratio of 1:5 for 2 h at room temperature, boiled at 95-100°C for either 30 or 60 min, cooled down, inoculated with 0.02% (w/w) of yoghurt cultures and incubated at 42±1°C until the product reached a pH value of 4.5-4.6. Collected data showed that longer heating period could reduce the fermentation time to reach the final pH in the rice yoghurt-liked products with smaller rice particle sizes of 212 and 150 microns. The viscosity of the rice yoghurt-liked product were significantly affected by the rice particle size and heating times. The highest viscosity was discovered in the rice product produced from rice particle size of 300 microns and 30 min boiling time. For the water holding capacity, the highest value of this parameter (61.05±18.60%) was found in the rice sample made from rice particle size of 300 microns with a heating time of 60 min, whereas the lowest syneresis of the rice product (0.02±0.03%) was determined in the rice yoghurt-liked product from 212 particle size and 60 min heating time.

Keywords: Black glutinous rice, Rice particle size, Heating time, Physicochemical properties.

INTRODUCTION

Pigmented rice (*Oryza sativa* L.) has been consumed for a long time in Asia, especially China, Japan, Korea and many countries in Southeast Asia. Several varieties of pigmented rice, particularly red and black rice, have been cultivated in Thailand [1]. Black glutinous rice derives its name from its rich natural anthocyanin compounds, such as cyanidin 3-glucoside and peonidin 3-glucoside, which possess anti-oxidative and anti-inflammatory activities [2]. Beside this, black glutinous rice also contains many beneficial components, including polyphenolics, flavonoids, vitamin E and γ -oryzanol. These antioxidant compounds eliminate reactive oxygen species such as lipid peroxide and superoxide anion radicals and lower cholesterol content [3]. Therefore, the rice could be utilised as a functional food product [4]. Although black glutinous rice has been used in several products, such as cosmetic, food products and candies, more rice diversification products are still needed to increase the consumption of the rice valuable components by the community.

Yoghurt is mainly made from milk that is allowed to be fermented in the presence of lactic acid bacteria, *Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *Bulgaricus* [5]. Although the product is accepted well around the world due to its flavour and aroma, the problems of lactose intolerance and cholesterol content are two major drawbacks

related to fermented dairy products [6]. Therefore, the yoghurt culture had been utilised in the fermentation of soy beverage [7]. The culture could also be used with another lactic acid bacterium to ferment Mahewu from maize and Tarhana from parboiled wheat meal [7]. In this study, the yoghurt culture was employed to produce yoghurt-liked product from black glutinous rice. The aim of the work was to have a better understanding about the effect of rice particle sizes and boiling times of the black glutinous rice solution on the physicochemical properties of the rice yoghurt-liked product.

MATERIALS AND METHODS

Preparation Of Black Glutinous Rice Powder

Black glutinous rice var. Lem Hua was grinded with a hammer mill (Armfield, UK) to produce rice powder. The rice powders were sieved through a metal screen with sizes of 300, 212 and 150 microns (or 50, 70 and 100 meshes, respectively), packed in polyethylene bags and kept at 4°C until used in the experiment.

Production of Black Glutinous Rice Yoghurt-liked Product

To produce rice solution, different sizes of black glutinous rice powder were separately soaked in distilled water at a ratio of 1:5 for 2 h [8]. The soaking rice was then boiled with its soaking water at 95-100°C for either 30 or 60 min [8]; cooled down; aseptically added with 0.02% (w/v) yoghurt cultures, containing *S. thermophilus* and *L. bulgaricus* and incubated at 42±1°C until the pH of the solution reached a value of 4.5-4.6 [9]. At the end of the fermentation time, the black glutinous rice yoghurt-liked product was kept at 4°C [10] for chemical, physical and microbial analyses.

Physical Analysis

The samples of the black glutinous rice yoghurt-like product were subjected to several physical property measurements, including color analysis using a colorimeter (Minolta Chroma Meter, Japan) [11], viscosity determination by a rotational viscometer (Brookfield MA02346, USA) [9], water holding capacity based on the method of Remeuf et al. [10] and syneresis following the method of Zare et al. [11].

Chemical Analysis

For the chemical characteristics, the rice yoghurt-liked product was determined for pH values using a pH-meter (Consort® C830T, Belgium) [11], total titratable acidity [9], moisture content [12], anthocyanin content [13], total phenolic content [1] and determination of 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radical scavenging ability [14].

Microbial Analysis

Determination of yoghurt cultures in the black glutinous rice yoghurt-liked product was carried out for the numbers of *S. thermophilus* using M-17 medium and *L. bulgaricus* by deMan Rogosa Sharpe agar at pH 5.4 [12].

Statistical Analysis

Collected data was statistically analysed using a Factorial in Completely Randomized Design of the Analysis of Variance. If the F value of the Analysis of Variance was significant, the Duncan’s New Multiple Range Test was applied to determine differences between treatment means. The statistical analysis was carried out by SPSS version 13.0 software (SPSS Inc., Chicago, IL, USA). Statistical significance between sample treatments was defined at $P < 0.05$.

RESULTS AND DISCUSSION

Physical Properties Of Black Glutinous Rice Yoghurt-liked Product

The physical properties of the rice yoghurt-liked product are displayed in Tables 4.1 and 4.2. The viscosity of the final product was significantly affected by the rice particle sizes. Bigger sizes of rice particle produced higher viscosity of the rice yoghurt-liked product. This could be due to higher water intake accomplished by smaller rice particles, considering a greater surface area, [15] that diluted the viscosity of the rice yoghurt-like product. The color of the rice yoghurt-liked product in this study was almost similar to the work of Chiangpa [8] for black glutinous rice solution, which were 20.69-21.32, 3.81-3.88 and 1.68-1.95 for L^* , a^* and b^* values, respectively. A slightly higher a^* value in this study compared to the previous study could be affected by different varieties of the black glutinous rice.

Table 1 Viscosity and color values of black glutinous rice yoghurt-liked product affected by rice particle sizes and boiling time

Boiling time (min)	Rice particle size (micron)	Viscosity (cP)	Color values		
			L^{*ns}	a^{*ns}	b^{*ns}
30	300	4232.00±1495.33 ^a	20.34±1.76	4.38±0.45	1.34±0.13
	212	1625.33±302.65 ^b	19.24±1.91	4.43±0.13	1.41±0.11
	150	1040.93±488.59 ^b	20.22±0.93	4.25±0.18	1.34±0.09
60	300	2820.00±960.03 ^a	24.31±0.21	4.92±0.73	1.47±0.12
	212	2299.33±834.91 ^a	24.04±0.04	4.41±0.28	1.36±0.03
	150	1710.67±265.10 ^b	22.09±2.30	5.96±0.98	1.69±0.25

^{a-c} Different letters within a column indicated significantly different treatments at $p < 0.05$

^{ns} Not significantly different

The water holding capacity and syneresis results of black glutinous rice yoghurt-liked product can be seen in Table 2. Both physical properties were not significantly affected by the rice particle sizes and boiling time of the rice solution ($p \geq 0.05$). However, the water holding capacity of the rice yoghurt-liked product was lower than that of stirred yoghurt from cow milk, which was in the range of 84 to 92% [16]. Lower water holding capacity in this study could be affected by lower total solid of the black glutinous rice solution and the absence of milk protein. Although different treatments in this study did not significantly affect the syneresis of the rice yoghurt-like product, the syneresis of the rice product could be considered low, below 9%. These values were lower than the syneresis of mango soy fortified set yoghurt added with 0.2-

0.6% stabilizers [12]. This result indicated that starch in the black glutinous rice could be utilised to reduce the application of stabilizer.

Table 2 Water holding capacity and syneresis of black glutinous rice yoghurt-liked product affected by rice particle sizes and boiling time

Boiling time (min)	Rice particle size (micron)	Water holding capacity (%) ^{ns}	Syneresis (%) ^{ns}
30	300	53.86±2.99	0.45±0.40
	212	40.33±2.79	8.19±8.99
	150	47.24±5.38	5.67±7.83
60	300	61.04±18.59	1.05±1.82
	212	54.81±13.06	0.02±0.03
	150	45.12±7.14	0.34±0.53

^{ns} Not significantly different

Chemical Properties Of Black Glutinous Rice Yoghurt-liked Product

The chemical properties of moisture contents, pH value and total titratable acidity of the black glutinous rice yoghurt-liked product are shown in Table 2. Different rice particle sizes and boiling time did not significantly affect the moisture content and pH values of the rice yoghurt-liked product. The finding of the moisture content was not surprising, since the moisture content of the rice product would be more affected by the ratio of water addition to the rice powder. For the pH and total titratable acidity, they were more influenced by the production of lactic acid by the yoghurt cultures. Since a predetermined pH value of 4.6 was established, the fermentation times of the rice yoghurt-liked product were 22, 26.7 and 27 h for rice particle sizes of 300, 212 and 150 microns, respectively, and a boiling time of 30 min. Applying a boiling time of 60 min caused the fermentation times to be 24, 23 and 23 h, respectively. Therefore, a combination of longer heating time and smaller rice particle sizes could produce a shorter incubation time. For the total titratable acidity of the rice yoghurt-liked product, the acidity of the rice product was higher than that of mango soy fortified set yoghurt reported by Kumar and Mishra [12]. This result could be partly affected by the absence of milk solids non-fat in the rice product, since the milk protein had a buffering capacity, and longer incubation time.

Table 3 Moisture content, pH value and total titratable acidity of black glutinous rice yoghurt-liked product affected by rice particle sizes and boiling time

Boiling time (min)	Rice particle size (micron)	Moisture content (%) ^{ns}	pH value ^{ns}	Total titratable acidity (% lactic acid)
30	300	87.60±0.29	4.36±0.21	1.11±0.17 ^b
	212	86.92±2.04	4.60±0.09	1.05±0.05 ^b
	150	84.94±0.95	4.62±0.05	1.31±0.15 ^b
60	300	85.50±1.10	4.71±0.43	0.79±0.10 ^b
	212	85.69±0.82	4.04±0.33	1.09±0.07 ^b
	150	88.89±3.86	3.79±0.13	1.37±0.09 ^a

^{a-b} Different letters within a column indicated significantly different treatments at $p < 0.05$

^{ns} Not significantly different

The antioxidant properties of black glutinous rice yoghurt-liked product, including total phenolic, 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radical scavenging activity and anthocyanin content, are exhibited in Table 4. The total phenolic of the rice product was not significantly affected by different treatments studied in this research. Sompong et al. [17] reported that in the black rice variety the phenolic acids were present as ferulic, vanillic and *p*-coumaric acid in the range of 24.7 to 39.5, 6.5-17.7 and 3.8-6.7 mg/100g sample, respectively. A much lower total phenolic acid in this study could be due to the addition of water into the rice powder and the chosen analysis method [17]. The results of DPPH scavenging activity and anthocyanin content were more affected by the rice particle sizes rather than the boiling times. Higher anthocyanin contents were found at smaller rice particle sizes (212 and 150 microns). This could be affected by bigger surface area of smaller rice particle sizes that led to higher anthocyanin released from the rice powder. It was reported that major antioxidant compounds in black rice were cyanidin 3-glucoside and peonidin 3-glucoside [3].

Table 4 Antioxidant properties of black glutinous rice yoghurt-liked product affected by rice particle sizes and boiling time

Boiling time (min)	Rice particle size (micron)	(mg of gallic acid equivalents/100 ml)	2,2-diphenyl-1-picrylhydrazyl (DPPH) (%)	Anthocyanin (mg of cyanidine-3-glucoside equivalent/l)
30	300	0.40±0.08	65.08±5.19 ^b	113.52±3.81 ^a
	212	0.41±0.05	66.96±0.90 ^b	113.33±11.26 ^a
	150	0.39±0.01	62.08±2.06 ^b	151.76±17.77 ^a
60	300	0.29±0.08	80.17±3.45 ^a	66.00±8.97 ^b
	212	0.34±0.03	67.56±0.53 ^b	101.74±7.75 ^a
	150	0.43±0.01	66.70±1.63 ^b	106.63±3.09 ^a

^{a-b} Different letters within a column indicated significantly different treatments at $p < 0.05$

^{ns} Not significantly different

Table 5 The number of yoghurt cultures in the black glutinous rice yoghurt-liked product affected by rice particle sizes and boiling time

Boiling time (min)	Rice particle size (micron)	<i>Lactobacillus bulgaricus</i> (log cfu/ml)	<i>Streptococcus thermophilus</i> (log cfu/ml)
30	300	5.90±0.42 ^b	6.03±0.48 ^b
	212	6.36±0.38 ^b	6.34±0.08 ^{ab}
	150	6.67±0.71 ^b	5.82±0.19 ^b
60	300	6.78±0.00 ^b	6.33±0.05 ^{ab}
	212	7.44±0.25 ^a	6.93±0.35 ^a
	150	7.43±0.10 ^a	6.78±0.24 ^a

The Number Of Yoghurt Cultures In Black Glutinous Rice Yoghurt-liked Product

The numbers of *S. thermophilus* and *L. bulgaricus* are presented in Table 5. It could be seen clearly that smaller rice particle sizes of 212 and 150 microns and boiling for 60 min significantly produced higher numbers of the yoghurt bacteria in the final rice product. This could be affected by lower pH of the rice solution after a longer boiling period [8] that might stimulate the growth of the starter cultures.

CONCLUSION

It could be concluded that the rice particle sizes and boiling times of the black glutinous rice solution significantly affected the viscosity, total acidity, antioxidant properties and the number of starter cultures in the final black glutinous rice yoghurt-liked product. Using smaller rice particle sizes of 212 and 150 microns with 60 min of boiling times could produce higher anthocyanin content and the number of yoghurt cultures in the final rice product.

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