# International Poster Presentations

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# English for International Communication (EIC) Students' Attitude and Satisfaction toward the Streaming Application Netflix in Improving Listening skill and English vocabulary learning.

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## Abstract

The purpose of this research aimed to investigate the attitudes of the people toward the streaming application Netflix in improving English listening skill and English vocabulary learning, and to study the satisfaction of the people toward the streaming application Netflix in improving English listening skill and English vocabulary learning. The participants were 1st – 4th years students who studied in English for International Communication major total of 92 people. The instrument for collecting data was questionnaire. The data was collected and analyzed for calculating quantitative data, which were Mean ( ), Standard Deviation (S.D.) and Percentage (%). The results of this research showed that people who have ever watched Netflix was 74 people (80.4%) and people who have never watched Netflix was 18 people (19.6%). Therefore, the mean of attitude toward Netflix in improving listening skills and English vocabulary learning was very high (4.29, S.D. = 0.707). It showed that the participants have good attitude in improving listening skills and English vocabulary learning toward Netfilx. Besides, the mean of satisfaction toward Netflix in improving listening skills and English vocabulary learning was very high (4.38, S.D. =0.632). It showed that the participants satisfy to improve listening skills and learning English vocabulary toward Netfilx.

**Keywords:** Netflix, Attitude, Satisfaction, English skills, Listening skills, English Vocabulary Learning

## Introduction

English is the most spoken one language; English is used to communicate in many countries. Some countries use English as a Lingua Franca or language used. Learning English is very significant for the daily life education and makes an opportunity for jobs. English plays an important role in daily life of Thai people and also people around the world. The entire humanity of today communicate usually in English. Whether it is to communicate directly, using the Internet, Watch TV or movies. (Crystal, 1997) Thus, Improving English skills is very important for Thai people.

Nowadays, the media take an important role in improving English skills for Thai people. Netflix is the most popular streaming application for people in Thai, especially Gen Y based on the research of Yungyuen (2017) conducted the research on Use and Satisfaction of People in Gen Y toward VDO Streaming Service. The result showed that Gen Y with the different demographic profile in gender, age, education level shows no difference in the use of streaming "Netflix" service, while the use of such service has an overall positive relationship with their satisfaction. Netflix is a streaming service that customers can use to watch a wide variety

of entertainment content for TV shows, movies, documentaries, and more across devices by internet connection. Netflix has just recently been available in Thailand but received a lot of attention because of the different contents because they have their own movies and series production or joint production. Customers can only watch on Netflix. A wide variety of movies and series from many countries, including Western, Korean, Japanese, and Thai subtitles for almost all titles. Netflix is available on many platforms such as Playstation 4, Smart TV, Xbox the quality of the picture and sound quality is still more acceptable than other service providers, which can be viewed on the big screen with ease (Thairath Online, 2017). In Netflix, there are many media for helping people to get knowledge from the application include English especially listening skill and new vocabulary, which are important for communication or daily life. In addition, there are many researches related to Netflix Application. For instance, Songkong, Katatho, and Phuakpong, (2019) conducted research on Consumer Perspectives and Behaviors and Results of Using a Video Streaming Service in Thailand: A Case Study of Netflix. Tomcharoen (2019) conducted research on Factors Influencing Consumer Behavior of Streaming Netflix in Chonburi Province. Yungyuen (2017) conducted research on Use and Satisfaction of People in Gen Y toward VDO Streaming Service, Netflix. Alongkorn and Somchai (2019) conducted research on the Causal Relationship Model of Intention to Watch Video Streaming Netflix of Consumer in Bangkok and the Metropolitan Region.

Improving English skills by using media is very important and interesting especially listening skill Krashen (1982) stated that listening is primarily important in the language learning and that the ability to speak and write fluently in the second will come on its own with time. There are many researches related to improving English especially listening skill and vocabulary. For instance, Yanarom (2013) conducted research on Developing English Listening-Speaking Skills of the M.5/1 Students through English Movies. Srithongkul (2019) conducted a research on Developing Listening-Speaking Skills in English for Communication Subject of Students at Dhonburi Rajabhat University Samutprakarn through the Echo English Application. Paowpan (2011) conducted research on A Study on Learning English Vocabulary through a Visual Memory Model based on the Theory of Multiple Intelligence for

From above, the researchers were interested in English for International Communication Students' Attitude and Satisfaction toward the Streaming Application Netflix in Improving English skills to be a guideline for studying English that is not limited to the classroom, and able to research and learn by themselves, and to develop listening skills and knowledge of English vocabulary.

## Objectives

1. To investigate the attitude of the EIC's students toward the streaming application Netflix in improving English listening skill and English vocabulary learning.

2. To study the satisfaction of the EIC's students toward the streaming application Netflix in improving English listening skill and English vocabulary learning.

## Research Questions

1. What is the attitude of EIC's students toward the streaming application Netflix for improving English listening skill and English vocabulary learning?

2. What is the level of satisfaction of EIC's students toward the streaming application Netflix for improving English listening skill and English vocabulary learning?

## Scope of the study

This research focuses on studying the attitude and satisfaction toward the English and Thai subtitle movies or series on "Netflix" in Rajamangala University of Technology Lanna Tak. There were 118 participants including English for International Communication 1st year students 39 people, English for International Communication 2nd year students 32 people, English for International Communication 3rd year students 21 people, English for International Communication 4th year students 26 people. This research was conducted through a questionnaire which assessed English for International Communication students' attitude and satisfaction toward Netflix for improving English listening skill and English vocabulary learning.

## Research Methodology

This research was studied about English for International Communication (EIC) Students' Attitude and Satisfaction toward Netflix in Improving listening skill and English vocabulary learning. This study was quantitative research. The objectives of the study aimed to investigate the attitude of the people toward Netflix in improving English listening skill and English vocabulary learning and to study the satisfaction of the people toward Netflix in improving English listening skill and English vocabulary learning. The researchers used data storage methods through questionnaires.

**Participants**

This research was collected data from participants by conducting a questionnaire which was about attitude and satisfaction of 1st – 4th year English for International Communication students toward the Netflix application in improving listening skill and English vocabulary learning

The sample of this study was 92 (n) people from 118 (N) population who are English for International Communication 1st year students 39 people, English for International Communication 2nd year students 32 people, English for International Communication 3rd year students 21 people, English for International Communication 4th year students 26 people which were 1st - 4th year English for International Communication student at Rajamangala University of Technology Lanna Tak. The Method of choosing population was adapted by Krejcie and Morgan (1970).

The researchers selected these the participants 1st - 4th years students who are the student in English for International Communication major because, their subjects are about English skill especially listening, speaking, reading, and writing skills. They need to find knowledge in other ways which are not just studying in the classroom. Thus, they apply technology in learning new knowledge such as watching movies, listening to music, watching cartoons, reading books, which influence to learning English extenuate boring. Currently, Netflix application is one of the most popular applications. Therefore, this research was specific to students who had experience with the Netflix application.

**Research instruments**

The research instrument was adapted from the research instrument of Thidarat Nganwikorn (2012) who conducted a research on Attitude and Satisfaction of Burmese Learners Studying Thai Language in

Language School of Thai Allied Committee with Desegregated Burma Foundation and Rommaneeya Surathamjanya (2015) who conducted research on The Result of Using Application for Teaching English Vocabulary on Tablet in English Subject for Prathomsuksa 2 students in Ratchaburi educational service area 2. The questionnaire consists of 4 parts as follows: General information, Experiences in using Netflix application in improving English skills, Attitudes toward Netflix in improving listening skill and learning English vocabulary, and Satisfaction toward Netflix in improving listening skill and learning English vocabulary.

## Research Methods

1. Created the questionnaire that was adapted from Thidarat Nganwikorn (2012) and Rommaneeya Surathamjanya (2015)

2. Questionnaires were checked and approved by 3 specialists.

3. Questionnaires were tested with 10 students in Tourism and Hospitality experimental people to find the content reliability.

4. Found the reliability of the questionnaire by using Cronbach's Alpha Coefficient by using the formula as follows:

Formula $\alpha = \frac{n}{n-1}\left[1 - \frac{\sum s_i^2}{s_x^2}\right]$

The results of reliability level from the coefficient alpha in part of the attitude is 0.85 and the satisfaction is 0.88 both of which are good

5. Questionnaires were used to collect data from participants with a total of 92 people.

6. The data was analyzed by using the statistical computer program (SPSS) with Mean ($\bar{X}$) and Standard Deviation (S.D.) for each item.

**Methods of data analysis**

The data analysis of this study as follows:

1. The data obtained were analyzed by using the statistical computer program (SPSS).

2 The analysis of the Mean ($\bar{\mathbf{X}}$), Standard Deviation (S.D.) and Percentage (%) were interpreted to discover Attitude and Satisfaction toward the Streaming Application Netflix in Improving English Skills.

3. The researchers collected and analyzed data for calculating quantitative data, which were Mean ($\bar{\mathbf{X}}$), Standard Deviation (S.D.) and Percentage (%), it was conducted by using the average formula as follows:

- Average (Mean, $\bar{\mathbf{X}}$); Formula $\bar{\mathbf{X}} = \frac{\Sigma x}{n}$
- Standard Deviation (S.D.); Formula S.D. = $\sqrt{\frac{n\sum x^2 - (\Sigma x)^2}{n(n-1)}}$
- Percentage (%); Formula Percentage (%) = $\frac{F}{N} \times 100$

4. The data analysis of mean score will be interpretation Mean Score Table of Moidunny, 2009

Table 1.Mean Score Table of Moidunny (2009)

| Mean Score | Interpretation |
|---|---|
| 1.00-1.80 | Very Low |
| 1.81-2.60 | Low |
| 2.61-3.20 | Medium |
| 3.21-4.20 | High |
| 4.21-5.00 | Very high |

5. Summarized results of analysis, discussion of results and recommendations will be in the result and discussion.

## Results

The students' experience toward Netflix in Improving English skills. This study applied quantitative data analysis with the use of statistical computer program (SPSS) in order to answer two research questions.

For the research, 92 students from 1st - 4th year students in English for International Communication Major responded the questionnaires. Descriptive analysis was carried out with the use of statistical computer program to show the mean ( $\bar{X}$ ), standard deviation (S.D.), and percentage (%) to display the diagram for making the results to be more cleared for answering the research questions.

This research investigated English for International Communication students' Attitudes and satisfaction toward Netflix in improving English skills. The instrument was piloted with 10 Tourism and Hospitality students to measure reliability. Then, the questionnaire was tested with the participants that are 92 1st - 4th year students majoring in English for International Communication major.

The questionnaire was responded 100 % by 1st - 4th year students in English for International Communication. Furthermore, table 4.1 displayed general information of the respondents on percentage to see if the respondents have ever watched movies on Netflix or not.

The table showed people who have ever watched Netflix was 74 people (80.4%) and people who have never watched Netflix was 18 people (19.6%).

Table 2. The people who have ever watched Netflix and have never watched Netflix.

| Question | Total | Percentage (%) |
|---|---|---|
| Ever watched Netflix application | 74 | 80.4 |
| Never watched Netflix application | 18 | 19.6 |

The investigation also showed the people have watch series or movie with subtitles such as Thai, English, and others (Korean and Russian).

Table 3. Subtitle has you watched in a series or movie on Netflix

| Subtitle | Total | Percentage (%) |
|---|---|---|
| Thai | 60 | 54.6 |
| English | 46 | 41.8 |
| Others (Korean, Russian) | 4 | 3.6 |

The above figure displayed the people who have ever watched Netflix in each subtitle as follows; 1.) Thai subtitle was 60 (54.6%). 2.) English subtitle was 46 (41.8%) people. 3.) others subtitle was 4 (3.6%).

For The Attitudes, the answer of participants was analyzed in order to answer the research question "what the Attitudes of people toward the streaming application Netflix for improving English listening skill and English vocabulary learning?". The instrument was questionnaire. The data were analyzed with the use of statistical computer program (SPSS). Then, the data was analyzed of the mean ($\bar{X}$) and Standard Deviation (S.D.). The mean was interpreted from the mean score table of Moidunny (2009). The Mean ($\bar{X}$) show Attitudes of people is high.

Table 4. The information of Attitudes toward Netflix in improving listening skill

| Attitudes toward Netflix in improving listening skill | $\bar{X}$ | S.D. | Meaning |
|---|---|---|---|
| 1. I think watching English series or movies on Netflix can improve my English listening skill. | 4.42 | 0.662 | Very high |
| 2. I think watching English series or movies on Netflix has impact on listening English in my daily life. | 4.34 | 0.708 | Very high |
| 3. I think watching English series or movies on Netflix allows me to understand many different accents of English. | 4.26 | 0.723 | Very high |
| 4. I think watching English series or movies on Netflix has beneficial results in my learning English. | 4.07 | 0.764 | Very high |
| 5. I think watching English series or movies on Netflix is a good English learning source especially for the listening skill. | 4.24 | 0.773 | high |
| **Total** | **4.26** | **0.726** | **Very high** |

From the table 4, Mean ($\bar{X}$) and standard deviation (S.D.) were divided into 5 items which was Attitudes toward Netflix in improving listening skill. Item 1. had the mean ($\bar{X}$) = 4.42 (S.D. = 0.662) which was very high level. Item 2. had the mean ($\bar{X}$) = 4.34 (S.D. = 0.708) which was very high level. Item 3. had the mean ($\bar{X}$) = 4.26 (S.D. = 0.723) which is very high level. Item 4. had the mean ($\bar{X}$) = 4.07 (S.D. = 0.764) which was high level. Item 5. had the mean ($\bar{X}$) = 4.24 (S.D. = 0.773) which is very high level

Table 5. Information of Attitudes toward Netflix in English vocabulary learning

| **Attitudes toward Netflix in English vocabulary learning** | $\bar{X}$ | **S.D.** | **Meaning** |
|---|---|---|---|
| 1. I think watching English series or movies on Netflix enables me to learn new vocabulary in various contexts. | 4.45 | 0.577 | Very high |
| 2. I think watching English series or movies on Netflix enables me to acquire new vocabulary unintentionally. | 4.34 | 0.668 | Very high |
| 3. I think learning vocabulary on Netflix enables me to develop the other 3 skills of English; writing, reading, and speaking. | 4.20 | 0.844 | high |
| 4. I think English series or movies on Netflix is a good source for learning new vocabulary. | 4.34 | 0.668 | Very high |
| **Total** | **4.33** | **0.689** | |

From the table 5, Mean ($\bar{X}$) and standard deviation (S.D.) were divided into 4. items which was the Attitudes toward Netflix in improving your learning English vocabulary. Item 1. had the mean ($\bar{X}$) = 4.45 (S.D. = 0.577) which is very high level. Item 2. had the mean ($\bar{X}$) = 4.34 (S.D. = 0.668) which was very high level. Item 3. had the mean ($\bar{X}$) = 4.20 (S.D. = 0.844) which was high level and item 4. had the mean ($\bar{X}$) = 4.34 (S.D. = 0.668) which was very high level.

For the satisfaction, the answer of participants was analyzed in order to answer research question that is what the level of satisfaction of people toward Netflix, a streaming application, in improving English listening skill and English vocabulary learning.

Table 6. Information of Satisfaction toward Netflix in improving listening skill.

| **Satisfaction toward Netflix in improving listening skill** | $\bar{X}$ | **S.D.** | **Meaning** |
|---|---|---|---|
| 1. I am satisfied with English series or movies on Netflix because it can improve my English listening skill. | 4.41 | 0.618 | Very high |
| 2. I am satisfied with English series or movies on Netflix because it enables me to understand the variety of English accents. | 4.31 | 0.71 | Very high |
| 3. I am satisfied with English series or movies on Netflix because it is a useful method for improving my English listening skill in my daily life | 4.39 | 0.637 | Very high |
| 4. I am satisfied with English series or movies on Netflix because it makes me enjoy learn to improve my listening skill. | 4.42 | 0.662 | Very high |
| **Total** | **4.38** | **0.656** | |

From the table 6, Mean ($\bar{X}$) and standard deviation (S.D.) were divided into 4 items which was the satisfaction toward Netflix in improving your listening skill. Item 1. had the mean ($\bar{X}$) = 4.41 (S.D. = 0.618) which was very high level. Item 2. had the mean ($\bar{X}$) = 4.31 (S.D. = 0.71) which was very high level. Item 3 had the mean ($\bar{X}$) = 4.39 (S.D. = 0.637) which was very high level and item 4 had the mean ($\bar{X}$) = 4.42 (S.D. = 0.662) which was very high level.

Table 7. Information of Satisfaction toward Netflix in improving learning English vocabulary

| **Satisfaction toward Netflix in English vocabulary learning** | $\bar{X}$ | **S.D.** | **Meaning** |
|---|---|---|---|
| 1. I am satisfied with English series or movies on Netflix because it is an effective method for learning new vocabulary. | 4.43 | 0.643 | Very high |
| 2. I am satisfied with English series or movies on Netflix because it can help me to improve my English vocabulary. | 4.31 | 0.639 | Very high |
| 3. I am satisfied with English series or movies on Netflix because it enables me to guess the new vocabulary from the context. | 4.32 | 0.599 | Very high |
| 4. I am satisfied with English series or movies on Netflix because it is a good source for learning new vocabulary. | 4.49 | 0.555 | Very high |
| **Total** | **4.39** | **0.609** | |

From the table 7, Mean ($\bar{X}$) and standard deviation (S.D.) were divided into 4 items which was the satisfaction toward Netflix in improving learning English vocabulary. Item 1. had the mean ($\bar{X}$) = 4.43 (S.D. = 0.643) which was very high level. Item 2. had the mean ($\bar{X}$) = 4.31 (S.D. = 0.639) which was very high level. Item 3. had the mean ($\bar{X}$) = 4.32 (S.D. = 0.599) which was very high level and item 4 had the mean ($\bar{X}$) = 4.49 (S.D. = 0.555) which was very high level.

Table 8. Total average Attitudes toward Netflix in improving listening skills and learning English vocabulary.

| | $\bar{X}$ | S.D. | Meaning |
|---|---|---|---|
| Attitudes toward Netflix in improving your listening skills | 4.26 | 0.726 | Very high |
| Attitudes toward Netflix in your English vocabulary learning | 4.33 | 0.689 | Very high |
| Total Average Attitudes toward Netflix in improving your listening skills and learning English vocabulary | 4.29 | 0.707 | Very high |
| Satisfaction toward Netflix in improving your listening skills | 4.38 | 0.656 | Very high |
| Satisfaction toward Netflix in your English vocabulary learning | 4.39 | 0.609 | Very high |
| Total Average Satisfaction toward Netflix in improving your listening skills and learning English vocabulary | 4.38 | 0.632 | Very high |

The table 8. showed Attitudes toward Netflix in improving your listening skill had the mean $\bar{X}$ = 4.26 (S.D. = 0.726) that mean was very high. The respondents' Attitudes toward Netflix in your English vocabulary learning had the mean $\bar{X}$ = 4.33 (S.D. = 0.689). Total Average Attitudes toward Netflix in improving listening skills and English vocabulary learning had the mean $\bar{X}$ = 4.29 (S.D. = 0.707) that mean was very high. The satisfaction toward Netflix in improving listening skills had the mean $\bar{X}$ = 4.38 (S.D. = 0.656) that mean was very high. The respondents' satisfaction toward Netflix in English vocabulary learning had the mean ($\bar{X}$)= 4.39 (S.D. = 0.609) that mean was very high. Total average satisfaction toward Netflix in improving listening skills and English vocabulary learning had the mean ($\bar{X}$ ) = 4.38 (S.D. = 0.632) that mean was very high.

## Discussion

As stated of two objectives of the research, this study investigated the Attitudes of the people toward the streaming application Netflix in improving English listening skill and English vocabulary learning, and studied the satisfaction of the people toward the streaming application Netflix in improving English listening skill and English vocabulary learning. Based upon these purposes the findings of the study were discussed as follows.

**1. Attitudes**

The result showed that the Attitudes of EIC's students toward Netflix in improving listening skill is very high. There were more than 50 % EIC's students think watching English series or movies on Netflix can improve English listening skill and 48.6 % EIC's students think that watching English series or movies on Netflix enables to learn new vocabulary in various contexts. This finding showed that most EIC's students English listening skill and learning vocabulary Attitudes were very high. The result showed that the participants have the good attitude in improving listening skill and learning vocabulary by watching the English and Thai subtitle movies or series on "Netflix". The result was in accord with Chidchon Yanarom (2013) study about Developing English Listening-Speaking Skills of the M.5/1 Students through English Movies. This research found that the teachers used foreign movie in teaching and learning process, the results of the development of students' listening and speaking skills were higher. This corresponds to the criteria set by teachers because foreign films allow language learners to practice listening and speaking by undertaking motivational activities. Besides, the learner can study English from English film and series, the learner can also studied repeatedly English by self-learning. That means watching movie and series on Netflix can improve English listening skill and develop English vocabulary. Besides, the result was in accordance with Ken Mahachanawong (2019) conducting a research on Using Tablet Application to Promote English Listening-speaking Abilities and Vocabulary Knowledge among Ethnic Prathomsuksa2 Students. The study found that multimedia media is a tool to help promote learners' vocabulary without being bored. Learners are satisfied to use it because the app contains images, animation, and the voice of a native speaker that makes learners conceptualize in memorizing various words efficiently. Learners can practice over and over freely. Thus, watching movie and series on Netflix can improve English listening skill and develop English vocabulary. In other cases, it makes learners interested in learning English without boring.

**2. Satisfaction**

This research has a purpose to survey about the satisfaction of EIC's students toward watching English movie and series in improving English listening skill and developing English vocabulary. There were more than

50 % of EIC's students are satisfied with English series or movies on Netflix because it makes me enjoy learn to improve my listening skill and 51.4 % EIC's students are satisfied with by watching the English and Thai subtitle movies or series on "Netflix" because it is a good source for learning new vocabulary. The finding showed that people are satisfied with using Netflix in improving English listening skill and learning vocabulary. The result was in accord with Wilada srithongkul (2019), study the Developing Listening-Speaking Skills in English for Communication Subject of Students at Dhonburi Rajabhat University Samutprakarn through Echo English Application. The results of the study of student satisfaction from Dhonburi Rajabhat University, Samut Prakan who used Echo English to improve their listening and speaking skills in the English foe Communication subject were overall very satisfied. Besides, the result was in accordance with Booppha Ponglangga (2016) conducted on The Effects of Using Animation Movie to Develop Speaking Ability and Satisfaction towards English Studying of Matthayom Suksa III Students of Phraowitthayakom School. Research findings were very high level because the post-learning English speaking ability of Mathayom Suksa III students of Phrao Witthayakom School who were taught with the use of animation movie was higher than their pre-learning counterpart ability at the .01significance level, and the students' overall satisfaction with English learning by using animation movie was at the highest level. Therefore, learning English listening skill and vocabulary through Netflix were satisfied and has a good effect on learning as well.

## Suggestion

The results of a research study English for International Communication Students'Attitudes and Satisfaction toward the Streaming Application Netflix in improving listening skill and English vocabulary learning at Rajamangala University of Technology Lanna Tak. This research studied on EIC's students and participants watched only English subtitle movies or series on Netflix.

Therefore, it will be useful to those who are interested to improve their English skills and continue research in the future. Considering the conclusion above, the researchers would like to propose some suggestions, which hopefully will be useful for teachers, students, and other.

1. This research did not specify the length of watching time. Thus, this research cannot be study about time to improve listening skill and vocabulary by watching Netflix. So, further studies should specify time to watch Netflix for improving listening skill and developing vocabulary competence.

2. This research did not specify the genre of movies and should also separate about ages that you watched. Some movies are age-restricted, which is why some movies cannot be watched by all ages. It is limitation of watching movies in improving listening skill and learning English vocabulary from Netflix because there are different levels of language for adults and children.

3. This research was studied only the improving listening skill and English vocabulary learning. So, further studies should study other skills to study whether accepting watching movies on Netflix can improve other English skills or not.

4. The questionnaire in future research should be stated that the participants have watching English movies or series from Netflix is for entertainment or improve their English skills to ensure the accuracy of the results and the effectiveness of the results. And it can also be useful information to those who are doing research on other consistent topics.

## Conclusion.

This research examined Attitudes and satisfaction toward Netflix, a streaming application in Improving listening skill and English vocabulary learning among students majoring in English for International Communication. The objectives of this research aimed to investigate the Attitudes of the people toward the streaming application Netflix in improving English listening skill and English vocabulary learning and to study the satisfaction of the people toward Netflix, streaming application in improving English listening skill and developing English vocabulary learning. And answer two questions of researcher that what is the Attitudes of people toward the streaming application Netflix for improving English listening skill and English vocabulary learning? And what is the level of satisfaction of people toward the streaming application Netflix for improving English listening skill and English vocabulary learning? The participants were a total of 92 EIC's students at Rajamangala University of Technology Lanna Tak but not including 4 researchers. The questionnaire was used as a research instrument. The questionnaire has 2 parts including Attitudes and satisfaction.

According to answer the question 1, the results showed that most students' English listening skill and English vocabulary learning Attitudes was very high. And the satisfaction of the students was very high in English listening skill and English vocabulary learning.

The result of people's Attitudes toward Netflix in improving listening skill was very high. And Attitudes toward Netflix in improving your English vocabulary learning was very high. Therefore, the results showed that most students' English listening skill and English vocabulary learning Attitudes' were very high. Because the application Netflix allows learners to watch series over and over again. The learners can practice listening skill and learning vocabulary motivational activities. Besides, the learner can also practice listening skill and learning vocabulary repeatedly by self-learning. Thus, watching movie and series on Netflix can improve English listening skill. The result was in accord with Chidchon Yanarom (2013) studied about Developing English Listening-Speaking Skills of the M.5/1 Students through English Movies.

The result of people's satisfaction toward Netflix in improving listening skill was very high. And satisfaction toward Netflix in improving English vocabulary learning was very high. Therefore, the results showed that most students' English listening skill and English vocabulary learning satisfaction were very high. Because the learners are interested in learning English and satisfy to practice Listening skill and learning vocabulary toward English series from Netflix. Thus, the learners can improve Listening skill and learning vocabulary efficiently. The result was in accord with Wilada Srithongkul (2019), studied the Developing Listening-Speaking Skills in English for Communication Subject of Students at Dhonburi Rajabhat University Samutprakarn through Echo English Application. Therefore, English for International Communication Students' Attitudes and Satisfaction toward the Streaming Application Netflix in Improving English skills is very good. And this research is useful for development or further research in the future.

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# Facebook Usage Behavior for Learning Animation of Animation and Digital Media Undergraduate Students, Bansomdejchaopraya Rajabhat University

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## Abstract

The purposes of research are to: 1) study the Facebook usage behavior of undergraduate students, 2) study the Facebook usage behavior for learning animation and 3) study the relationship between undergraduates students' general information, students' Facebook usage behavior and the usage of Facebook for learning animation. The sample are 118 undergraduate students from Animation and Digital Media Program, Bansomdejchaopraya Rajabhat University selected by random sampling method. The research tool is self-administered online questionnaire divided into 3 parts. The result found that students' behavior of using Facebook can be seen that the most frequent of Facebook 6.00 pm – 12.00 pm, the most time usage per day more than 4 hours, the most access places is at home, the most access device is smartphone, the most people who influence their use is their friends, the main purpose of using Facebook are entertainment and the main activities in Facebook are reading news. The usage of Facebook for learning animation can be seen that for communication most students chatting with friends, searching for an idea/work from famous person and sharing idea/work from famous person.

**Keywords**: Animation, Learning, Social media, Students behavior

## Introduction

From the survey of internet user behavior in Thailand 2017 was found that Gen Z's habits spend time in number 1 is social media (Office of Strategy Electronic Transactions Development Agency, 2017). Nowadays, social media have become apparent for communication between people in the internet world. It focuses on building online communities where people can exchange experiences, share pictures, activities or things that intersest to each other, including for studying as well. For student in the new generation that grows with new innovations according to the IT world uses social media to learning, researching and seeking new knowledge to develop one's potential. Social media is a part of web technology that work on the internet both in personal computer (PC) and smart phone with the purpose of communicate, exchange, share stories, events between peple (Wannaphapha, 2017). It was shown that human communication using social networks has become the center of human communication in the digital age. Resulting in a network of communication links in reality world and the virtual world formed as an exchange activity, share information news based on interests, activities, or mutual interests which making social networks play a role and huge influence in communication.

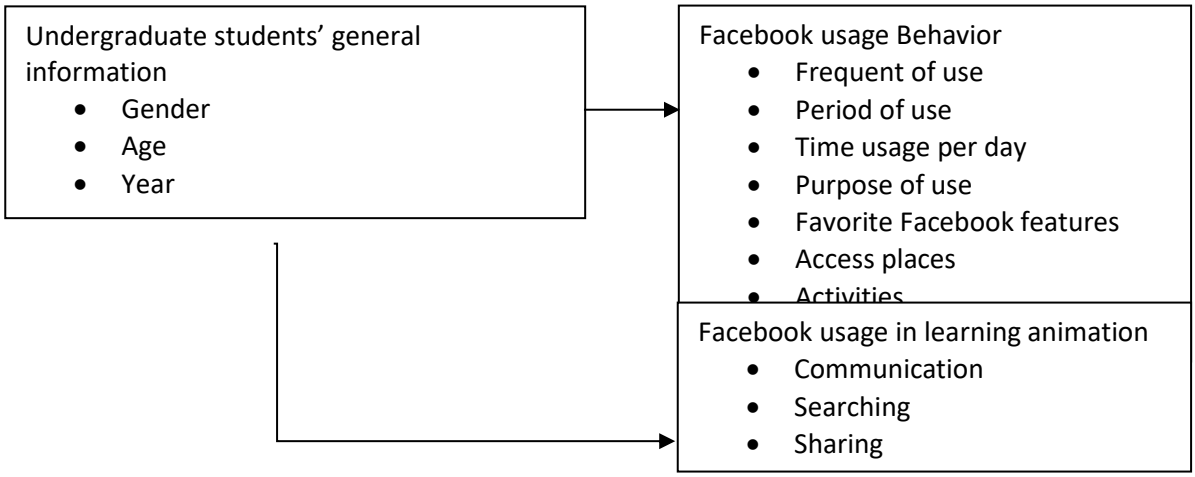
Since its inception in 2004, Facebook has grown to more than one billion global users and reaches one out of seven people worldwide (Smith, Segall & Cowley, 2011). Facebook provide a one-to-many communication environment for people to communicate with friends as well as with increasingly larger circles of acquaintances and relative strangers. Through wall posts, status updates, pictures, liking others' posts and links, users can reconnect and stay in touch with people they have known for years, project an identity to people they hope to meet, and self-disclose to relative strangers. How individuals use Facebook is highly individual, but also based on larger cultural norms (Elmasry, Auter & Peuchaud, 2014). By November 2013, there were more than 1 billion Facebook users worldwide (Smith, 2013) and by far the most popular social networking sites (SNS) worldwide is Facebook, now having more than 1.7 billion active users (Statistica, 2016). One possible reason for Facebook's success is based on the human drive to form social bonds and to communicate (Wilson et al., 2012).

However, leaning in university nowadays use Facebook as a studying tool not only for entertainment in their private life but also keep pace with the change in technology and knowledge in their studying. Moreover, learning in Program of Animation and Digital Media, Bansomdejchaopraya Rajabhat University, uses computers and internet as a primary tool which knowledge that is changing rapidly all the time can be obtained from the internet. So, Facebook is one of the most important channels to study in this field. In order to know the students' behavior of using Facebook and to determine the similarities and differences in how students use Facebook for studying Animation and Digital Media. To address this problem, in this research will survey the students Facebook usage behavior by using questionnaire. This method should yield reliable data that will be useful for learning and teaching in this program to develop the learning plan, to be appropriate and efficient meet the needs of the target group and continue to be in line with the current learning situation.

## Objectives

The objectives of this research are to: 1) study the Facebook usage behavior of undergraduate students, 2) study the Facebook usage behavior for learning animation and 3) study the relationship between undergraduates students' general information, students' Facebook usage behavior and the usage of Facebook for learning animation.

## Conceptual Framework




## Method

This research is a quantitative research by determining variables to collect statistical data. This method can perceive information, feelings, thoughts, and understand the behavior by being in directly contact with information or situations. The population are 170 undergraduate students from Program of Animation and Digital Media at Bansomdejchaopraya Rajabhat University. The sample are 118 undergraduate students selected by random sampling method (drawing lots) calculated the sample size from Krejcie and Morgan (1970). Using self-administered online questionnaire form which is reliable as a research tool. Questionnaire are divided into 3 parts: part 1 is the questionnaire about students' general information, part 2 is the questionnaire about the Facebook usage behavior and part 3 is the questionnaire about the Facebook usage for learning animation. The statistic used to analyze the data in this research are frequency and percentage.

## Result

In this section, research finding divided into 3 parts. The first part is the is a multiple-choice questionnaire with only one answer about the general information of the students. The result as shown in table 1.

Table 1 Students' general information

| **Students' information** | | **Response frequencies** | **Percentage** |
|---|---|---|---|
| Gender | Male | 58 | 49.15 |
| | Female | 60 | 50.84 |
| Age | 18-19 | 25 | 21.18 |
| | 19-20 | 39 | 33.05 |
| | 21-22 | 31 | 26.27 |
| | 23-24 | 21 | 17.79 |
| | More than 24 | 2 | 1.69 |

| | | | |
|---|---|---|---|
| Year | 1 | 25 | 21.18 |
| | 2 | 42 | 35.59 |
| | 3 | 31 | 26.27 |
| | 4 | 20 | 16.94 |
| Income per month | Less than 3000 THB | 75 | 63.39 |
| | 3001-4000 THB | 21 | 17.40 |
| | 4001-5000 THB | 12 | 10.90 |
| | 5001-6000 THB | 5 | 4.30 |
| | More than 6000 THB | 5 | 4.30 |

From table 1, students general information found that students' gender are male is 49.15% and female is 50.84%. Students age at 18-19 years old is 21.18%, 19-20 years old is 33.05%, 21-22 years old is 26.27%, 23-24 years old is 17.79% and more than 24 years old is 1.69%. Students year from first to fourth year are 21.18%, 35.59%, 26.26% and 16.94% respectively. Students income per month are less than 3000 THB is 63.39%, 3001-4000 THB is 17.40%, 4001-5000 THB is 10.90%, 5001-6000 THB is 4.30% and more than 6000 THB is 4.30%.

The second part is the questionnaire about students' Facebook usage behavior which students can choose only one answer. The result as shown in table 2.

Table 2 Students' Facebook usage behavior

| **Usage behavior** | | **Response frequencies** | **Percentage** |
|---|---|---|---|
| Frequent of use | 1 time a day | 0 | 0.00 |
| | 2-3 times a day | 7 | 6.30 |
| | 4-5 times a day | 49 | 41.60 |
| | All the time | 62 | 52.10 |
| Period of use | 6.00 am – 12.00 am | 7 | 5.93 |
| | 12.00 pm – 6.00 pm | 17 | 14.40 |
| | 6 pm – 12.00 pm | 52 | 44.06 |
| | 12.00 pm – 6.00 am | 5 | 4.23 |
| | All the time | 37 | 31.35 |
| Time usage per day | Less than 30 minutes | 12 | 10.16 |
| | 30 minutes – 1 hour | 17 | 14.40 |
| | 1 hour – 2 hours | 17 | 14.40 |
| | 2 hours – 3 hours | 15 | 12.71 |
| | 3 hours – 4 hours | 25 | 21.18 |
| | More than 4 hours | 32 | 27.11 |
| Access places | Home | 66 | 55.93 |

| Usage behavior | | Response frequencies | Percentage |
|---|---|---|---|
| | Dormitory | 27 | 22.88 |
| | Internet café | 0 | 0.00 |
| | University | 2 | 3.38 |
| | On the go | 23 | 19.49 |
| Access device | PC | 33 | 27.96 |
| | Notebook | 25 | 21.18 |
| | Smartphone | 56 | 47.45 |
| | Tablet | 4 | 3.38 |
| People influence | Friends | 71 | 60.16 |
| | Family | 10 | 8.47 |
| | Teacher/Lecturer | 5 | 4.23 |
| | Other | 32 | 27.11 |
| Most common use of internet | Entertainment | 59 | 50.00 |
| | Education/Research | 2 | 1.69 |
| | Social relations | 5 | 4.23 |
| | To show identity | 0 | 0.00 |
| | Communication | 37 | 31.35 |
| | Other | 15 | 12.71 |
| Main activities | Post/comment | 5 | 4.23 |
| | Reading news | 52 | 44.06 |
| | Follow your friend's life | 10 | 8.47 |
| | Like/share | 51 | 43.22 |

From table 2, the students' behavior of using Facebook with the following topics can be seen that the frequent of Facebook use 2-3 times per day is 6.30%, 4-5 times per day is 4.60% and use all the time is 52.10%. Students period of Facebook use 6.00 am – 12.00 am is 5.59%, 12.00 pm – 6.00 pm is 14.40%, 6 pm – 12.00 pm is 44.06%, 12.00 pm – 6.00 am is 4.23% and use in every period is 31.35%. Facebook time usage per day less than 30 minutes is 10.16%, 30 minutes – 1 hour is 14.40%, 1 hour – 2 hours is 14.40%, 2 hour – 3 hour is 12.71%, 3 hours – 4 hours is 21.18% and more than 4 hours is 27.11%. Facebook access places are home 55.93%, dormitory 22.88%, university 3.38% and on the go 19.49%. Access device are smartphone, PC, notebook and tablet with 47.45%, 27.96%, 21.18% and 3.38% respectively. The people who influence their use 60.61% is their friends, 8.47% is their family, 4.24% is their teacher/lecturer and 27.11% is other people such as actor or singer. The main purpose of using Facebook are entertainment is 50.00%, education/research is 1.69%, Social relations is 4.23%, communication is 31.35% and other reason such as playing games is 12.71%. The main activities in Facebook

are post/comment is 4.23%, reading news is 44.06%, follow their friend's life 8.47% and like/share at 43.22%.

For the third part is the questionnaire about students' Facebook behavior for learning animation which is a multiple choice questionnaire and students can choose more than one answer. The result as shown in table 3.

Table 3 Students' Facebook usage behavior for learning animation

| **Usage behavior for learning** | | **Response frequencies** | **Percentage** |
|---|---|---|---|
| Communication | Chatting in animation open group | 44 | 37.28 |
| | Chatting with friends | 61 | 51.69 |
| | Chatting with famous person | 12 | 10.16 |
| | Watching Live/stream | 42 | 35.59 |
| | Other | 20 | 16.94 |
| Searching | Free video tutorial | 77 | 65.25 |
| | Solving problem | 39 | 33.05 |
| | Update recent news | 37 | 31.35 |
| | Idea/work from famous person | 86 | 72.88 |
| | Finding job | 30 | 25.42 |
| | Learning online course | 9 | 7.62 |
| | Other | 12 | 10.16 |
| Sharing | Tutorial | 61 | 51.69 |
| | Idea/work from famous person | 79 | 66.94 |
| | Their work | 34 | 28.81 |
| | File | 20 | 16.94 |
| | Other | 30 | 25.42 |

From table 3, the usage of Facebook for learning animation of undergraduate students with the following topics can be seen that for communication, students chatting with friends is 51.59%, chatting in animation open group is 37.28%, watching live/stream is 35.59%, chatting with famous person is 10.16% and other is 16.94%. For searching information it was found that students search for idea/work from famous person at 72.88%, free video tutorial at 65.25%, solving problem their found at 33.05%, update recent news at 31.35%, finding job at 25.42% and other is 10.16%. Finally for their sharing, it was found that most students share idea/work from famous person is 66.94%, share tutorial is 51.69%, share their own work is 28.81%, share file is 16.94% and other is 25.42%.

The relationship between undergraduates students' general information, students' Facebook usage behavior and the usage of Facebook for learning animation. It is found that, first year students have different time usage per day and for learning animation. They used Facebook for chatting with their friends or watching live that there are interested also their search/share tutorial and inspiration work from famous person. However, the fourth year students use Facebook to chatting in a public group with stranger more than friends, their searching all the knowledge/information from Facebook, shared their own animation work and finding job to prepare for their graduation. For students who spend time in Facebook 3-4 hours or more than 4 hours usually have a public group discussion in Facebook group that all people are interested in the same things such as Thai CG group, 3D modeling group or 2D animation group. Moreover, their also spend time watching live or stream from famous person or famous animation company such as when the company released a new version of the 3D render software which comes with the introduction of new features or when famous digital artist demonstrate how to do digital sculpting. But for students who spend less time in Facebook their usually chatting among friends which their have no opening of new social media connection. For searching information in Facebook most students search for idea or graphics artwork from famous person and free video tutorial but for the third or fourth years students their have more specific filed and more deeper such as the specific problem their found also there is more updated than the younger year students. Most students interest in free video tutorial and online courses for additional knowledge from learning in the classroom but most students have low monthly income problems causing that they cannot buy online courses. For sharing in Facebook, third or fourth years students start to share their own work in their own timeline or group to be publicity of their work to increase job opportunities in the future and for sharing exchange the comment with other people.

**Conclusion and Discussion**

In general, the studied of social media such as Facebook for education can apply in teaching and learning to attract students attention. Facebook can make normally facilitate student's satisfaction in their private life and for learning animation that can be counted as a part of student's everyday life which make the students pay attention and learn well. The finding indicate that students' main purpose of using Facebook are for entertainment and for communication. Students have a habit of using a smartphone for communication and entertainment which their can talk, discussion and chatting through Facebook as instead of communicating over the mobile phone (Sasithanakornkaew, 2015) which is found that students use the devices to connect Facebook are personal computer, notebooks and smartphones to be useful in entertainment and fun, searching for information, news, friends and stories in general

and free time (Tanteepatham, 2011). Most students access Facebook from smartphone which smartphone has restrictions on accessing the website or video tutorial than accessing with PC which may create limitations in learning such as the platform to open video file format. Facebook can meet the lifestyle and needs of the students, up-to-date, easy to access, facilitates and comfortable. A quarter of all students use Facebook more than 4 hours a day or stay online all day which shows that Facebook has played a huge role in their daily life with the most usage period between 6.00 pm to 12.00 pm which is the time after school and their have their own time to relax so, to making the learning content. The place used are home, dormitory and on the go respectively (Saiseesod, 2013). People who most influence the student's Facebook use is their friends, friends are their closest people and their spent a long time together at the university and have similar interests. The results of data analysis on the length of time spent on Facebook in the study this is in line with the results of the study that no student has never used social media and students who use social media through internet cafes will have the highest average academic achievement due to the restrictions on internet use therefore, students need to reap the most benefit from each use (Gulatee et al., 2015).

From the student's Facebook usage behavior for learning Animation, the finding suggest that from first year to fourth year have the different Facebook usage behavior in education differed. In the first year in university social media for learning less than the third year because the first year students are learning fundamental subjects while the senior year study more deeper and focus on learning in the professional field with more researching and self-learning than first year students (Poomjan et al., 2015). For communication topic, found that the features of Facebook which most of the people like the most is to know the which are from chatting with friends, public group discussion and watching live/stream respectively. According to the concept of communication behavior in the globalization era, sender and recipient can communicate at the same time such as chatting with friends. Through the internet, social network is a platform that can exchange ideas on various issues or doing activities together thus enabling communication to be done easily, conveniently and quickly. For searching information topic, most students do research by self-study method which are idea/work from famous digital artist, free tutorial, solving problem and update news. From surveys found that the social networks user are suffering from fear of missing out news if there are not online (Mashable, 2013). Facebook is a public place to share information either from an organization, company or individual.

The finding suggest that as to improve the efficiency of learning, university or teachers should be design the learning method through social networks such as Facebook that are suitable for students. Teaching through Facebook whether it is assignments, consultations or submissions

will help attract students' attention. The students are easily accessible and create a great bond between other people, such as sending work or consult about learning with teachers through social networks or create an account Social network for each study group to be a source of discussion in various topics set by the teacher. (Hemmin and Vichitthamaros, 2014). Also lecturer should concern about the disadvantage of Facebook which are students cannot concentrate on their studies in classroom because the mind is focused on the screen, the use language for chatting with friends will use a language that is not correct in modern slang because it is easy to spell.

## Suggestion

Our suggestion for future research are conduct research with qualitative research in depth to perceive benefits. As well as the students' behavior in the use of social networks might be done by an in-depth interview also additional variables related to technology acceptance should be studied such as anxiety, attitude toward the technology and enjoyment. Moreover, future researchers should carry out the specific reasons why students in different societies use Facebook in different ways, what restrictions they perceive, and how real-world conditions meet social media.

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# The Satisfaction Study of Digital Exhibition of Thonburi Art

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## Abstract

The purpose of this research was to study visitors' satisfaction of digital exhibition in the aspects of content and quality of exhibition design quantitatively. Questionnaire was used to measure satisfaction. The findings revealed that 1) Satisfactions on digital exhibition of Thonburi Art of website sample visitors in the aspects of content and quality were at a high level ($\overline{X}$)= 4.35(. 2) Satisfactions on digital exhibition of Thonburi Art (Prototype) in the aspects of content was at a high level in which the mean of exhibition content was at a high level ($\overline{X}$)= 4.37( and the aspect of satisfaction was at a high level ($\overline{X}$)= 4.57( in the aspects of the pride of Thai art history. 3) Satisfactions on digital exhibition of Thonburi Art (Prototype) in the aspects of quality was at a high level ($\overline{X}$) = 4.33( and the highest means in the aspect of quality was in the aspect of digital exhibition of Thonburi Art compatible with learning in the 21st century = 4.45 ($\overline{X}$)

**Keywords** : Thonburi Art, Digital Exhibition, Satisfaction

## Introduction

"Krung Thonburi" was founded by Somdet Phra Chao Krung Thonburi or King Taksin the Great who was crowned King at Krung Thonburi in 1768. During his fifteen-year reign (1768 – 1782), he constructed the country, administered the politics, economy, religions and arts and culture as well as waging war with both Thais and Burmese to unify Thailand again.

Chunlatat Phayakaranon (2014, 25 June) stated that based on the fact that there was limitation from a great loss, Somdet Phra Chao Krung Thonburi Maha Raj paid a great deal of attention to collect and restore Art piece. It can be said that this is the inheritance of Arts in the late Ayutthaya period which did not lose in time. Thonburi Arts was from Ayutthaya artisans, so the Ayutthaya pattern was brought in too. Therefore, the Arts returned to its glory and became the inheritance for the Rattanakosin period.

Thongchue Khiatthong, Chalong Soonthonnon, and Samutcha Apisitsuksonti (2015, p.78) conducted the research of "Encyclopaedia of Thonburi Arts for Youth, Digital Version" and found that although Krung Thonburi was Thailand capital for only 15 years and in a period of establishment of country, there were some of art creation that were national heritages. Some of the artisans lived during the Ayutthaya period as well, so

to define the style precisely was difficult. It can be concluded that Thonburi arts was the "arts for life and city" that preserved Thainess with some development to be different from the limitation of the country situation at that time, materials, tools and capital. Therefore, the art pieces tended to be simple and direct with Ayutthaya style. These pieces of arts were to create the nation and became the foundation for the Rattanakosin arts. Moreover, it was found that there were Thonburi Arts in every kind of art, they are 1) Painting 2) Sculpture 3) Architecture 4) Literature 5) Music, drama and performance, 6) Fine arts and Applied Art and 7) other arts from different period involved with Thonburi. These priceless Thonburi arts is lack of the collection and exhibits to be known broadly. Thai people who lose the opportunity of learning these arts are all over the country as the said Arts are scattered and fixed in place in various temples. In case of the antiques and historical sites as well as the body of knowledge of Arts in Thonburi period usually appeared in annals or history records which is a media difficult to access for young generation to learn. There are some that have been exhibited in The Phra Racha Wang Derm Restoration Foundation which is the organization responsible for the restoration of Phra Racha Wang Derm or Thon Buri Palace and open as the museum for public which are not attracted the interest of the new generation. Therefore, the researchers saw that the advancement and novelty of modern technology media should be used for exhibition.

Things that can reach to the new generation well is digital exhibition. This digital exhibition is the collection of arts in forms of photos, videos, graphics with narration and music, then creates into digital media and present on the internet. At present, Thai Government is aware the necessary of using digital technology as an important tool. Therefore, the digital exhibition will response to this policy. To hold the exhibition to be in line with the objectives, satisfactions needed to be studied. Supphachai Tansiri (2017, p. 32) stated that good communication, no matter what form, depend on the analysis of (the audience) target group carefully. The audiences are regarded as important customers. So, it is vital to study the need of audience, who they are, how many of them, what they need from questionnaire, observation, audiences' reaction, and then use the collect data to improve the more satisfying exhibition.

Therefore, the researchers are interested to study the satisfaction of Thonburi Art digital exhibition. The sample population are people who learn from online media in short period of time with accuracy. This will lead to build knowledge and understanding of Thonburi Art as well indirectly result in taking pride in history through the country's art. It can also foster the concept of profound gratitude of the monarchy institute that not only contribute to the welfare of the country and also preserve the arts and culture to inherit until now

## Research Objective

The research aims to study satisfaction of visitors' Thonburi Arts digital exhibition. This is a quantitative research of sample population who visited digital exhibition

## Research Methodology

The study of satisfaction of Thonburi Arts digital exhibition under the project of "Thonburi Art Digital Exhibition" was a quantitative research with the methodology as follows:

**1. Research Population**

The sampling of the study of satisfaction of Thonburi Arts digital exhibition (prototype) is visitors of Thonburi Arts digital exhibition during August 2018 as well as the target group is visitors of the exhibition during March – April 2019 whose age is 17 – 36 years (Gen Y) and other groups.

**2. Research Tool**

Tool for satisfaction study of Thonburi Arts digital exhibition is a satisfaction survey. The survey was checked by experts and the researchers corrected to find Content Validity that is to say the experts considered, and test validity as follows:

2.1 Tool Building for satisfaction survey

2.1.1 Steps in building tool for satisfaction survey of Thonburi Arts digital exhibition are:

1) Study the details of the contents which are divided into 2 parts. They are the satisfaction of Thonburi Arts digital exhibition on the quality of content and the quality of exhibition design
2) Set the satisfaction survey score as 5-point rating scale

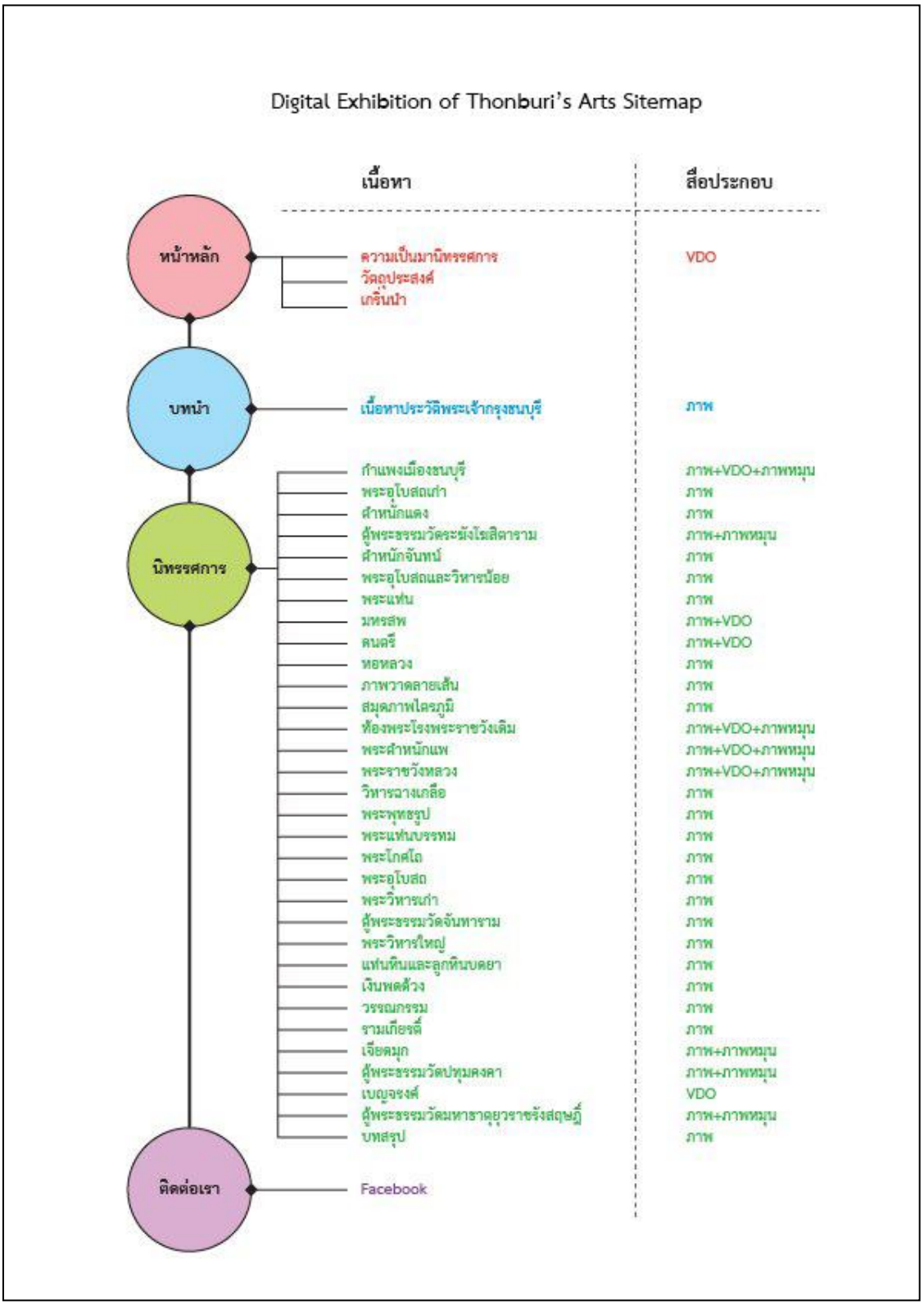
2.1.2 Steps in measuring quality for satisfaction survey are:

1) Present the satisfaction survey to 5 experts to check the content validity and the appropriateness of the satisfaction survey with 5-point rating scale and improve the survey according to the experts' suggestion.
2) Take the approved satisfaction survey to find IOC (Index of Item Objective Congruence) of content validity. The IOC of the survey were between 0.80 -1.00 with the average mean equals 0.92 which proved the appropriateness. The researchers then choose 22 question items with means over 0.50 to be used. Therefore, the means ($\overline{X}$) are around 4.50-5.00with the average mean equals 4.40which proved the high appropriateness. S.D. was0 .55.
3) Try out the satisfaction survey with 15 people who are not the sample to check the accurate of language used.
4) Find out the quality of the satisfaction survey by selecting 22 question items with power of discrimination between 0.2$\leq$. 08.
5) Check the overall quality of the survey by calculating reliability from Cronbach's $\alpha$ - Coefficient which equals 0.78 showing the appropriateness.

2.2Steps for designing Digital Exhibition of Thonburi Art

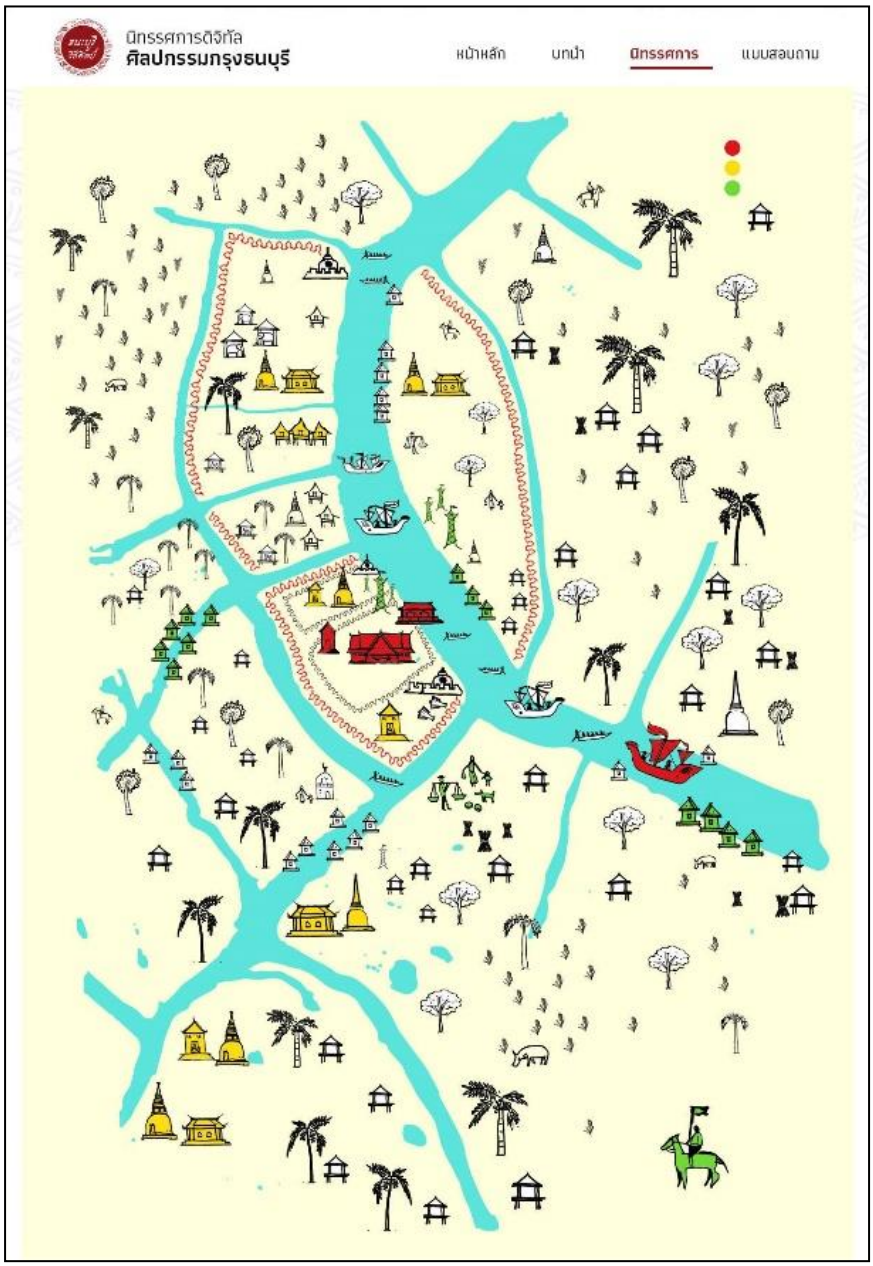
The study of satisfaction is under the project of "Thonburi Art Digital Exhibition". There are exhibition designing steps as follows:

1) Study the concepts and ideas in digital exhibition design
2) Study the Thonburi Art Digital Exhibition design pattern
3) Design Thonburi Arts digital exhibition (prototype)
4) Upload Thonburi Arts digital exhibition (prototype) to the internet through http://thonburiart.dru.ac.th




Picture 1 website map of Thonburi Arts digital exhibition (prototype)


Picture 2 Web pages of Thonburi Arts digital exhibition (prototype)




Picture 3 thonburi map in thonburi arts digital exhibition (prototype)

**3. Data collection**

Data collection for studying satisfaction

The researchers upload the approved and improved satisfaction survey into the internet through http://thonburiart.dru.ac.th/index.html, then tested with the visitor group of Thonburi Arts digital exhibition whose age was between 17-36 years mainly and others during March – April 2019. The results were then analyzed.

**4. Data Analysis**

Statistics used to analyze data s for the satisfaction of Thonburi Arts digital exhibition were Percentage, Mean and Standard deviation or S.D.

## Research Findings

To evaluate and analyze the findings, the researchers used survey with rating scale to collect data on the design of Thonburi Arts digital exhibition. The survey was tested and evaluated the satisfaction from the sampling population which was the target group. Then, the data collected was analyzed. The visitors' satisfaction of Thonburi Arts digital exhibition (Prototype) can be concluded as follows:

1. Data analysis of general information of the survey

From the satisfaction survey of Thonburi Arts digital exhibition for exhibition's visitors between March – April 2019, there were 84 informants. The results were as follows.

1.1 The age period of digital exhibition visitors was in line with the main target group and the sub target group, range from high to low, the Gen Y (18 – 37 years) amounts to 63.60%, Gen X( 35-53 years) amounts to 28.80%, and Baby Boom (54-72 years) amounts to 7.60 %

1.2 The result of satisfaction of the content of digital exhibition (prototype)

Table 1 shows the means of satisfaction of the content of digital exhibition (prototype)

| Item | Content | Mean | S.D. | Satisfaction Level |
|---|---|---|---|---|
| 1 | The Concept "Thonburi Vithisilp" of the exhibition is interesting | 4.37 | 0.65 | High |
| 2 | Exhibition contents are appealing and suitable | 4.23 | 0.76 | High |
| 3 | The contents present the importance of Thonburi Arts | 4.38 | 0.80 | High |
| 4 | The quantity of information presented is appropriate. | 4.20 | 0.87 | High |
| 5 | The contents are thoroughly and accurate showing Thonburi Arts and ways of life. | 4.35 | 0.65 | High |
| 6 | The contents are interrelated through each section continuously. | 4.31 | 0.67 | High |
| 7 | The contents of Thonburi Arts digital exhibition are understandable | 4.36 | 0.72 | High |
| 8 | The contents make Thonburi Arts style to be clearer | 4.43 | 0.71 | High |
| 9 | The contents make the visitors proud of Thai Arts history. | 4.57 | 0.66 | Very high |
| 10 | The contents make the visitors aware and appreciate the value of Thonburi Arts | 4.48 | 0.59 | High |
| Total and Percentage | | 4.37 | 0.71 | High |

From the table, it can be seen that the sample were satisfied with Thonburi Arts digital exhibition (prototype) in the contents at a high level in which the average mean of the exhibition content was at a high level ( $\overline{X}$ = 4.37, S.D. = 0.71) and the satisfaction was at a high level ( $\overline{X}$ = 4.57, S.D. = 0.66) in the item of 'The contents make the visitors proud of Thai Arts history'.

1.3 The result of satisfaction of the quality of digital exhibition (prototype)

Table 2 shows the means of satisfaction of the quality of digital exhibition

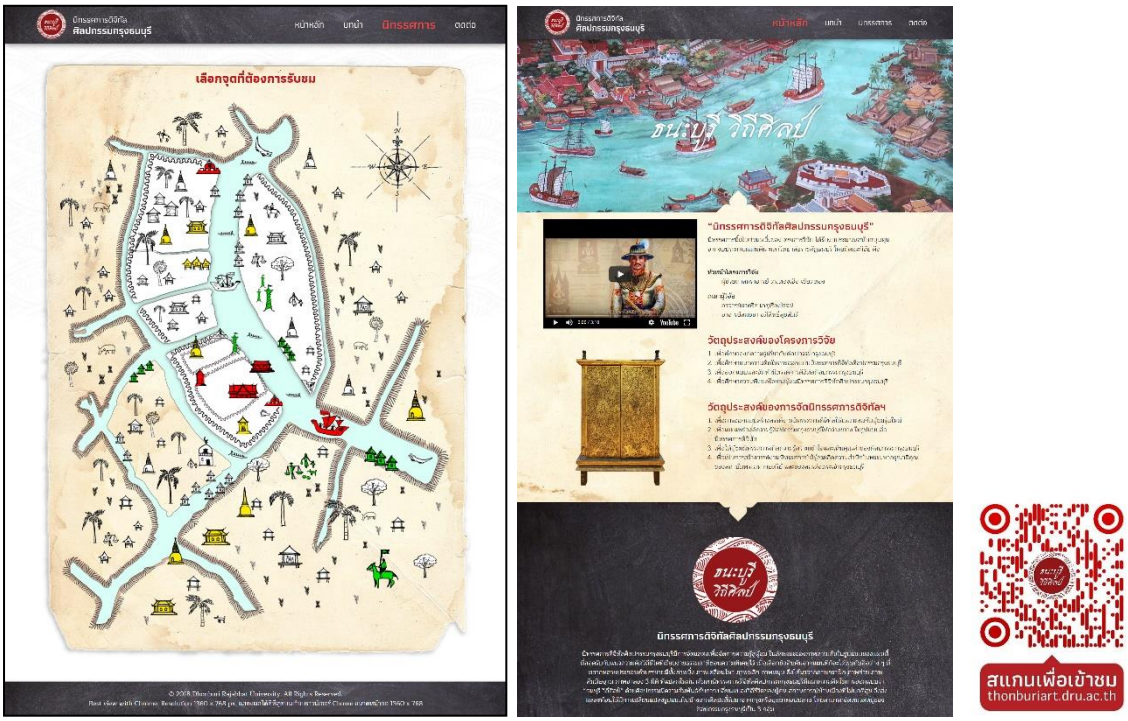
| Item | Content | Mean | S.D. | Satisfaction Level |
|---|---|---|---|---|
| 1 | Digital exhibition can be accessed easily and accurately. | 4.38 | 0.71 | High |
| 2 | The design of digital exhibition is beautiful and interesting. | 4.29 | 0.75 | High |
| 3 | The exhibition is attractive and easy to use | 4.38 | 0.69 | High |
| 4 | The colors used in the design of exhibition is appealing and suitable. | 4.43 | 0.60 | High |
| 5 | The navigation is easy to use and convenient. | 4.21 | 0.80 | High |
| 6 | The letter size and design are clear, readable and appropriate. | 4.24 | 0.72 | High |
| 7 | The illustrations are helpful for the understanding. | 4.32 | 0.71 | High |
| 8 | The Videos help make better understanding of the contents | 4.27 | 0.81 | High |
| 9 | Narration and media are appropriate with the contentsคำ | 4.26 | 0.79 | High |
| 10 | 3 D pictures help to make the contents understandable and appealing | 4.43 | 0.76 | High |
| 11 | Thonburi Arts digital exhibition is in accordance with the learning of the 21st century | 4.45 | 0.64 | High |
| 12 | The design of the exhibition to search through map is interesting, modern and attractive to use. | 4.33 | 0.71 | High |
| Total and Percentage | | 4.33 | 0.72 | High |

The table revealed that the samples satisfied with the quality of Thonburi Arts digital exhibition (prototype) at a high level in which the average means of the quality of exhibition was 4.33 ( $\overline{X}$ = 4.33, S.D. = 0.72). the highest score in quality was in the item 'Thonburi Arts digital exhibition is in accordance with the learning of the 21st century' which the mean equals 4.45 ( $\overline{X}$ = 4.45, S.D. = 0.64)

Table 3 shows visitors' satisfaction of Thonburi Arts digital exhibition (prototype)

| Satisfaction after viewing digital exhibition | ( $\overline{X}$ ) | S.D. |
|---|---|---|
| 1. Content of digital exhibition | 0.37 | 0.71 |
| 2. Satisfaction of quality of digital exhibition | 4.33 | 0.72 |
| Overall satisfaction of viewing of digital exhibition | 4.35 | 0.75 |

The sample of visitors of Thonburi Arts digital exhibition (prototype) showed the high level of satisfaction on Thonburi Arts digital exhibition with mean( $\overline{X}$ ) of 4.35 Then, the researchers took the analysis of visitors' satisfaction and designed and developed into Thonburi Arts digital exhibition (Developed) on Dhonburi Rajbhat University under the name http://thonburiart.dru.ac.th (the same URL bur replaced the prototype) as can be seen in picture 4




Picture 4 Thonburi Arts digital exhibition (Developed)

## Research Discussion

The study results of satisfaction of Thonburi Arts digital exhibition (prototype) showed that the subjects of Thonburi Arts digital exhibition (prototype) had satisfaction level in content aspect at a high level, $\overline{X}$ 4.37 in which the highest satisfaction was in the item of 'The contents make the visitors proud of Thai Arts history'. Because the viewing of exhibition was self-search, the visitors' thought then are constructed. This is in accordance with Jerome S. Bruner's Cognitive Learning Theory that human will receive the thing they're interested in and learning is the process of self-discovery or Discovery Learning. Bruner's Cognitive Learning Theory has 3 main steps. The first step is Enactive Representation. The second step is Iconic Representation. And the third step is Symbolic Representation. These learning help create discovery as learners are curious and have the drive to explore and learn things by the discovery.

The subjects of Thonburi Arts digital exhibition (prototype) had satisfaction level in quality aspect at a high level, $\overline{X}$ 4.33 in which the highest satisfaction was in the item of 'Thonburi Arts digital exhibition is in accordance with the learning of the 21st century' This is in accordance with Dittaya Piyapan (2014) who studied on "Digital Values and Online Communication Behavior of Thai Children and Youth". The findings of this study showed that the first free time activity that Thai children and youth chose was using the internet and the frequency of online media usage is daily and the length of usage is more than 3 hours per day. These findings revealed that Thai children and youth have a high level in online communication behavior. Moreover, Thai children and youth had digital value in freedom, honesty, transparency, cooperation, entertainment and innovation at high levels. Also this conforms with Office of Knowledge Management and Development – OKMD

(2019) which stated that the skills needed for living and working in the 21st century are learning and innovation skills, life skills and information and technology literacy skills.

This is in line with Dumitrescu, Lepadatu&Ciurea (2014, pp. 102-110) that studied in "Creating Virtual Exhibitions for Educational and Cultural Development" that virtual exhibition advantages are; information updating, new element adding or easy content changing. Applied with education through digital presentation, the advantages are the building or reproducing physical characteristics of fragile and valuable objects or antiques. It helps reducing the chance of damage of relics. Virtual exhibition is the expansion of viewing capacity through the participation of various multimedia contents such as texts, pictures, sounds, and videos in which can be revisit later. This helps improving in-depth understanding and leading to better learning of the contents than the normal exhibition.

The subjects of Thonburi Arts digital exhibition (prototype) had satisfaction level on Thonburi Arts digital exhibition (prototype) at a high level, $\overline{X}$ 4.35 . This is in accordance with Supphachai Tansiri (2017, p. 4) who stated that exhibition is a kind of visual arts presenting useful information or story or educating audiences by multimedia usage which exhibitors deem suitable by considering art components, graphic presentation, 3d materials and activities audiences find satisfaction. This idea was supported by N. Chivarov, V. Ivanova, D. Radev and I. Buzov) 2013, pp. 122-126( who studied "Interactive Presentation of the Exhibits in the Museums Using Mobile Digital Technologies" . The study showed that these technologies are easy to use and access. This help increase interest in cultural heritage. Moreover, digital technology help improve and update museum exhibition. The new method will attract visitors who are young and the main target and make them a part of interesting multimedia and participate. This creates not only the interests in history and culture heritage but also awareness and opportunity to expand the additional information of items presenting the museum through digital and graphic gallery. This improves visitors' experience, help create a lively exhibition, enable communication with visitors, and increase self learning in every level. Also, the museum exhibition will be easily usable and accessible to all foreign tourists to gain opportunity to receive information in their language no matter what they are fashion, art, sciences or history.

Although, the exhibition presented a wide variety of contents, the direction and trends of the exhibition were consistent and harmonious. the informants who were mainly people aged between 18-37 years amounts to 63.60% are the Gen Y. these people satisfied the digital exhibition at a high level.

This is in line with Chewasit Boonyakiet (2016, p.113) who said that searching is vital, "in other word, the significant conclusion of the research showed that the critical point of reading with information quantity or the complex of content. Egle pointed out to utilize this crisis by creating activity stimulating student to read label by "Search and Find Activity". So, this activity will make museum visit is more than just a field trip but create exercise that help develop children's literacy". This is in accordance Loris Barbieri, Fabio Bruno, Maurizio Muzzupappa who studied "Virtual museum system evaluation through user studies" to evaluate and compare the option for interface design. The population was divided into 2 groups to test Virtual museum system to find out the fondness of 2 types of Virtual museum. The findings showed that users preferred system B which the design allowed users participation effectively. Visitors revealed their interests and eagerness for virtual exhibitions as mostly come from their curiousness. The system that allowed users to participate in the control of operation system by using UI and controller tools are now the main development of Virtual museum. To

increase efficiency, it needs to emphasize on the easiness and cheerfulness with the potential in entertainment and education.

The workshop participants of digital exhibition of Thonburi Arts were satisfied the overall of the digital exhibition of Thonburi Arts at a high level $\overline{X}$ 4.32. This conform with the study of "Interactive Media on the Floor of the Excavated of Dinosaur : A case study of Sirindhorn Museum, Kalasin Province" by Sudarat Sonbua, Suebsiri Saelee, and Chatklaw Jareonpon (p. 197, 2017). The study revealed that the presentation of contents in which use motion pictures, interactive, the name of the content was at the top of the screen while the information at the bottom and the illustration in the middle of the screen with the forest as the background accompanied by the sound of nature, dinosaur and music, was assessed by experts and The efficient of the interactive floor from the expert is excellent ( =4.45 ). The average satisfaction of the 150 audiences, 5-55 years old, is excellent ( =4.47). It was found that the results of the evaluation by content experts that are appropriate high level also evaluation by technique experts that are appropriate high level..

Chatklaw Jareonpon (2017, p. 197). Found that the presentation of contents in which use motion pictures, interactive, the name of the content was at the top of the screen while the information at the bottom and the illustration in the middle of the screen with the forest as the background accompanied by the sound of nature, dinosaur and music, was assessed by experts and , the efficient of the interactive floor from the expert is excellent ( =4.45 ). The average satisfaction of the 150 audiences, 5-55 years old, is excellent ( =4.47 This is also in accordance with Rattanaporn Chiengkham, Prachyanun Nilsook and Panita Wannapiroon research on "The 3D virtual exhibition about the social and cultural development in Thailand Maha Chakri Sirindhorn anthropology centre" (2014,p85-93). It was found that 1) 3D virtual exhibition consisted of 4 topics, namely, pre-historical era, Thai ethnic groups, language and letter, and archeology in history. 2) the quality evaluation by experts in the aspect of content was at a high level and in the aspects of techniques was at a high level too. 3) The student learning on 3D virtual exhibition having higher scores than student learning with permanent exhibition statistically significant at the .05 level. 4) The students are very satisfied with learning of 3D virtual exhibition

## Recommendations

1. Recommendations for further study

1.1 There should be research on the comparison of satisfaction between digital exhibition and normal exhibition

1.2 There should be study on Thonburi learning center according to youth's opinion

2. Recommendation for utilizing the research findings

2.1 Dhonburi Rajabhat University should publicize the Thonburi Arts digital exhibition website widely so that the university will Thonburi knowledge and information center

2.2 Dhonburi Rajabhat University should develop Thonburi arts as a subject and use the digital exhibition as main teaching material.

2.3 The Phra Racha Wang Derm Restoration Foundation and King Taksin the Great Foundation should use digital exhibition of Thonburi Arts website to connect and create Thonburi knowledge network.

## Conclusion

The findings of the target visitors satisfaction showed the satisfaction on Thonburi Arts digital exhibition as the followings.

The satisfaction on Thonburi Arts digital exhibition (prototype) revealed the samples satisfied with in the contents at a high level in which the average mean of the exhibition content was at a high level ( $\overline{X}$ = 4.37) and the highest score was in the item of 'The contents make the visitors proud of Thai Arts history'.

The visitor samples of Thonburi Arts digital exhibition (prototype) satisfied with the quality of exhibition at a high level ( $\overline{X}$ = 4.33). in which the highest score in quality was in the item 'Thonburi Arts digital exhibition is in accordance with the learning of the 21st century'

The sample of visitors of Thonburi Arts digital exhibition (prototype) showed the high level of satisfaction on Thonburi Arts digital exhibition with mean ( $\overline{X}$ ) of 4.35

From the satisfaction to the development of exhibition design, the values and benefits of this research result in the study of Thonburi Arts knowledge will be of interests for younger generation and those interests can easily access and learn. Above all else, this will honor the glory of Somdet Phra Chao Krung Thonburi or King Taksin the Great who saved and unified Thailand and make visitors aware of the importance of the monarchy institute that contribute to the welfare of the country.

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# Structural Equation Model Development : Human Resource Management and Commitment of Hotels in East Coast Southern Sub Region

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## Abstract

The objectives of this study are to analyze the resource management of hotel employees in east coast southern sub region. and to examine the associated factors by conducting a quantitative approaches. The samples in quantitative data research consisted questionnaire of 400 hotel employees from 5 out of 5 hotels that are members of the Thai Hotels Association - Southern Chapter. Statistical analyses were conducted using mean values, percentages, One-Way ANOVA, Structural Equation Modeling (SEM), quantitative findings revealed that every dimension of human resource management of hotel employees was rated at a high level (Mean = 3.82). While human resource recruitment was rated at the highest level (Mean = 3.91), human resource development was rated relatively lower than other factors of human resource management (Mean = 3.76). At the provincial level, the top-performing provinces in human resource management are Chumphon Province and Phang Nga Province, where both were rated at the highest level (Mean = 4.07). On the other hand, Nakhon Si Thammarat Province was rated at the lowest level (Mean = 3.40). After a few adjustments, the results from the SEM model were shown to be valid. Data points were fitted empirically, yielding a Chi-square index of (X2) = 887.125, df = 123, RMSEA = 0.07 (ranging 0.068 to 0.076 within the 90% Confident Interval), CFI = 0.95, and RMR = 0.02. The model demonstrated human resource management that factors influencing include: organizational commitment (overall influence = 0.80).

**Keywords:** Structural Equation Model, Human resource management, Commitment, Hotel

## Introduction

Tourism industry is the world's fastest growing and biggest sector with myriad employment. In 2017 Thailand gained 963,058 baht from the business, which was about 8.5 percent of the export value (55.1 percent of all service sectors), or 5.8 of Thai gross domestic product (GDP). The business provides job opportunities for more than two million people or 6-7 percent of all businesses. This includes the spread of incomes and employment to many tourist attractions in rural areas; however, the sector still requires much more labor. In addition to the quantitatively necessity, businesses in tourism sector are active in promoting expertise of their staffs provided that the sector is highly competitive. Thus, those organizations have recognized the significance of employing personal management theories in doing such tasks (Ranee Isichaikun, 2007).

Hotel industry is dominant to the growth of Thai tourism industry. It attracts foreign currency, reduces the current account and balance of payment deficit, increases more job opportunities, and spreads incomes to staffs at practitioner levels (Deloitte-Travel Tourism & Leisure, 2004; Dessler; 2006). Besides, this results in the growth of relevant businesses such as construction, shipping, catering, handicraft and others (Getz & Petersen, 2005). According to National Statistical of Thailand in 2018, there were 9,865 hotels and quest houses with 695,914

rooms available, 93,853,419 guests, 237,344 staffs, who earned about 197,124 per year. The fast growing of hotel industry results in the critical needs of professional staffs, who have enough fundamental knowledge. Meanwhile, experienced personnel have more opportunities to work for any hotels, which offer more benefits in the forms of money or non-money. This results in higher labor turnover (Chaisompaong Chaowprasert, 2003; Vidal, 2007).

Considering the fast growing rates, huge market shares, high employment rates, and competitiveness, businesses in tourism industry are inevitably required to promote expertise for their people to be more qualified. Likewise, the Seventh, Eighth, Ninth, and Tenth National Economic and Social Development Plan propose the substantial status of human resource development, quality of life and environment, manufacturing base and service improvement, promotion of fairness and reduction of economic and social inequality, and the strengthening of morale in crises. These include the arrangement for the participation in ASEAN Community in 2015 in which eight strategies have been included. The fourth strategy centers at the development of human resources by improving ASEAN educational standard, handicraft skills, as well as language skills. The goal is to investigate labor, entrepreneurs, and governmental officers. Consequently, the researcher of this study is interested in examining human resource management and capability of hotel staff in service departments in southern Thailand. This study was aimed to investigate the management of those hotels because Commitment human resource management results in loyalty in one's organization, perception on fairness, organizational citizenship behavior, and quality of tasks, which could finally improve the hotels' performances.

## Objective of the Study

1. To investigate human resource management of hotels in east coast southern sub region.

2. To develop a structural equation model of Commitment human resource management of hotel staff in east coast southern sub region.

## Scope of the Study

The Population of this study was 5 hotels staff in east coast southern sub region, who were members of Thai Hotel Association.

**The Participants**

The sample size of this study was calculated through many processes proposed in previous studies. 5 hotels from 5 were selected and 400 of their staff were the participants of this study. The multi-stage method was employed to calculate the sample size to ensure the attainment of hotel staff in different areas in east coast southern sub region. The numbers of the staff depend on the ratio of the total amount of hotels in each province. Only those who have worked for at least six month were included, provided that they get through the period of probation (Chi & Gursoy, 2009). Simple random sampling was employed by drawing the names of all hotels in the south. After that the researcher contacted the hotels to request for corporation in doing questionnaire. If any hotels were inconvenient to do such task, the other ones were drawn again to substitute them

## Research Methodology

Descriptive statistics through SPSS was applied to provide explanations of background information of the participants and the intended factors. Each step can be explained as follows:

1. The analysis of background information of the participants, frequency, percentage, mean, and standard deviation (S.D.) were employed,

2. The statistical analysis of factors involved with calculation of mean, S.D., skewness, and kurtosis in describing the distribution of each intended factor through probability. The targeted skewness was 2.0, while the kurtosis was 7.0 (Byrne, 2010, Kline, 2010),

The analysis of measurement model dealt with two steps; the analysis through assuring component and structural equation models (Anderson & Gerbing, 1988).
of the Structural Equation Model

| Statistical Values | Criteria (m ≥ 30) |
|---|---|
| X2 | Significant p-value |
| Comparative Fit Index (CFI) | CFI > 0.90 |
| Standard Root Mean Square Residual (SRMR) | SRMR ≤ 0.08 (comparing to CFI, which is higher than .92) |
| Root Mean Square Error of Approximation | RMSEA < 0. 07 ( comparing to CFI, which is equal to 0.90 or higher) |

Hair et al., (2010).

**Research Tools**

This study employed mixed-methods methodology. The major approach was quantitative and the qualitative was compliment to answer the research questions. The research tools included : A set of questionnaire in which three sections were featured;

Section 1: Background information of the respondents such as genders, age, status, work duration, salary, and educational level,

Section 2: The survey of attitudes toward human resource management, in which Ivancevich (2001)'s criteria were modified. They included four aspects; human resource procurement, human resource rewarding, human resource management, and protection and maintenance of human resources. This part featured 15 items,

Section 3: The commitment to the organizations, in which Mowday et al. (1982)'s criteria were adapted. It contained 9 items of three facets; trust and acceptance on the organizations, efforts for the organizations, desire to be a part of the organizations,

In order to ensure the reliability of the questionnaire, Cronbach's Alpha Coefficient was performed. Meanwhile, Revelle, W., Zinbarg, R., 2009's criteria were adopted. It was found that cronbach's alpha coefficient was between 0.70 – 0.95, which showed high reliability of the research tool.

## Results

According to the first section of the questionnaire, 60.6 percent of the participants were women and 39.4 percent were men. 54.3 percent of them aged between 25-35, while 21 percent aged between 36-45. Most of the participants were single (60.5%) with only 36.2 married. The majority of the participants worked for their hotels for 1-3 years (35.6%), the rest of them had 6 month to 1 year working duration (22.2%). In terms of their monthly incomes, 62 percent of the participants gained between 10,001 – 20,000 baht and 19.4 percent obtained less than 10,000 baht. Finally, most of the participants achieved bachelor's degrees (49%), while only 28.4 percent acquired high school certificates/ diplomas.

The mean and S.D. of overall human resource management of each province were evaluated. Results showed that Chumphon obtained the highest mean scores of 4.07. Concerning human resource procurement, Suratthani acquired the highest mean scores at 4.45, followed by Chumphon with 4.13. In terms of human resource rewarding, Chumphon also obtained the highest means, 4.11 and 4.01 respectively. Finally, Nakhon si Thammarat gained the highest mean scores of 4.15 regarding protection and maintenance of human resources.

Moreover, the overall mean scores and S.D. of human resource management in terms of hotel sizes showed that large hotels obtained the highest score of 4.05 followed by medium hotels, which attained 3.82, and 3.56 mean scores of small hotels.

The analysis of measurement model revealed that Chi-Square (X2) was equal to 1003.966, df was 118, and RMSEA was 0.072. Besides, the RMSEA was from 0.075 to 0.084, CFI was equal to 0.952, and RMR was 0.022. This could be simplified that the correlation between the model and the empirical data was high.

Table 2 Discriminant validity of measurement models

| Variable | CR | AVE | $\sqrt{\mathbf{AVE}}$ |
|---|---|---|---|
| Human Resource Management | 0.86 | 0.60 | (0.770) |
| Commitment | 0.80 | 0.65 | (0.806) |
| Organizational Citizenship Behavior | 0.89 | 0.61 | (0.781) |
| Organizational Justice | 0.78 | 0.51 | (0.715) |
| Efficiency | 0.90 | 0.69 | (0.830) |

According to table the square root of average variance extracted of each latent variable in the same row and column (Hair et al, 2010) was its . Human resource management was 0.770, while organizational loyalty exceeded 0.806, and organizational citizenship behavior was 0.781. Besides, the organizational fairness

was 0.715, and the work efficiency was 0.830. The results implied that the measurement model had discriminant validity.

This study was entitled, “Developing Structural Equation Model: Human Resource Management of Hotel Staff in east coast southern sub region.” The unit of analysis was personal level. The participants were hotel staff in 5 provinces in east coast southern sub region., which included Chumphon, Surat Thani, Nakhon Si Thammaratt and Patthalung (Thai Hotel Association, 2012). 5 hotels among 5 of them were selected. Meanwhile, 400 staff, who worked for those hotels for more than 6 months provided responses through a set of questionnaire. It was equal to 80.06 percent of the questionnaire.

In addition to the quantitative research tools, a qualitative data source through an interview was adopted. 30 of the hotel staff were interviewed (2 from each hotel). The data analysis was bi-faceted. First, the quantitative analysis employed SPSS/PC for windows in calculating frequencies, percentage, mean, S.D., skewness, and kurtosis. Likewise, AMOS for windows was applied to analyze the confirmative components and the structural equation model, which affected human resource management. The second section was the qualitative analysis, in which content analysis was applied.

## Discussion

The present study entitled, “Developing Structural Equation Model: Human Resource Management of Hotel Staff in east coast southern sub region,” aimed to 1) investigate human resource management of hotels in east coast southern sub region, and 2) to develop a structural equation model of effective human resource management of hotel staff in east coast southern sub region. The analysis of five variables of a structural equation model was performed. The discussions featured two aspects according to the research objectives. Regarding the first research objective, considering from all the four aspects of human resource management; procurement, rewarding, management, and protection and maintenance, most of the hotel staff perceived human resource management in their organizations as “High” with the mean of 3.82. Next, in terms of human resource management processes, recruitment obtained the highest scores. This means that those hotels in the south of Thailand have qualified methods for recruiting according to Beer et al (1984) human resource management concepts.

**The Second Research Objective**

With regard to the development of the structural equation model for effective human resource management of hotel staff in the east coast southern sub region, the most two prominent factors were recruitment (3.96), and protection and maintenance (3.87). Regarding the commitment to the organization, it was found that trust and organization acceptance and the desire to be a part of the organization had the highest impact on the commitment with the mean of 4.01 and 3.93 respectively. In terms of preferable member behavior the majority of the participants perceived assisting behavior as the dominant indicator with the mean scores of 4.22, while cooperation gained 4.18. Meanwhile, fairness of rewarding and processes were the outstanding indicators for organization fairness with the mean scores of 3.88 and 3.86 respectively. Finally, it was found

that expense and workload were the most noticeable factors for quality of jobs at 3.99 and 3.95. The following section provides more explanations for the findings: Mowday et al. (1982)'s concept was adopted in explaining commitment to the organization and it was discovered that staff had high commitment to their organizations. The mean score of trust and organization acceptance was the most significant indicator for organization commitment (4.02) with the mean score of 3.94 in the desire to be a part of the organizations, while efforts for the organizations gained the lowest at 3.81. Thus, hotel staff would have higher commitment to their organization provided that they have high acceptance and strong trust in the organization, which is congruent to Yang (2010).

## Conclusion

The first research objective was to investigate human resource management of the hotels in east coast southern sub region. With regard to the mean scores of the overall human resource management, almost every hotel obtained high mean scores of 3.16. Human resource procurement gained the highest mean scores of 3.97, and human resource development acquired the lowest at 3.82. Besides, considering the whole situations of human resource management in each province Chumphon exceeded the highest scores of 4.07, and Ranong was with 4.05. The one with the lowest scores was Nakhon Si Thammarat.

The second research question was to investigate the structural equation model for human resource development of hotel staff in the east coast southern sub region. It was discovered that almost all factors fell into "high" scale. The analysis of background information, which facilitated the examination of the model for human resource management of hotel staff in the east coast southern sub region, included the investigation of observed variable distribution and the relations between those variables. The results showed that obviously form mean, S.D., skewness, and kurtosis, all the data was normally distributed and near to zero.

The analysis of the confirmative components and the structural equation model was performed through the examination of confirmative components for the construct validity of a preferable structural equation model. Results showed that a preferable model should include 2 variables. At the beginning, the investigation of the model did not show high correlation between the model and the empirical data. Thus, the model was revised and correlation between some observation variable were acceptable based on theories and previous studies as well as the correlation on SPSS. In this study, the model was revised by studying the relationship between the errors on 7 lines of the graph including the relationship between trust and organization acceptance and responsibility awareness behavior, the errors of the desire to be members of organizations and responsibility awareness behavior, the errors of responsibility awareness behavior and consideration behavior, the errors of responsibility awareness behavior and the quality of work, the errors of association behavior and cooperation behavior, and the errors of responsibility awareness behavior and endurance behavior. Meanwhile, the errors of assistance behavior and endurance behavior were also calculated. After the revision the X2 was equal to 1003.966, the df was 118, and the RMSEA was 0.072. Besides, the RMSEA were from 0.075 to 0.084, CFI was equal to 0.952, and RMR was 0.022. To put it simpler, the correlation between the model and the empirical data was high. The minor variables could be explained as follows:

1. It was found that confidence and acceptance in the organization were the best indicators for commitment to the organizations with the mean scores of 4.02, while the desire to be a part of the organizations was at 3.94.

2. In terms of the prosocial organizational behavior, assistance behavior and cooperation behavior were the most desirable with the mean scores of 4.22 and 4.18 respectively.

3. The results showed that fairness of rewarding was the most effective indicator of fairness in the organizations with the means scores of 3.88, while fairness of processes gained 3.86.

4. Finally, expense with the mean of 3.99 was the best indicator of quality of jobs, followed by workload of which the mean was 3.95.

## Suggestion from the Research

The present study was entitled "Developing Structural Equation Model: Human Resource Management of Hotel Staff in Southern Thailand." The population was hotels in the south of Thailand, which registered for Thai Hotel Association, while there are numbers of unregistered hotels in the areas. In addition, this study centered at investing the overall situations of human resource management of all hotels with no attention on sizes of the hotels. Thus, the study on the unregistered group in terms of their sizes would provide holistic results.

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# Effect of Panang Curry Recipe Modification on Nutritional Values, Sensory Acceptability and Purchasing Decision

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## Abstract

This research aimed to compare the nutritional values, sensory acceptability and purchasing decision between the regular and modified recipes of Panang curry. The modified recipe was adjusted from the regular recipes by replacing coconut milk with cereal coconut milk, reducing shrimp paste and increasing herbs and spices. After the recipe modification, the nutritional values of 200 g of samples of two recipes were analyzed using the nutritional analysis program (INMUCAL-Nutritions version 4.0, Institute of Nutrition, Mahidol University). Total energy of modified recipe (397 kcal) was lower than that of the regular recipe (488 kcal). The total energy percentage of the modified recipe was comprised of carbohydrate (18.0 %), protein (25.0 %) and Lipid (57.0 %). Moreover, the modified recipe was lower in saturated fatty acid, cholesterol and sodium than the regular recipe. The sensory acceptability and purchasing decision were assessed by 20 volunteers using the 9-point hedonic scale and five-point hedonic scale, respectively. The result showed no significant differences between the modified recipe (8.65±0.73) and regular recipe (8.74±0.81) in overall acceptability score ($p>0.05$). moreover, the regular and modified recipes of Panang curry were of high purchasing scores (4.70±1.09 and 4.36±0.89, respectively). This result indicated that the modified recipe could replace the regular recipe as a healthier alternative.

**Keywords**: Panang curry, Modified recipe, Nutritional value, Sensory acceptability, Purchasing decision

## Introduction

Thai cuisine has gained popularilty around the world because of its unique appearance, harmonious blend of flavors, aromas and health benefits. One of most well-known dishes is Panang curry (Singsomboon, 2015). The common herbs of Panang curry paste include chili, shallot, garlic, lemongrass, galangal, coriander root, coriander seeds, kaffir lime rind, fennel and pepper with add shrimp paste, coconut milk and meat (Kanchanakunjara et al., 2015; Sirisomboon & Nawayon, 2016). These herbs and spices not only enhance the flavor, aroma, and color, but they can also boost immunity and protect from acute and chronic diseases such as inflammatory, cancer, cholesterol and high blood pressure (Thakur & Sharma, 2018; Guldiken et al., 2018). Many lines of evidence suggest that these spices and herbs possess antioxidant, anti-inflammatory, antitumorigenic, anticarcinogenic, and glucose- and cholesterol-lowering activities as well as properties that

affect cognition and mood reviewed inJiang, 2019. However, the recipe also contains shrimp paste, which contains a higher amount of  or sodium chloride to prevent deterioration and food poisoning. High dietary sodium consumption is associated with high blood pressure, which is a major risk factor for cardiovascular diseases (Nitipong, Kamonwan, & Teeraporn, 2020). In addition, coconut milk added to the curry contais a high saturated fatty acid content (Amirah, 2020). The major medium chain fatty acid consists of lauric acid, capric acid and caprylic acid, contributing increased blood cholesterol levels, low-density lipoprotein, and  risk for cardiovascular disease (Abdullah et al., 2018; Briggs, Petersen, & Kris-Etherton, 2017).

This study aimed to modify the Panang curry recipe to increase the nutritional values while maintaining the consumer acceptance. This was accomplished by adopting the guideline for adapting recipe is reducing and replacing ingredients including coconut milk with cereal coconut milk (Marcus, 2013). Cereal coconut milk derived from rice bran oil contains several phytochemical compounds such as tocotrienols, tocopherols, phytosterols, polyphenols, squalene, and gamma-oryzanol that were reported to benefit human health (Pongpian & Panpraneecharoen, 2019). The nutritional values, sensory acceptability and purchasing decision between regular and modified recipes were used as main parameters for the comparison

## Materials and methods

### Modification of Panang curry recipe

The Panang curry recipe was adjust and lebelled as “modified”.  The ingredients of the curry were bought at Talaadthai market, Phatumtani province, Thailand. Then the ingredients were cleaned and prepared. The Panang curry ingredients of the regular and modified recipes are shown in Table 1. The main ingredients, chicken thigh and coconut milk were replaced with chicken breasts and cereal coconut milk (made from rice bran oil), respectively. The curry paste were modified by increasing the amount of spices or herbs (0.5 of times), including shallot bulbs, garlic, lemon grass, galangal root, bergamot peel, coriander root, coriander seed, caraway, peanut. Fish sauce, palm sugar, shrimp paste and salt were reduced by 0.5 times.

The ingredients of curry paste were pounded thoroughly using mortar and pestle. Two tablespoons of the prepared curry paste were mixed with chicken. Coconut milk or coconut milk substitute were simmered and curry paste were added. After frying until fragrant, chicken, palm sugar, fish sauce were added and simmered for 7-10 minutes. The serving was decorated with Kaffir lime, Basil and Red chili.

Table 1 Panang curry ingredients of regular and modified recipes (for 5 serving)

| Ingredients | Regular recipe | Modified recipe |
|---|---|---|
| Main ingredients | | |
| Chicken thigh (g) | 500 | - |
| Chicken breast (g) | - | 500 |
| Coconut milk (mL) | 500 | - |
| Cereal coconut milk (mL) | - | 500 |
| Fish sauce (tsp) | 1 | 0.5 |
| Palm sugar (tbsp) | 1 | 0.5 |
| Kaffir lime (leaves) | 5 | 5 |

| Ingredients | Regular recipe | Modified recipe |
|---|---|---|
| Red chili (seed) | 2 | 2 |
| Basil (leaves) | 5 | 5 |
| Curry paste ingredients | | |
| Dried chili (seed) | 10 | 10 |
| Shallot bulbs (tbsp) | 5 | 7.5 |
| Garlic (tbsp) | 4 | 6 |
| Lemon grass (tbsp) | 1 | 1.5 |
| Galangal root (tsp) | 1 | 1.5 |
| Kaffir lime (tsp) | 1 | 1.5 |
| Coriander root (tbsp) | 1 | 1.5 |
| Black pepper (seed) | 10 | 15 |
| Coriander seed (tbsp) | 1 | 1.5 |
| Fennel (tsp) | 1 | 1.5 |
| Peanut (tbsp) | 4 | 6 |
| shrimp paste (tsp) | 1 | 0.5 |
| Salt (tsp) | 1 | 0.5 |

**Nutritional values of Panang curry recipes**

Nutritional values of 200grams (1 serving) of the regular and modified recipes were compared using the nutritional analysis program (INMUCAL-Nutritions version 4.0, Institute of Nutrition, Mahidol University). The data were presented in forms of energy (Kcal), sugar (g), protein (g), sugar (g), dietary fiber (g) vitamin (mg) and mineral (mg) contents.

**Sensory acceptability test and purchasing decision of Panang curry recipes**

The regular and modified Panang curry recipes were compared based on the sensory acceptability test and purchasing decision. The samples were evaluated by 20 volunteers who can eat food containing spices. Volunteers were students of Valaya Alongkorn Rajabhat University under the Royal Patronage who consented to join this study. The samples were labeled with three litter-digit randomized codes before serving to volunteers. The appearance, odor, taste, viscosity (liquid phase) and overall acceptability of samples was assessed using the 9-point hedonic scale (1: extremely dislike to 9: extremely like). Volunteers were also questioned about the purchasing decision of two recipes using the five-point hedonic scale (1: definitely would not buy, 5: definitely would buy).

**Data analysis**

Results from nutrition data, sensory acceptability test and purchasing scores were reported as mean ± standard deviation. Independent t-test was applied to determine the differences of sensory scores and purchasing scores between the regular and modified recipes.

## Results and discussions

**Nutritional values of Panang curry recipes**

Nutritional values of the regular and modified Panang recipes are shown in Table 2. The results indicated that most of the total energy percentage of regular recipe was from fat (71%). After modifying the Panang curry recipe, the total energy percentage of fat was reduced to 57%. Moreover, the modified recipe contained less total saturated fatty acid (3.7 g, 8.4 % of Thai DRI) and cholesterol decreased (50.0 g, 16.7 % of Thai DRI) compared to the regular recipe (23.6 g, 43.5 % of Thai DRI and(58.0 g, 19.3 % of Thai DRI), respectively. The saturated fatty acid and cholesterol are root causes of various health issues such as cardiovascular diseases and obesity-related type 2 diabetes (Gershuni, 2018). The lower level of fatty acid and cholesterol of the modified recipe was mainly due to replacing coconut milk with cereal coconut milk. Rice bran oil cantains several phytochemical compounds such as tocotrienols, tocopherols, phytosterols, polyphenols, squalene, and gamma-oryzanol that are beneficial to human health (Pongpian & Panpraneecharoen, 2019). Furthermore, the modified recipe was higher in protein, carbohydrate calcum and vitamin C, and lower in energy (397 kcal vs. 488 kcal, Table 2). The higher dietary fiber of the modified recipe (11.4 g) was likely due to the increase in spices and herbal contents. In addition, the modified recipe was lower in sodium because of the reduction of salt, shrimp paste and fish sauce and is likely to reduce the risk of hypertension (Nitipong, Kamonwan, & Teeraporn, 2020).

Table 2 Nutritional values of the regular and modified Panang curry recipes (1 serving or 200 g)

| **Nutritional values** | **Panang Curry** | |
|---|---|---|
| | **Regular recipe** | **Modified recipe** |
| Carbohydrate (g) | 13.8 | 18.3 |
| % of total energy | 11.0 | 17.0 |
| Protein (g) | 21.3 | 24.4 |
| % of total energy | 18.0 | 25.0 |
| Fat (g) | 38.7 | 25.3 |
| % of total energy | 71.0 | 57.0 |
| Total Saturated Fatty acid (g) | 23.6 | 3.7 |
| % of Thai DRI | 43.5 | 8.4 |
| Cholesterol (mg) | 58.0 | 50.0 |
| % of Thai DRI | 19.3 | 16.7 |
| Sugars (g) | 4.8 | 3.3 |
| % Thai DRI | 3.9 | 3.3 |
| Dietary fiber (g) | 6.9 | 11.4 |
| % Thai DRI | 27.6 | 45.6 |
| Sodium (mg) | 685.1 | 488.9 |
| Calcium (mg) | 85.1 | 87.5 |
| Iron (µg) | 3.5 | 3.4 |
| Vitamin C (µg) | 27.9 | 36.3 |
| **Total energy (kcal)** | **488** | **397** |

**Sensory acceptability of Panang curry recipes**

The sensory acceptability of the regular and modified recipes is shown in Table 3. The result showed that the appearance and odor of regular recipe displayed a significantly higher score than that of the modified recipe ($p \leq 0.5$). This was likely due to more spices and herbs were added to the modified recipe, resulting in a stronger smell and darker color. The taste of two recipes was not significantly different, indicating that replacing coconut milk with cereal coconut milk and increasing spices in modified recipe did produce any differences in taste. It was also found that the regular recipe was more viscous than the modified recipe possibly due to the higher fat content (Amirah, 2020). However, the modified recipe (8.65±0.73) and regular recipe (8.74±0.81) had no significant differences in overall acceptability score ($p > 0.05$). This result suggested that the modified recipe was preferred as the regular recipe. Therefore, we concluded that the modified recipe was a suitable candidate for a healthy Panang curry.

Table 3 Sensory characteristics of the regular and modified Panang curry recipes

| Characteristics | Regular recipe | Modified recipe |
|---|---|---|
| Appearance | 8.64±0.89* | 8.30±0.92* |
| Odor | 8.14±0.89* | 8.05±0.76* |
| Taste | 8.34±0.89 | 8.30±0.92 |
| Viscosity (Liquid phase) | 8.84±0.61* | 8.65±1.09* |
| Overall acceptability | 8.74±0.81 | 8.65±0.73 |

Asterisks denoted significant difference in preference score between regular and modified Panang curry recipes (*$p \leq 005$)

**Purchasing decision of the Panang curry recipes**

Purchasing decision of the Panang curry recipes is shown in Table 4. The result suggested that the regular recipe (4.70±1.09) received a significantly higher purchasing decision than the modified recipe (4.36±0.89). However, the two recipes of Panang curry were of a high purchasing score. This result indicated that the modified recipe has the potenntial to be developed commercially.

Table 4 Purchasing decision of the regular and modified Panang curry recipes

| Recipe | Purchasing decision |
|---|---|
| Regular | 4.70±1.09* |
| Modified | 4.36±0.89* |

Asterisks denoted significant difference in purchasing score between regular and modified Panang curry recipes; *$p \leq 005$

## Conclusion

This study compared the nutritional values, sensory acceptability and purchasing decision of the regular and modified Panang curry recipes. The nutritional values of the modified recipe contained lower energy

than of that regular recipe. The modified recipe was also lower in fat and energy but higher in protein and carbohydrate. In particular, the saturated fatty acid in the modified recipe was lower. Sodium content was decreased in the modified recipe, while vitamin C and calcium increased. The consumer acceptability of the regular and modified recipes was high in all characteristics, leading to a high score in purchasing decision. Overall, the modified recipe is offered a healthier alternative without significant effect on the consumer acceptability.

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# Anti-Periodontal Pathogen Porphyromonas gingivalis and Antioxidant Activities of Thai Medicinal Plant Extracts

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## Abstract

Eight plant extracts including rhizomes of Acorus calamus (mytle grass), Alpinia officinarum (lesser galangal) and Zingiber officinale (ginger), fruits of Carissa carandas (caranda plum), Garcinia schomburgkiana (garcinia) and Spondias pinnata (hog plum ), fruit peels of Citrus hystrix (kaffir lime ) and flowers of Hibiscus sabdariffa (red sorrel) were determined for their anti-oral pathogen Porphyromonas gingivalis and antioxidant activities. Anti-P. gingivalis activity was tested by disk diffusion assay and minimum inhibitory concentration (MIC) determination. Garcinia and ginger extracts displayed the strongest anti-P. gingivalis activity (0.39 mg/mL MIC), while the extracts of mytle grass, lesser galangal and hog plum exhibited relatively strong anti-P. gingivalis activity (0.78 mg/mL MIC). In addition, the antioxidant activity of these plant extracts was evaluated by ferric reducing antioxidant power (FRAP) assay. The extracts of hog plum and ginger had strong antioxidant activity with the reducing capacity of 3.60 and 3.49 mM Fe (II) /g extract, respectively, whereas other extracts had lower reducing capacity (0.16-1.06 mM Fe (II) /g extract).

**Keywords**: Periodontitis, Garcinia schomburgkiana, Zingiber officinale, Spondias pinnata

## Introduction

Periodontitis is a prevalent biofilm-mediated inflammatory disease. It destroys gingival tissue and can cause tooth loss. This disease is initiated when the microorganisms embed in subgingival dental plaque. One of the widely accepted as a periodontal pathogen is *Porphyromonas gingivalis*, an anaerobic Gram-negative bacterium (Sakanaka *et al.* 2016). There were evidence showing a relationship between destruction of tooth supporting tissue, inflammatory response and *P. gingivalis* (Cekici *et al.* 2014). Normally, antibiotics have been used as therapeutic strategy. However, some antibiotics result in side effects such as liver injury (Björnsson *et al.* 2010), tooth staining (Claydon *et al.* 2006) and antibiotic resistance development of bacteria in subgingival sites (Bidault *et al.* 2007). This represents a threat to public health which affects high health care costs as increased duration of illness, treatment and hospitalisation (Barbieri *et al.* 2016). Thus, these require the need to search for safer drugs.

Medicinal plants as an alternative source of antibacterial agents have recently attracted great interest. A wide variety of plants have been reported to possess useful biological activities (Barbieri *et al.* 2017). Many researches have been focused on antibacterial activity of plants

against oral pathogen such as *P. gingivalis* (Kraivaphan *et al.* 2013; Sundaram *et al.* 2020). Moreover, some medicinal plants are rich in antioxidant compounds including vitamins, minerals and polyphenols (Fierascu *et al.* 2018). These plants include fruits of garcinia (*Garcinia schomburgkiana*), hog plum (*Spondias pinnata*) and caranda plum (*Carissa carandas*), rhizomes of ginger (*Zingiber officinale*) and lesser galangal (*Alpinia officinarum*), flower of red sorrel (*Alpinia officinarum*) and etc. So far, only few plants with both strong anti-*P. gingivalis* and antioxidant activities have been reported. Thus, the aim of this study was to search for new plants with these potential activites.

## Materials and Methods

### Extraction of Plant Materials

Eight species of Thai medicinal plants were used in this study (Table 1). The plant materials were cut, dried and ground to a powder. Fifthteen gram of each was then soaked in 85% ethanol (150 mL) and shaken at 150 rpm, 30 $^{O}$C for 48 hours. After filtering the mixture, the filtrate was evaporated by vacuum rotary evaporator and air dried. The crude ethanolic extracts were diluted with 10% dimethyl sulphoxide (DMSO) solution to obtain a final concentration of 200 mg/mL stock solution.

Table 1. Medicinal plants used in this study

| Scientific name | Common name/Thai name | Family | Plant part |
|---|---|---|---|
| Acorus calamus Linn | Mytle grass/ Wan num | Acoraceae | Rhizomes |
| Alpinia officinarum Hance | Lesser galangal/ Karlek | Zingiberaceae | Rhizomes |
| Carissa carandas Linn | Caranda plum/ Ma-now-ho | Apocynaceae | Fruits |
| Citrus hystrix DC. | Kaffir lime/ Makrud | Rutaceae | Fruit peels |
| Garcinia schomburgkiana Pierre | Garcinia/ Madan | Crusiaceae | Fruits |
| Hibiscus sabdariffa Linn | Red sorrel/ Krajeabdang | Malvaceae | Flowers |
| Spondias pinnata (L.f.) Kurz | Hog plum/ Makoknum | Elaeocarpaceae | Fruits |
| Zingiber officinale Roscoe. | Ginger/ King | Zingiberaceae | Rhizomes |

### Microorganism and Culture Preparation

*Porphyromonas gingivalis* JCM 12257 was cultivated in BHI broth supplemented with 5 mg/L hemin (Sigma-Aldrich, Switzerland) and 1 mg/L menadione (Sigma-Aldrich, Switzerland), and incubated in anaerobic condition at 37$^{O}$C for 48 h. The turbidity was adjusted to match that of 7 McFarland standard ($1.0\times10^{8}$ CFU/mL).

### Antimicrobial Susceptibility Testing

Animicrobial activity of all plant extracts was tested against *P. gingivalis* JCM 12257 by disk diffusion assay and minimum inhibitory concentration determination

### Disk diffusion assay

The disk diffusion test against *P. gingivalis* was performed using the procedure as described by Kraivaphan *et al.* (2013). Briefly, cell suspension (100 µL) of *P. gingivalis* was swabbed onto the surface of BHI agar supplemented with 5 mg/L hemin, 1 mg/L menadione and 5% blood. This agar medium surface was aseptically placed with sterile 6-mm filter paper discs (Grade AA DISC, GE Healthcare, UK). Then, 15 µL of 200 mg/mL plant extract was added onto each paper disc. The plates were incubated at 37 $^{\circ}$C for 10 d under anaerobic condition. Antimicrobial activity was evaluated by measuring diameters of inhibition zones. The 10% DMSO solution was used as a negative control, while ampicillin (1 mg/mL) was used as a positive control. The experiment was done in triplicate.

**Determination of Minimum Inhibitory Concentrations (MICs) and Minimum Bactericidal Concentrations (MBCs)**

The MICs of all plant extracts against *P. gingivalis* were evaluated by agar dilution method (Kraivaphan *et al.* 2013). Each plant extract at the final concentrations of 0.02 – 1.56 mg/mL in BHI agar supplemented with 5 mg/L hemin, 1 mg/L menadione and 5% blood was prepared in a sterile test tube, and examined for the MIC. Then, a loopful of cell suspension was streaked onto the surface of this BHI slant. After incubation at 37$^{\circ}$C for 10 d, the growth of *P. gingivalis* at different concentrations of plant extracts was recorded. The lowest concentration of the plant extract that completely inhibited visible growth of *P. gingivalis* was recorded as the MIC. Then, MBCs determination was performed by continuing from BHI agar tube of the MIC test with no visible growth by culture transferring onto a new BHI agar surface. After incubation, the growth of *P. gingivalis* at different concentrations of plant extracts was recorded. The lowest concentration of the plant extract with no visible growth was recorded as the MBC. The MBC is the lowest concentration of plant extracts which was able to inactivate or kill the microorganisms. The 10% DMSO solution was used as a negative control, whereas ampicillin (0.05-5 mg/mL) was used as a positive control.

**Determination of Antioxidant Activity**

Antioxidant activity of each plant extract was determined by ferric reducing antioxidant power (FRAP) assay according to the method as described by Lado *et al*. (2004). Briefly, 100 µL of each plant extract (1 mg/mL in 30% ethanol) were mixed with 3 mL FRAP reagent, and then left in a water bath at 37$^{\circ}$C for 5 min. Working FRAP reagent was prepared by mixing 25 mL of 300 mM acetate buffer with 2.5 mL of 10 mM TPTZ (2,4,6-tri-2-pyridyl-2-triazine, Fluka, Sigma-Aldrich, Switzerland) in 40 mM HCl solution and 2.5 mL of 20 mM $FeCl_3.6H_2O$. Then, absorbance reading was taken against blank (FRAP reagent) at 594 nm using UV-visible spectrophotometer (UV1601, Shimadzu Scientific Instruments (Oceania) Pty. Ltd., Australia). The □-tocopherol (Fluka, Switzerland) was used as a positive control. The absorbance obtained was compared with the standard curve of known Fe(II) concentration (0.047-6.0 mM $FeSO_4.7H_2O$). The reducing capacity of the plant extracts was expressed as $Fe^{2+}$-TPTZ concentration in the sample (mmol Fe (II)/g extract).

## Results and Discussion

**Anti- *Porphyromonas gingivalis* activity of Medicinal Plant Extracts**

All plant extracts tested could inhibit the growth of *P. gingivalis* with inhibition zone diameter of 8.33-11.33 mm (Table 2). Garcinia and ginger extracts displayed the strongest anti-*P. gingivalis* action with the MIC of 0.39 mg/mL, followed by the extracts of mytle grass, lesser galangal and hog plum (0.78 mg/mL MIC).

However, the extracts of caranda plum, kaffir lime and red sorrel had lesser anti- *P. gingivalis* with 1.56 mg/mL MIC (Table 2). For MBC determination, the MBCs of all extracts against *P. gingivalis* were the same as their MIC values.

Table 2. Anti-*Porphyromonas gingivalis* activity of medicinal plant extracts

| **Plant extracts (common name)** | **Diameter of Inhibition zone (mm)[a] ± SD** | **Minimum Inhibitory Concentration (mg/mL)** |
|---|---|---|
| Mytle grass | 9.33 ± 0.28 | 0.78 |
| Lesser galangal | 10.83 ± 0.28 | 0.78 |
| Caranda plum | 8.33 ± 0.28 | 1.56 |
| Kaffir lime | 10.17 ± 0.58 | 1.56 |
| Garcinia | 11.33 ± 0.58 | 0.39 |
| Red sorrel | 9.17 ± 0.28 | 1.56 |
| Hog plum | 10.67 ± 0.28 | 0.78 |
| Ginger | 11.17 ± 0.28 | 0.39 |
| Ampicillin | 28.38 ± 0.58 | 0.05 |

[a]Data are mean of three replications. **Note**: For disk diffusion test, all plant extracts were tested at 200 mg/mL, while ampicillin was tested at 1 mg/mL.

The anti- *P. gingivalis* of garcinia may be due to the action of its bioflavonoids. Xu *et al.* (2013) reported that bioflavonoid GB-1 extracted from the plant in the same genus called *Garcinnia kola* could inhibit the growth of *P. gingivalis* W83 with the MIC of 64 µg/mL. In addition, antibacterial activity of garcinia may be due to high acid content in garcinia fruit. Suntornsuk *et al.* (2002) revealed that vitamin C was found in garcinia fruit at 4.6 mg/100 g fresh fruit.

In the current study, the extract of ginger could inhibit the growth of *P. gingivalis* at 0.39 mg/mL MIC. This was in agreement with those reported by EL-Sherbiny (2015). Pathogenic bacterial strains isolated from 33 patients with root canal infection were used as tested microorganisms to evaluate the anti-*P. gingivalis* activity of ginger. They reported that ginger extract had antibacterial action against *P. gingivalis* at 0.6 mg/mL MIC. This may be due to the action of active compounds in ginger. Park *et al.* (2008) reported that ginger extracts from Korea had antibacterial activity against *P. gingivalis*, *Porphyromonas endodontalis* and *Porphyromonas intermedia* at 50 µg/mL. The active compounds in ginger were identified by HPLC technique as [10]-gingerol, [12]-gingerol, 5-acetoxy-[6]-gingerol, 3,5-diacetoxy-[6]-gingerdiol and galanonolactone. The compounds with antibacterial activity against *P. gingivalis* were [10]-gingerol and [12]-gingerol. This is in agreement with those reported by Jolad *et. al.* (2005). In addition, red sorrel extract had anti-*P. gingivalis* activity.

The results are in agreement with those reported by Sulistyani *et al. (*2016). They reported that red sorrel extract had antibacterial activity against oral pathogenic bacteria such as *Streptococcus mutans*, *Fusobacterium nucleatum* and *P. gingivalis.* This was probably due to the action of organic acids in red sorrel especially protocatechuic acid.

**Antioxidant activity of Medicinal Plant Extracts**

Antioxidant activity of plant extracts was evaluated by FRAP method. This was performed to determine the capacity of sample to retard oxidation by redox reaction and color change of ferric tripyridyltriazine ($Fe^{3+}$-TRTZ) complex. When ferric tripyridyltriazine ($Fe^{3+}$- TRTZ) complex gains electron, it will change to ferrous tripyridyltriazine ($Fe^{2+}$-TRTZ) compound which is blue violet in color. The more dark in color indicates the more strong reducing capacity (strong antioxidant activity) of the plant extract. Among all extracts, hog plum extract had the strongest antioxidant activity (3.60 mM Fe(II) /g extract) which means that 1 g extract could change ferric tripyridyltriazine ($Fe^{3+}$-TPTZ) complex to ferrous tripyridyltriazine ($Fe^{2+}$-TPTZ) complex of 3.60 mM, but it was lower than that of α-tocopherol (5.5 mM Fe(II) /g). Ginger extract had relatively strong antioxidant activity (3.49 mM Fe(II) /g extract). However, other plant extracts had moderately antioxidant activity (0.16 -1.06 mM Fe(II) /g extract, Table 3).

Table 3. Antioxidant activity of medicinal plant extracts

| **Plant extracts (common name)** | **Antioxidant activity by FRAP assay (mmol Fe (II) /g extract)[a] ± SD** |
|---|---|
| Mytle grass | 1.06 ± 0.01 |
| Lesser galangal | 0.16 ± 0.00 |
| Caranda plum | 0.37 ± 0.05 |
| Kaffir lime | 0.81 ± 0.05 |
| Garcinia | 0.96 ± 0.02 |
| Red sorrel | 1.05 ± 0.03 |
| Hog plum | 3.60 ± 0.09 |
| Ginger | 3.49 ± 0.03 |
| α-tocopherol | 5.5 ± 0.07 |

[a]Data are mean of three replications.

Hog plum extract had the strongest antioxidant activity. This is in agreement with those reported by Saikia *et al.* (2016). They evaluated antioxidant activity of hog plum (*Spondias pinnata* L. Kutz) extracted by 80% acetone and found that it contained total phenolics of 1,654.5 mg gallic acid/ 100 g extract, total flavonoids of 65.63 mg quercetin/ 100 g extract and reducing capacity of 4,836.81 μmol/ 100 g extract. Moreover, Langyanai *et al.* (2017) also reported strong antioxidant activity of hog plum extract.

In summary, the results of the current study clearly confirmed that ginger, garcinia, hog plum, mytle grass and lesser galangal extracts have therapeutic potential against periodontal pathogen *P. gingivalis*. Hog plum and ginger extracts can potentially be used to develop formulations in dental care products as anti-*P. gingivalis* and antioxidant agents for prevention and treatment of periodontitis.

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# Community Business Management on Self-sufficiency Economy in Kiriwong District Nakhon Si Thammarat Province

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## Abstract

The aims of this present study are bi-facets, Firstly, it aims to investigate components of Self-Sufficiency Economy in community business management. Secondly, components of community business management and components of the Self-Sufficiency Economy are studied. Purposive sampling was applied to gain 300 participants. Data were collected using a set of questionnaire. Quantitative data analysis was employed and data presentation applied percentage (%), mean), and standard deviation (S.D.). Results show that human resource management, marketing management, production management, and accounting and financial management are the keys elements of community business management (mean = 3.98 and S.D. = 0.79). Meanwhile, moderation, reasonableness, self-immunity, appropriate knowledge, and ethics and virtues are highly crucial components of Self-Sufficiency Economy (mean = 3.81 and S.D. = 0.76)

**Keywords**: Community business management, Self-Sufficiency Economy, Use of template

## Introduction

Community businesses play their keys roles in assisting communities to survive in the global world. In general, investment of community businesses is relatively small. The exclusive goal of the businesses is to promote employment in the communities. At the beginning, the income from selling is not necessarily high as the ideal goal is for all the community people to survive. Besides, due to its small scale, the management is usually flexible. Meanwhile, the income at the early phase and the investment are not large. Likewise, sellers and customers are usually close and it is likely to be started easily. The businesses cover four areas: production, retailing, wholesaling, and servicing. The benefits of these businesses include promoting entrepreneurship, providing more employing opportunities, promoting industrial business, strengthening the community, and lessening social problems, which are threatening the nation. However, systematic management is necessary for an effective community business.

Similarly, Self-Sufficiency Economy refers to the development, which has three main components: moderation, reasonableness, and self-immunity, with two accompanying conditions: appropriate knowledge and ethics and virtues (Office of the Secretary General, Online, 2007). The philosophy has been featured as one of the goals in the Tenth National Economic and Social Development Plan (2007-2011) and the Eleventh National Economic and Social Development Plan (2012-2016). The philosophy can be a guideline for sustainable and stable economy,

especially during external economic crisis until Thailand has sustainable development. In other words, sustainable development, a current development trend, refers to continuous and abiding advancement with adequate resources and appropriate environment. The focus of Self-Sufficiency Economy covers six aspects: 1) promoting economy and well-being of community people, 2) promoting agricultural production, 3) promoting sufficiency and self-reliance to alleviate external risks, 4) depending exclusively on ability of self or the community, 5) producing more than exchanging, and 6) integrating local wisdom for creative development (MOE, 2002). Majority of the community people in Kiriwong District, Nakhon Si Thammarat Province, are farmers, consisting of 2,500 agricultural groups. The management in those groups attracts much attention from the research team. Consequently, a study namely, Community Business Management on Self-Sufficiency Economy in Kiriwong District Nakhon Si Thammarat Province was conducted to investigate the management. The results might contribute to beneficial practice in the future.

## Objective of the Study

1. To investigate the components of Self-Sufficiency Economy in the management of community businesses in Kiriwong District, Nakhon Si Thammarat Province

2. To investigate the components of community business management and the components of Self-Sufficiency Economy in Kiriwong District, Nakhon Si Thammarat Province

## Scope of the Study

The scope in conducting the study namely, Community Business Management on Self-Sufficiency Economy in Kiriwong District Nakhon Si Thammarat Province is presented below:

The population included 6 agricultural business groups: fried durian, curry paste, dessert, bio-compost, off-season durian planting, and golden banana plating. The participants were residing in Kiriwong District Nakhon Si Thammarat Province. The population was 300 people from three villages in Moo 1, Moo 3, and Moo 5. It was possible for the research team to identify the total numbers of the population; thus, the data were collected from all of them.

## Research Methodology

### Research Tools

This study employed a set of close-ended questionnaire, which was adapted from Choiychanchayakon (2010), Siriwat (2005), and Suthiratsuntorn (2004) The questionnaire consisted of 3 sections as presented below:

Section 1: The background information featured 11 close-ended questions in a checklist format.

Section 2: The application of Self-Sufficiency Economy on community businesses and community management was in close-ended form. All of the 18 items were in Likert Scale format. The data were measure through an interval scale.

Section 3: The management of community business was in a close-ended form and featuring Likert Scale. It included 15 items and was measured through an interval scale.

## Conclusion and Discussion

### Conclusion

The results of the study namely, Community Business Management on Self-Sufficiency Economy in Kiriwong District Nakhon Si Thammarat Province, are summarized below:

The results of Section 1: background information revealed that most respondents were female (65.0 percent). They were aged from 40-49 years old (34 percent), 30-19 years old (20.7 percent), and only 20- 29 years old (20.3 percent). Most of them (83 percent) were married, 11 percent were single, while 5.6 percent were divorced. Regarding their education, 34.3 percent of the respondents finished early secondary level, 34 percent achieved primary level, and 11.3 percent obtained vocational certificates. Most of them or 53.3 percent were rubber gardeners, while 17 percent were workers, and 15.7 percent were sellers. Concerning their positions in the business groups, 70.7 percent was the committee and members, 13 percent was the vice presidents, while only 10.7 percent was treasurers. In addition, they also took other roles, for example, 44 percent was committee and members of career groups, 17.7 percent was community committee, while 13.3 percent was community philosophers. Most of the products of the groups were from off-season durian planting and golden banana planting (20 percent), while fried raw durians, curry paste, dessert, and bio-compost shared 15 percent. 45 percent of the respondents gained 10,000 – 19,999 baht a month, while 39.3 percent obtained less than 10,000 baht, and 8.7 percent gained around 20,000 – 29,999 baht. Most of them (47 percent) attended community business training two times a year, once a year (28 percent), and three times a year (16 percent). For those who had never attended any training, most of them (68.7 percent) extended their guilt on inconvenience, lack of interest (17.7 percent), and not being selected as a representative (13 percent).

The results of Section 2: The application of Self-Sufficiency Economy on community businesses and community management

Table 1 Summary of application of Self-Sufficiency Economy on community businesses and community management

| **Factors of philosophy of community businesses** | $\bar{X}$ | **S.D.** | **Level of Priority** |
|---|---|---|---|
| Moderation | 3.35 | 0.69 | moderate |
| Reasonableness | 4.05 | 0.78 | high |
| Self-immunity | 4.10 | 0.79 | high |
| Appropriate knowledge | 3.90 | 0.80 | high |
| Ethics and virtues | 4.17 | 0.78 | high |
| **Total** | **3.81** | **0.76** | **high** |

As showed in table 2, in general the application of Self-Sufficiency Economy in the community businesses was high ($\bar{x}$ =3.91and S.D. = 0.77). Ethics and virtues gained the highest mean of ($\bar{x}$ = 4.17 and S.D. = 0.78), followed by self-immunity ($\bar{x}$ =4.10 and S.D. = 0.79). Likewise, the application of reasonableness was also high ($\bar{x}$ =4.05 and S.D. = 0.78), while the same trend was also found in appropriate knowledge ($\bar{x}$ =3.90 and S.D. = 0.80), followed by $\bar{x}$ of 3.35 and S.D. of 0.69 for moderation.

The results of Section 3: Management of Community Businesses

Table 2 Mean and S.D. of the priority given to each areas of community business management

| Community Business Management | $\bar{x}$ | S.D. | Level of Priority |
|---|---|---|---|
| Human resource management | 4.05 | 0.74 | High |
| Marketing management | 3.90 | 0.82 | High |
| Production management | 4.04 | 0.76 | High |
| Accounting and financial management | 3.95 | 0.87 | High |
| **Total** | **3.98** | **0.79** | **High** |

As indicated in table 3, overall the management of the community businesses was high ($\bar{x}$ =3.98 and S.D. = 0.79). To be more specific, the areas which gained high priority included: human resource management ($\bar{x}$ =4.05 and S.D. = 0.74), production management ($\bar{x}$ =4.04 and S.D. = 0.76), accounting and financial ($\bar{x}$ =3.95 (S.D. = 0.87), and marketing management ($\bar{x}$ = 3.90 and S.D.= 0.82), respectively.

## Discussion

The results of the study namely, Community Business Management on Self-Sufficiency Economy in Kiriwong District Nakhon Si Thammarat Province can be discussed in 2 areas below:

**The components of Self-Sufficiency Economy**

The data analysis of the application of the components of Self-Sufficiency Economy indicated that all the components were found in the management of community businesses in Kiriwong District Nakhon Si Thammarat Province. The outstanding components were moderation, reasonableness, self-immunity, appropriate knowledge, and ethics and virtues, which are congruent to the Office of the Secretary General (Online, 2007). The institution clarifies King Rama IX's Self-Sufficiency Economy that it has three components and two accompanying conditions as mentioned earlier. Similarly, Wiriyaphan (2007) has extended that three elements must gain critical consideration when applying Self-Sufficiency Economy. Firstly, being moderate focuses on the balance of living, not too much or too little. It is advisable for people to realize their ability and not pay much attention to materials. People are freed and depend on self until they become self-reliant. Secondly, being sufficient is associated with reliance on logic, being careful, and employing knowledge in considering a certain agenda. Next, promoting mental sufficiency refers to encouraging people to feel full regardless of their heart or materials, raising awareness of morals and loyalty. Sufficiency is promoted, while greediness is lessened so that people are mentally and bodily happy. They are less likely to hurt others as well as the society. The major goal is for human being to be as much self-reliant as possible. As a result, they tend to provide others

with more social, resource and environmental, technological support as well as integrating new technology into local wisdom. Finally, regarding economy, much attention is paid on economical use of money by reducing unnecessary pay. Instead sufficient living is promoted, while debt with unworthy return should be avoiding.

**The components of community business management**

The data analysis of the community business management on Self-Sufficiency Economy reveals that human resource management, marketing management, production management, and accounting and financial management are the keys elements of community business management. The result is congruent with Laohawanit (2001) and Sirabucha (2006), which examine leather product community business in Laharn, Laharn District, Udon Thani Province. Whereas, the four elements of community business management are different from those found in international contexts, for example, Miller N.J. and Besser T.L.(2000)'s. The researchers discover five crucial elements of community business management: collaborating in the community, variety of alternatives, collaborating between communities, promoting expertise for entrepreneurs and managers, and promoting networking to external businesses. Similarly, Jackson E. T. (2004) adds that successful community business management should additionally focus on preserving natural resources and promote positive relationship between communities. Regarding this, the community should become an entrepreneur who transfers their knowledge and makes mutual agreement.

## Suggestion and Contribution

**Suggestion from the research team**

Apart from the favor of the Self-Sufficiency Economy, some other elements such as extent of participation in the management or leadership are also necessary for successful community businesses. Hence, these elements should be included in further studies.

**Contribution of the study**

This study discovers that human resource management, marketing management, production management, and accounting and financial management are necessary for business management. Therefore, relevant organizations such as Community Development Department, Office of Small and Medium Enterprises, or other organizations in relevant to community businesses could benefit from the results.

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# The Development of Clear Salad Dressing from Fruit and Vegetables and Its Sensory Evaluation

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## Abstract

Nowadays the trend of healthy diet becomes more popular. Salad is one of the popular healthy diets because of its various kinds of vegetables. The salad dressings that normally consume along with salad can be made to be healthier. This study used sensory evaluation, nutrients and energy analysis by INMUCAL-Nutrient V.3 NB.3 program. The Orange-juice-and-cauliflower salad dressing has 135.49 kcal of energy, 15.14g of sugar, 7.63g of fat, and 18.56mg of sodium which is low. It also contains 16.31g of carbohydrate, 22.03mg of phosphorus, 76.92mg of potassium, and 27.92 RAE of vitamin A which is high. For the pomegranate-juice salad dressing has 140.96 kcal of energy, 8.21g of sugar, 10.32g of fat, and 8.56mg of sodium which is also low. There are also 11.59g of carbohydrate, 13.39mg of phosphorus, and 34.64mg of potassium which are high. In summary, the orange-juice-and-cauliflower salad dressing has overall sensorial satisfaction in 'very like' (7.32) while the pomegranate-juice salad dressing also has the overall sensorial satisfaction in 'very like' (7.67). So, the development of clear salad dressing to improve nutrition values can be an alternative choice for health concerning consumers.

**Keywords**: Salad Dressing, Fruit, Vegetables, Sensory Evaluation

## Introduction

Nowadays, people around the world are concerning about their health much more than before and the consumption of healthy food is also drastically increased. One of the popular healthy food is salad which contains various kinds of vegetable. Salad dressings which eat together with the salad can be changed to be healthier, e.g. clear salad dressing and thick salad dressing (Bootsrapa L. and Trairat K., 2018). The salad dressing consist of egg yolk, oil, sugar, vinegar, salt, mustard, and pepper. As you can see, egg yolk is one of the main ingredients in salad dressings that contains high fat and cholesterol which prone to increase the risk of atherosclerosis, hypertension, some cancers, and obesity. A survey of fruit and vegetable consumption of Thai people showed that 75 percent of Thai people consume fruit and vegetable less than standard requirement of WHO which suggests to consume 400g of fruit and vegetables. Presently, it is found that Thai people consume protein, carbohydrate, and fat in excessive amount of the requirement. However, the consumption of dietary fiber and iron is lower than the requirement. The dietary fiber and iron are essential to human's health which helps to reduce and prevent many diseases (Satheannoppakao W., Aekplakorn W., and Pradipasen M., 2009:2192-8).

Fruit and vegetables are classified in high-phytonutrient group. Phytonutrients are unable to synthesis by human and only come from plant sources. The phytonutrients can help to reduce oxidative stress, degeneration, and inflammatory process, as well as increase immunity. Different color of fruit and vegetables also has different type of phytonutrients. Therefore, in order to get enough of nutrients, one should consume different kinds of fruit and vegetables of approximately 400-500g per day. From the statistical survey in Thailand demonstrated that 80 percent of Thai people consume total amount of fruit and vegetables only 276g per day. Due to climate and postharvest conditions, the nutrients in fruit and vegetables are loss by more than 20 percent. Pomegranate (Punica granatum L.) is a fruit in the family Punicaceae, which is increasing in popularity in both fresh and juice consumption. It is rich in many phytonutrients such as anthocyanin which is abundantly found in its rind, juice, and seed. It can prohibit the growth of cancer cells. Another phytonutrient found in pomegranate is flavonoid group substances which are found mostly in its juice and rind. It can induce the death and prohibit the multiplication of cancer cells. It also has anti-oxidative and anti-inflammatory properties (Gil et al., 2000; Hong et al., 2008; Karasu et al., 2012; Shema-Didi et al., 2012) (Hong, M. Y., Seeram, N. P., & Heber, D., 2008) (Karasu, C, 2012). Radish is rich in antioxidant and many nutrients such as carbohydrate, dietary fiber, protein, calcium, phosphorus, iron, vitamin A, B1, B12, niacin, C, and essential oil. Radish juice is able to entrap virus and bacteria, and also expectorate. It also contains very similar enzymes that found in human digestive system that can digest carbohydrate, protein, and lipid. The research suggested that the consumption of radish juice or bulb and leaves of this plant also helps to reduce the overall inflammation (Goyeneche R et al., 2015). With these beneficial properties of these fruit and vegetables, this study aims to develop clear salad dressings from the remnants of fruit and vegetables. By adding fruit and vegetables into the salad dressings is to add an alternative choice to consumers to consume more fruit and vegetables as well. The main consideration in this study is nutritional values and the utilization of remnants of fruit and vegetables. There is also sensory evaluation to evaluate the sensorial satisfaction as well.

## Materials and method

There are 2 formulae used in this study as follows:

Ingredients for orange-juice-and-cauliflower salad dressing formula including:

| | | |
|---|---|---|
| 1) Orange juice | 10 | tablespoons |
| 2) Vinegar | 9 | tablespoons |
| 3) Radish | 4 | tablespoons |
| 4) Refined sugar | 10 | tablespoons |
| 5) Cauliflower | 1 | tablespoon |
| 6) Minced garlic | 1 | teaspoon |
| 7) Olive oil | 6 | tablespoons |
| 8) Honey | ½ | tablespoons |
| 9) Orange peel | 1 | teaspoon |

| | | |
|---|---|---|
| 10) Pepper | 1 | gram |
| 11) Carrot | 4 | tablespoons |

**Method for making orange-juice-and-cauliflower salad dressing formula**

1. Squeeze oranges, then mix orange juice, sugar, and vinegar together. Put the orange juice on the stove until it boils and then leave it until cool.

2. Clean radishes, carrots, and cauliflowers and then cut them into 0.5cm-width wedges.

3. Cut carrots and radishes into small dices. Then mix orange juice with olive oil until well blended.

4. Put in honey then pepper, respectively. Mix them well. Put cut carrots and radishes, then minced garlic and cauliflowers. Leave it until cool. Then put orange peels into salad dressing containers. Put the salad dressing in the sterile containers and chill them. The salad dressings can be kept for one month.

Ingredients for pomegranate-juice salad dressing including:

| | | |
|---|---|---|
| 1) Pomegranate | 10 | tablespoons |
| 2) Radish | 4 | tablespoons |
| 3) Cauliflower | 3 | tablespoons |
| 4) Chili | 1 | head |
| 5) Shallot | 4 | tablespoons |
| 6) Minced coriander root | 1 | teaspoon |
| 7) Vinegar | 7 | tablespoons |
| 8) Refined sugar | 6 | tablespoons |
| 9) Olive oil | 8 | tablespoons |
| 10) Honey | ½ | tablespoons |

**Method of making pomegranate-juice salad dressing**

1. Squeeze pomegranates and filter 2-3 times. Pour it in a bowl, put refined sugar and mix it well.

2. Cut the radishes into 0.5cm-width wedges. Soak the cut radishes in salt and rinse them until they are unsalted. Then cut the radishes again into small dices.

3. Cut the cauliflowers into small pieces, cut the stem part into small dices. Soak and rinse as same as the radishes.

4. Put the pomegranate juice on the stove and use medium flame until it starts to boil then turn off the fire. Then put vinegar and use medium flame again, stir until boils then turn off the fire immediately.

5. Pour olive oil into the pomegranate juice little by little and blend it together until they are well blended.

6. Stir the salad dressing, put all of the vegetables into the salad dressing one by one. Start from radishes, then stem cauliflowers, diced shallots, sliced chilies, minced coriander roots, and flowers of cauliflowers. Mix them well around 5min. Then put in honey and mix well them together. Leave it until cool. Then put in in sterile containers and chill in a refrigerator. It can be kept for one month.

The data collection tools used in the study is sensory evaluation. The statistical analysis was conducted by INMUCAL-Nutrient V.3 NB.3 program.

**Sensory evaluation**

There were 37 untrained evaluators. The orange-juice-and-cauliflower salad dressing and pomegranate-juice salad dressing were evaluated by 22 and 15 evaluators, respectively. The sensory evaluation consisted of appearance, color, odor, flavor, taste, and overall satisfaction. The 9-point hedonic scale was used as follows: 9 = extremely like, 8 = very like, 7 = like, 6 = slightly like, 5 = neither like nor dislike, 4 = slightly dislike, 3 = dislike, 2 = very dislike, 1 = extremely dislike.

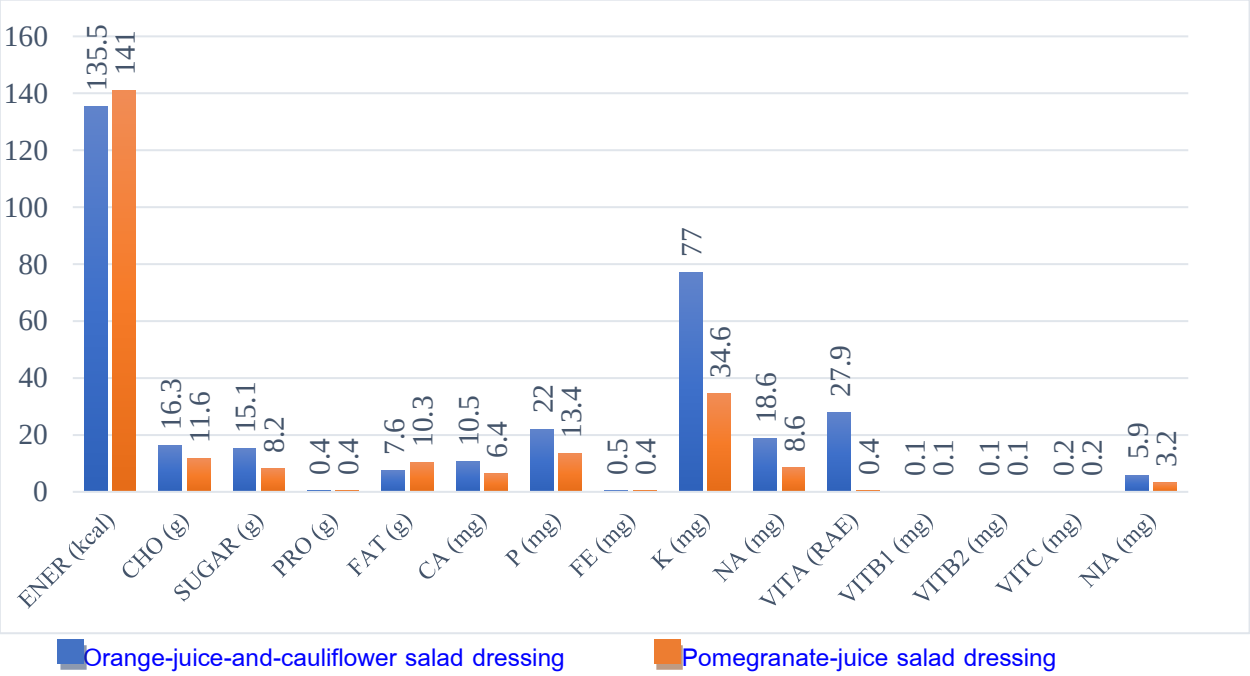
**Data of energy and nutritional values of orange-juice-and-cauliflower salad dressing and pomegranate-juice salad dressing**

From the development of the salad dressings to have appropriate nutritional values by adding remnants of fruit and vegetables from Wat Thai Buddhagaya and Wat Thai Temple Kushinagar, India into the salad dressings to improve the nutritional values of the salad dressings and to utilize the remnants of fruit and vegetables results in both salad dressing formulae have energy and nutritional values as shown in Table 1 and Table 2. The data were shown as per serving as follows:

1. The orange-juice-and-cauliflower salad dressing had 135.49kcal of energy, 15.14g of sugar, 7.63g of fat, and 18.56mg of sodium which appeared as low amount. It also consisted of 16.31g of carbohydrate, 22.03mg of phosphorus, 76.92mg of potassium, and 27.92 RAE of vitamin A which appeared as high amount.

2. The pomegranate-juice salad dressing had 140.96kcal of energy, 8.21g of sugar, 10.32g of fat, and 8.56mg of sodium which appeared as low amount while carbohydrate, phosphorus, and potassium were high (11.59g, 13.39mg, and 34.64mg, respectively).

Energy and nutritional values of salad dressings, per 1 serving




## Result of the sensory evaluation

The sensory evaluation of the orange-juice-and-cauliflower salad dressing of 22 participants including monks, nuns, volunteers, staff, and normal people can be interpreted as follows: extremely like = 8.01-9.00,

very like = 7.01-8.00, like = 6.01-7.00, slightly like = 5.01-6.00, neither like nor dislike = 4.01-5.00, slightly dislike = 3.01-4.00, dislike = 2.01-3.00, very dislike = 1.01-2.00, extremely dislike = 0.00-1.00 scores.

The sensory evaluation of the pomegranate-juice salad dressing of 15 participants including monks, nuns, volunteers, staff, and normal people can be interpreted as follows: extremely like = 8.01-9.00, very like = 7.01-8.00, like = 6.01-7.00, slightly like = 5.01-6.00, neither like nor dislike = 4.01-5.00, slightly dislike = 3.01-4.00, dislike = 2.01-3.00, very dislike = 1.01-2.00, extremely dislike = 0.00-1.00 scores.

Table 1 Sensory evaluation of salad dressing

| **Characteristics** | **Salad dressing formula** | |
|---|---|---|
| | **Orange-juice-and-cauliflower** | **Pomegranate-juice** |
| Appearance | 6.86 ± 1.93[a] | 7.13 ± 1.46[a] |
| Color | 7.41 ± 1.59[a] | 6.80 ± 1.74[a] |
| Smell | 7.00 ± 2.12[a] | 6.73 ± 1.94[a] |
| Taste | 7.55 ± 1.37[a] | 7.80 ± 1.15[a] |
| Flavor | 6.86 ± 2.01[a] | 7.07 ± 1.58[a] |
| Overall acceptability | 7.32 ± 1.62[a] | 7.67 ± 1.35[a] |

It was consistent with the Leelawat B and Kaewsaad T experiment. It was found that the ratio of salad dressing to be low in fat. (Rice bran oil: rice flour: xanthan gum) affects the sensory acceptance of color and flavor. Rated for color and flavor preference, the most and not a significant difference ($p \leq 0.05$) (Leelawat B and Kaewsaad T, 2018).

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# The Use of Coherence Devices in Academic Writing: A Case Study of Non-English Major University Students

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## Abstract

One important element in academic writing is coherence. Coherence can be described as logical connection of ideas. To achieve it a writer needs to employ different techniques such as using transition signals to relate ideas or using pronouns to refer to key nouns. However, putting all coherence devices together to create a good piece of writing is a challenging task, especially for students who do not acquire extensive skill in writing. Therefore, this study aims at investigating how university students use coherence devices in their writing and what problems they have when applying them. To conduct the research four coherence techniques explained in textbook: Writing Academic English Level 4 (4th edition) written by Oshima and Hogue (2006) were used as a key reference in the study. The techniques consist of repeating key nouns, using consistent pronouns, using transition signals, and arranging ideas in logical order. In addition, 30 opinion essays written by fourth year students at a state university were randomly selected for the analysis. The results and discussion of the study will be further discussed in the conference's presentation.

**Keywords:** Academic writing, Coherence, Coherence techniques, Coherence devices

## Introduction

Of all the four skills of English writing seems to be the most difficult for learners of English as a foreign language (EFL) due to the complexity of writing process. According to Knapp and Watkins (2005), learning to write is a difficult and complex series of processes that require a range of explicit teaching methodologies throughout all the stages of learning. For this skill writers need to verbalize their abstract ideas in their brain into a written form by paying attention to many things (idea, concept, vocabulary, and grammar) (Khunaifi, 2015). This means writing requires writers to use substantial effort as they have to learn the complicated process and combine several skills efficiently in order to communicate their ideas in written form.

For academic writing one important element that is always taken into account in writing is coherence. Coherence refers to the flow of ideas; that is, the movement from one sentence to the next must be logical and smooth (Oshima and Hogue, 2006). Thornbury (2002) sees coherence as capacity of a text to "make sense. In other words, sentences in a text need to be connected logically to make the text meaningful and can be understood by readers.

To achieve coherence, writers need to employ different methods such as repeating key words or phrases, using pronouns to link sentences. However, many foreign language learners find difficulties in making their writing coherent. From teaching English academic writing to Thai university students for many years, the researchers found that many of them, though having some knowledge about coherence, could not apply

coherence devices correctly and efficiently. Therefore, this study was conducted to examine the use of coherence devices in students' writing with the purpose to find out how they applied the devices in their writing and what errors occurred when applying them. Discovering results of the study might enable the researchers to find solution to help students to achieve coherence in their writing.

## Methodology

### Sample

The sample of the study was 30 fourth year undergraduate students of the School of Architecture and Design (SoAD) of King Mongkut's University of Technology, Thonburi (KMUTT), Thailand. All of them enrolled in LNG 107: Academic Reading and Writing which is a compulsory English courses of SoAD. Their English proficiency levels ranged from intermediate to upper intermediate (according to their standardized test scores submitted to SoAD during their enrollment). Based on the scores, their English skills were supposed to be good even though they were not English-major students.

### LNG 107: Academic Reading and Writing

The course is one of compulsory courses for students who study in international programmes of KMUTT. It aims at developing learners' academic reading and writing skills. Students will learn to write different types of essay and use references and citations throughout the writing process. After studying this course, the students are expected to be able to communicate their ideas logically and write well-organised essays with appropriate citations.

### Instrument and data analysis

Thirty opinion essays of the same topic written by the abovementioned students as their final examination were randomly selected for analysis. The controlled topic for this exam was *"In your opinion, what skills do you need to succeed in online learning?"* It was purposely used to correspond with the situation that the students were encountering at the time when teaching and learning methods were suddenly changed from physical classroom to online learning due to the covid-19 pandemic.

To analyze the use of coherence devices in those essays, the researchers employed the methods explained in the book *"Writing Academic English Level 4 fourth edition"* by Oshima and Hogue (2006) which was used by the researchers for teaching LNG 107 course at the university.

According to Oshima and Hogue (2006), there are four coherence devices to help writers to achieve coherence in academic writing:

**1. Repeating key nouns and using key noun substitutes** – Repeating key nouns of the written topic is the easiest way to achieve coherence. However, there is no fixed rule about how often to repeat key nouns. If writers do not want to repeat a key noun again and again, they can use key noun substitutes i.e. synonyms or expressions that contain the same meaning.

**2. Using consistent pronouns** – When using pronouns, writers must use the same person and number throughout their writing.

**3. Using transition signals** – They are words and expressions that guide readers from one idea to the next. There are several different categories of transition signals to serve different purposes of use. The types used in this study are listed below:

3.1 To list ideas in order of time and importance such as first, first of all, next, most important

3.2 To add a similar or equal idea such as and, in addition, moreover, as well, besides

3.3 To add an opposite idea such as but, however, on the other hand, nevertheless

3.4 To explain or restate an idea such as in other words, that is, in particular

3.5 To make a stronger statement such as in fact, indeed

3.6 To give another possibility such as or, on the other hand, otherwise

3.7 To give an example such as for example, for instance

3.8 To express an opinion such as in my opinion, in my view

3.9 To give a reason such as for, because, for this reason

3.10 To give a result such as so, therefore, thus, as a result

3.11 To add a conclusion such as to conclude, to summarize, in conclusion

**4. Arranging ideas into logical order** – This technique helps writers arranging and discussing their ideas in logical order such as chronological order and logical division of idea.

## Findings and Discussion

From the study, it was found that most students used cohesive devices in their writing. These devices were repeating key nouns, using consistent pronouns, using transition signals, and arranging ideas in logical order as listed by Oshima and Hogue (2006). However, each student applied the devices differently due to their own writing styles and preferences. The use of each device is discussed in the following.

**Repeating key nouns and key noun substitutes**

Oshima and Hogue (2006) explained that one technique to establish coherence and unity in English writing was repeating key nouns. As the main topic for the opinion essay assigned to these 30 students was ‘online learning’, most students unavoidably used the word as their key noun. Moreover, they also knew how to substitute the key nouns with synonymous words (key noun substitutes). Table 1 below lists down the frequency of the use of key nouns while Table 2 shows the key noun substitutes that students chose in their writings to replace the word ‘online learning’.

Table 1 The number of students with the different frequency of key nouns use

| Key noun | 3 uses or fewer | 4-6 uses | 7-9 uses | 10-14 uses | 15 uses or more |
|---|---|---|---|---|---|
| Online learning | 6 students | 11 students | 9 students | 3 students | 1 student |
| Students | 9 students | 5 students | 5 student | 6 students | 5 students |
| Skills | 3 students | 6 students | 2 students | 2 students | 0 student |

Table 2 The number of uses of most used key noun substitutes to replace 3 key nouns: online learning, student and skill

| Key noun substitutes for 'online learning' | No. of use | Key noun substitutes for 'students' | No. of use | Key noun substitutes for 'skills' | No. of use |
|---|---|---|---|---|---|
| Online class | 31 | Learners | 25 | Factors | 3 |
| Online platform | 14 | Children | 12 | Abilities | 2 |
| Online education | 9 | People | 5 | | |
| Online classroom | 6 | Kids | 5 | | |

It is clearly seen that students knew that repeating key nouns and using key noun substitutes are critical in writing as it helps remind readers the main topic being discussed. As stated by Halliday and Hasan (1976), Oshima and Hogue (2006), and Tanskanen (2006), repetition of key words and the use of their synonyms are one important technique of creating coherence in academic writing. From Table 1, the word 'online learning' was used the most as it was the topic of the writing and 20 students used it repeatedly for 4-9 times in their writings. Meanwhile, Table 2 reveals the words 'online class' and 'online platform' seemed to be the most popular key noun substitutes among the 30 students with the number of use of 31 and 14 respectively, followed by 'online education' and 'online classroom'. For the key noun 'students', the words 'learners' (25 uses) and 'children' (12) were most used as its key noun substitutes. Meanwhile, the key noun 'skills' had only the words 'factors' (3 uses) and 'abilities' (2 uses) as its substitutes.

It can be concluded that students knew how to use this device of repeating key nouns and key noun substitutes to have coherence in their writing. However, there are few students who kept using the key nouns repeatedly with very few uses of key noun substitutes; this might be because these students tried to avoid complex grammatical rules—such as, in this case, how to use the right key nouns—which they did not feel confidently enough to write (Touchie, 1986).

**Using consistent pronouns**

Another device to achieve coherence in academic writing is the use of consistent pronouns (Oshima & Hogues 2006). In the students' 30 writing pieces, the use of consistent pronouns were found throughout each piece. Table 3 below shows the most used pronouns including 1st personal pronouns, 2nd personal pronouns and 3rd personal pronouns.

Table 3 The number of use of most used personal pronouns in students' writings

| Pronouns | 1st most used | 2nd most used | 3rd most used |
|---|---|---|---|
| 1st personal pronouns | we (57) | I (29) | us (15) |
| 2nd personal pronouns | you (53) | one (7) | yourself (4) |
| 3rd personal pronouns | it (75) | they (29) | them (25) |

From Table 3, it is clearly seen that students seemed to use the 3rd personal pronouns the most, followed by the 1st personal pronouns and 2nd personal pronouns, respectively. The pronoun 'it' was of the most popular use (75 uses), followed by 'they' (29 uses) and them (25 uses). For the 1st personal pronouns, the pronoun 'we' was of the most popular use (57 uses), followed by 'I' (29 uses) and us (15 uses). Regarding the 2nd personal pronouns, the pronoun 'you' was of the most popular use (53 uses), followed by 'one' (7 uses) and yourselves (4 uses). For the reason that the 3rd personal pronouns became the most used ones among the three personal pronouns, it may be because this type of personal pronoun can refer to things, ideas, situations, concepts or even previously mentioned items in each writing (Swan, 2017) while the 1st and 2nd personal pronouns can be referred to only persons. This can be clearly seen in the referents of each type of pronoun the students referred to. For the 3rd personal pronoun 'they', students tended to refer it to plural nouns such as students, teachers, people, courses or skills while they referred 'it' to various singular nouns of concrete and abstract nouns. A number of examples included online learning, time, data, the Internet, technique or even the COVID-19 situation. It is seen that students knew how to use different types of pronoun for different referents. On the other hand, more than half of students faced challenges in using these pronouns correctly in terms of lexical and grammatical aspects. The researchers did the analysis of students' use of different types of pronouns and found different patterns of errors which can be categorized into 5 types and some examples of each pattern are discussed in the following.

1. Using 'it' to refer to a plural noun (5 cases)

***Example 1***

*We are facing **the new tools** for learning process. Even though, it is hard during the start, **it** come with a lot of benefit if we get used to **it**.*

This writer clearly used 'it' to refer to 'the new tools' which is a plural noun.

***Example 2***

***More students** maybe see and listen than in the classroom. **It** will help each other solve the problem like a chain effect.*

This writer used 'it' to refer to 'more students' which is a plural noun. Also the predicate 'will help each other solve the problem…' in the latter sentence clearly shows that the referent of the pronoun 'it' is 'more students'.

2. Using 'them', 'they' or 'themselves' to refer to a singular noun (17 cases)

***Example 3***

*One can have access to more **information** online since most of **them** are in English.*

Instead of using 'it', this writer in fact used 'them' to refer to 'information' which is an uncountable noun. Therefore, using 'them' for such referent is not grammatically correct.

***Example 4***

*They also can find more information by go through the internet and preparing questions to ask **professor** in the next online class also may write **them** some emails.*

This writer used 'them' to refer to 'professor', a singular noun, which is not grammatically correct. To correct the sentence, the noun 'professor' should be changed into a plural one: professors.

***Example 5***

***The ministry of higher education** lack of understanding **their** citizens in case of the connection preparation and the devices for learning that mentioned above.*

Instead of using 'its', this writer used 'their' to refer to 'The ministry of higher education', a singular noun, which is not grammatically correct.

***Example 6***

*Instated of working on a computer, **a student** can work on **their** handbook and shared to the other.*

This writer used 'their' to refer to 'a student', a singular noun, which is not grammatically correct. To correct the sentence, the writer should change 'their' to 'his or her'.

***Example 7***

*Moreover, **every mistake** that happened will make us learn and solve **them** and find the new solution together.*

Instead of using 'it', this writer used 'them' to refer to 'every mistake', a singular noun, which is not grammatically correct.

3. Using both the first personal pronoun 'I' or 'we' and second personal pronoun 'you' in their essays to address their readers / message receivers. (8 cases)

***Example 8***

*Computer Literacy is also the one problem that **I** need to succeed more better. **You** cannot expect to do well in an online class unless **you** are computer literate.*

This writer used 'I' (1st personal pronoun) in the earlier sentence to relate himself or herself to an action. Still he or she then changed the subject of the following sentence to 'you' (2nd personal pronoun) even though the flow of information still continues from the earlier sentence that the action in the second belongs to the same subjects of the first.

***Example 9***

*For example, if **we** have used 'Microsoft team', it is easier for **you** once **you** try to use 'Zoom meeting'.*

This writer used 'we' (1st personal pronoun) in the subordinate clause in the beginning of this sentence to relate himself or herself to an action. However, he or she then changed the subject of the following sentence to 'you' (2nd personal pronoun) in the main clause that follows despite the action in the main clause related to the same subjects of the subordinate clause.

***Example 10***

***Student** must take the responsibility for **themselves** because no one can control **you** more that **yourself**. Moreover, Online learning is hard but if **we** have willingness, it's not too difficult for **your** intention.*

This writer used 'themselves' (3rd personal pronoun), 'you' (2nd personal pronoun) and 'yourself' (2nd personal pronoun) in the same sentence to relate to the subject of the sentence 'students'. Also he or she did the same in the following sentence as of the use of both 'we' (1st personal pronoun) and 'your' (2nd personal pronoun) to refer to the same subject.

4. Using the second personal pronoun 'you' to refer to students in general in their essays to address their readers / message receivers. (4 cases)

***Example 11***

*The first and most important reason to help **students** be successful in online learning is to keep **your** self-motivation and self-discipline all the time. The second thing that can help **you** to succeed in the online class is **you** have to has space to study properly.*

This writer used 'your' and 'you' (2nd personal pronouns) to refer to the referent 'students'. In fact, he or she should change these 2nd personal pronouns to 3rd personal pronouns: their, them and they, respectively.

***Example 12***

*Another reason is communication skills improvement, in an online learning program, **students** won't have as much access to **your** professors as **you** would in a more traditional program. With an online*

*class, **students** get to control their learning environment, which helps **you** develop a deeper understanding of classes.*

This writer used 'your' and 'you' (2nd personal pronouns) to refer to the referent 'students'. In fact, he or she should change these 2nd personal pronouns to 3rd personal pronouns: their, they and them, respectively.

5. Referring pronouns to unclear referents (8 cases)

***Example 13***

*…could it be better if the government helps and try to support the students to more touchable with **online education** to make **an equalization of the education system**. Moreover, it can increase or support students in understanding the lesson more. **Seeing by using the e-book or videotape recorder**, **it** will be better enough.*

This writer used the pronoun 'it' three times in this example; however, it is unclear which referent— 1) online education, 2) an equalization of the education system or 3) seeing by using the e-book or videotape recorder— that the pronoun 'it' in the last sentence refers to.

***Example 14***

*The school need to provide the online storage space for the student in order to support **the files from the student** due to their work, **the lecture of the class** that allows the student to download **it** later…*

It is unclear which referent— 1) the files from the student, 2) the lecture of the class or 3) both of 1) and 2)— that the pronoun 'it' refers to.

***Example 15***

*For this COVID-19 situation, everyone stays at home because the school, the university is lockdown to prevent **the spread that makes people work from home or learning at home**. Because of **this situation incident**, **it** doesn't be anyone to prepare in time or ready to online, which some people may be very new to **him**, may need time to study how to use it.*

This writer used the pronoun 'it' two times in this example; however, it is unclear which referent— 1) the spread that makes people work from home or learning at home, 2) this situation incident, or 3) another unidentified referent — that the second pronoun 'it' refers to. Also it is unclear which referent that the pronoun 'him' refers to. It seems that this pronoun cannot be related to any referent or the writer used this pronoun incorrectly.

From the mentioned errors in 5 different patterns, it is clearly seen that most students seemed to have problems in the following categories

1. using 'them', 'they' or 'themselves' to refer to a singular noun (17 cases);
2. Using both the first personal pronoun 'I' or 'we' and second personal pronoun 'you' in their essays to address their readers / message receivers (8 cases);
3. Referring pronouns to unclear referents (8 cases).

One possible reason to explain these patterns of errors is L1 interference or language transfer. This type of error is identified by Richards and Schmidt (2010) and Brown (2007) as the one caused by the interference of the native language of users—Thai language for these students. That is, the native language of learners has influence on their use of the second language, which is English in this study. In Thai language, native users of the language generally refer to any 3rd personal pronoun as the word 'kháw'. It can substitute for both male and female 3rd personal pronouns, either in singular or plural forms (Smyth, 2002). This leads to a possible explanation why there are 17 cases of students having used 'them', 'they' or 'themselves' to refer to a singular noun as per the L1 interference. It can be assumed that they had translated their ideas in Thai into English when writing essays.

Another possibility of these errors is the students' lack of inconsistency when using pronouns in their writings. While writing, students tended to focus on many issues in limited amount of time such as development of the main idea, word choice, grammar, coherence and cohesiveness and their own stress to do their best (Wirantaka, 2016). In other words, they have already known how to correctly use pronouns but their outcomes turned out grammatically incorrect. This may be considered the type of error called 'slips', caused by the nervousness, tiresome or other intrinsic conditions of students that affected their writings (Harmer, 2012).

**Using transition signals**

According to Oshima and Hogue (2006), using transition signals to show how one idea is related to the next is one powerful device to create coherence and unity in English writing. All of 30 students in this study used this device in their writing. As a result, a variety of transition signals were seen when analyzing the piece of writing of each student. Table 4 below shows 11 types of transition signals used and the three most used transition signals of each type.

Table 4 The number of types of transition signals used in students' writings and three most used transition signals of each type

| Type of transition signals | Total use | 1st most used | 2nd most used | 3rd most used |
|---|---|---|---|---|
| 1. to list ideas | 82** | firstly (11) | secondly (9) | lastly (7) |
| 2. to add a similar or equal idea | 117* | and (49) | also (26) | Another (14) / moreover (14) |
| 3. to add an opposite idea | 56*** | but (33) | however (10) | nevertheless (4) |

| | | | | |
|---|---|---|---|---|
| 4. to give an example | 20 | for example (12) | such as (3) | as (2) |
| 5. to express an opinion | 15 | in my opinion (9) | from my opinion (3) | from my perspective (2) |
| 6. to give a reason | 47 | because (24) | as (10) | because of (5) |
| 7. to give a result | 38 | so (20) | therefore (12) | by doing this (2) |
| 8. to add a conclusion | 19 | in conclusion (9) | to summarize (3) | in summary (2) |
| 9. to give another possibility | 6 | if (4) | or (2) | - |
| 10. to make a stronger statement | 3 | in fact (1) / according to the fact that (1) / of course (1) | - | - |
| 11. to explain or restate an idea | 1 | in the other word (1) | - | - |
| **TOTAL** | **368** | | | |

From Table 4, it is clearly seen that students used transition signals to connect ideas in their writing together to create coherence. After analyzing all students' writings, it was found that there were 11 types of transition signals in students' essays. Also, it was found that the most frequent signals use by the students was 'and' (49 uses) and the frequent type of signals was 'to add a similar or equal idea' (117 uses) which is in accordance with the study of Nugraheni (2015). Meanwhile the transition signals 'to list ideas' (82 uses) and 'to add an opposite idea' (56 uses) were the second and third most used ones in the study. In addition, the transition signals that were most used in the essays were simple connectors, such as 'and', 'but', 'because', 'so' etc. as seen in Table 4.

In general, students were found to use this device most frequently despite some errors related to the rules of using each type of transition signals. One clear example is the use of coordinating conjunctions such as 'so', 'and' or 'but'. A few students used these conjunctions in the beginning of a new sentence. In fact, they function as connectors that connect equal elements such as two main clauses in a compound sentence. As a result, this type of use is considered grammatically incorrect.

**Arranging ideas in logical order**

The last device to establish coherence in writing is the technique called arranging ideas in logical order. It means writers need to display their ideas "in some kind of order that is logical to a reader accustomed to the English way of writing" (Oshima & Hogue, 2006, p.34). There are several kinds of logical order in English. One of them is logical division of ideas where writers normally divide their topic into parts to discuss separately. For this study, it was found that all 30 students used

this device to arrange and discuss their topic ideas in sequence. They also knew how to use related transition signals in the right category, 'to list ideas' (82 uses) which in fact was the second most used type of transition signal in this study. In the meantime, the signals in this category mostly used are firstly (11), secondly (9) and lastly (7). Some examples of other signals used by students are 'next', 'then', 'the first', 'thirdly' and 'finally'.

**Conclusion and Implications**

The findings of the study answered the questions on how students applied coherence devices in their writing and what errors occurred when they applied them. The results of the study showed that most of the students used all the four coherence techniques in their writing stated by Oshima & Hogue 2006. Overall, students were found to use transitional signals the most although some of them produced some errors using them. Meanwhile, for the use of repeating key nouns, a few students kept repeating the key nouns without using any substitutes or hardly used substitutes. It can be concluded that the more students repeated key nouns in their writings, the less they used substitutes. This behaviour might be explained as 'avoidance'. Due to Touchie (1986), "some syntactic structures are difficult to produce by some learners. Consequently, these learners avoid these structures and use instead simpler structures" (pp.78-79)

Another coherence device frequently used in the essays was the use of consistent pronouns. However, more than half of the students made significant errors when using pronouns to refer to things, persons, and actions as well as to address their readers. This can be clearly seen from the examples provided in the findings. This means using this device was rather problematic for Thai students and also complies with the study of Wilfitri and Fatimah (2020) as they found out that some students replaced key nouns with wrong pronoun and had the inconsistency in using the singular and plural form one noun. One possible cause of this type of error was the interference of their mother tongue (L1 interference) and slips as mentioned above.

In sum, these findings show that students in general knew how to use all four coherence devices to establish cohesiveness in their writings. However, the use of each device contains some errors particularly the use of consistent pronouns. This has led the researchers to realize the more emphasis on the use of cohesive devices especially the use of consistent pronouns. Another possibility for researchers is the further study on how to enhance students' competency regarding the use of pronouns in their writings.

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# In Vitro and in Silico Anti-inflammatory Activity of Phenolic Compounds Isolated from Dillenia indica L

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## Abstract

Four known compounds (**1**-**4**) were isolated from the fruit of *Dillenia indica* L., a medicinal plant belonging to the Dilleniaceae family. The structures were characterized by spectroscopic methods and direct comparison of their physical properties with those reported in the literature. There was three flavone, including kaempferide (**1**), dillenetin (**2**), and quercetin (**3**), together with gallic acid (**4**). Compounds **1**-**4** exhibited significant anti-inflammatory activity by preventing bovine serum albumin's denaturation with the $IC_{50}$ of 2.18, 5.07, 0.51, and 4.66 mM, respectively. Moreover, a molecular docking study of the most potent compound was performed to find the inhibitors' binding mode into the binding site of bovine serum albumin.

**Keywords**: Inflammation, Anti-denaturation, *Dillenia indica*, Molecular docking

## Introduction

Significant non-specific defense response to tissue injuries caused by a pathogen or wound is inflammation characterized by warmth, redness, pain, and swelling (Chen et al., 2017). Furthermore, protein denaturation that leads to antigen formation may cause inflammation. Also, multiple human illnesses are related to inflammation (Elisha, Dzoyem, McGaw, Botha, & Eloff, 2016). The non-steroidal anti-inflammatory medicines (NSAIDs) are the therapeutic drug generally used to manage inflammatory conditions that have possible side effects, including indigestion, stomach ulcers, allergic reaction, and reappearance of symptoms following discontinuation (Jackson & Hawkey, 2000). Several non-steroidal anti-inflammatory drugs such as diclofenac sodium prevent denaturation of bovine serum albumin (BSA) at pathological pH (Hasan, 2019). Thus, compounds capable of preventing protein denaturation could be of potential value in treating inflammatory.

*Dillenia indica* L. (Dilleniaceae) is a medicinal plant used in Southeast Asia, and it is called Ma-tad in Thai. The pulp from the fruit gives a sour taste and is used in Thai Mon cuisine in curries, jams, and jellies. The crude extract from leaves of *D. indica* was investigated for bioactive metabolites, and flavonoids were isolated and identified. Bioactive compounds from *D. indica* were found to possess xanthine oxidase inhibitory activity (Khammee, Rattanapittayapron, Rangjaroen, Jaratrungtawee, & Kuno, 2019). However, other activities, such as anti-denaturation activities, have not been reported. Therefore, the present study's main objective was to investigate the anti-inflammatory potential of *D. indica* by testing its *in vitro* and *in silico* anti-denaturation activities.

## Materials and Methods

### General Experimental Procedures

$^{1}$H NMR and $^{13}$C NMR spectra were recorded on a Bruker AVANCE III 500 NMR. High-resolution electrospray ionization-time of flight (HRESI-TOF) mass spectra were recorded on a Bruker MicroTOF mass spectrometer. UV spectra were recorded using a PerkinElmer VICTOR Nivo. IR spectra were obtained from a Bruker TENSOR II FTIR by using the attenuated total reflectance (ATR) technique. Column chromatography was performed on silica gel 60 (Merck Code No. 7734).

### Plant

Fruits of *D. indica* were collected from Nonthaburi province (13.906289, 100.483087), Thailand, in August 2019.

### Extraction and Isolation

The fresh fruits of *D. indica* (3.5 kg) were ground and soaked in acetone (3.5 L x 3). The acetone extract was evaporated to dryness to provide a crude extract. The 41.4 g of acetone extract was chromatographed on a quick silica gel column (10 x 4.6 cm, 150 g) eluted by a gradient of *n*-hexane-acetone (0─100%, stepwise) to provide ten fractions (D1 to D10). Fraction D3 (2.67 g) was further chromatographed on a silica gel column (4 x 63 cm) eluted with a gradient solvent from n-hexane-acetone (100:0) to 100% acetone to give seven fractions (D3.1 to D3.7). Fraction D3.4 was filtered and washed with cold hexane to give a yellow solid of **1** (1.05 g, kaempferide (**1**), 2.53 %). Fraction D4 (475.3 mg g) was separated by silica gel column chromatography (CC) (10% acetone-n-hexanes) to give subfraction D4.1–D7. Subfraction D4.4 (209.8 mg), after repeated silica gel CC (20% acetone-n-hexane) and recrystallization from $CH_2Cl_2$─MeOH (1:9), provided yellow needles of compound **2** (55.7 mg, dillenetin (**2**), 0.13%). Fraction 6 (2.13 g), after silica gel CC (15% acetone-n-hexane), yielded subfraction D6.1–D 6.9. Fraction D 6.5 (2.13 g) gave 3 (935.7 mg, quercetin (**3**), 2.66%) as yellow needles, after recrystallization (MeOH–$CH_2Cl_2$). Fraction D8 (935.4 mg) was purified by CC eluted with a gradient system of acetone – n-hexane and MeOH to give ten fractions, D8.1-D8.5. Fraction D8.4 (0.231 g) was purified by recrystallization with EtOH to give colorless crystals of **4** (85.4 mg, gallic acid (**4**), 0.2%).

Kaempferide (**1**): yellow solid; mp 226 - 228 °C [mp 224–226ºC (Nguyen, Shi, Luan, & Wang, 2015)]; $R_f$ 0.5(40% acetone - hexane); $\lambda_{max}^{MeOH}$ nm (log $\varepsilon$ ) : 247 (3.02), 260 (3.00), 298 (2.99), 362 (2.93), 395 (2.91); ATR-FTIR cm$^{-1}$: 3463 (OH), 1651(conjugated C=O), 1614 (aromatic C=C), 1293 (C-O); $^{1}$H )400 MHz, acetone-$d_6$ ($\delta$ 12.04 (1H, s, 5-OH, H-5), 8.22 (1H, d, *J* = 8 Hz, H-6′), 8.22 (1H, d, *J* = 8 Hz, H-2′), 7.11 (1H, d, *J* = 8 Hz, H-3′), 7.11 (1H, d, *J* = 8 Hz, H-5′), 6.54 (1H, d, *J* = 1.6 Hz, H-8), 6.27 (1H, d, *J* = 1.6 Hz, H-6), 3.90 (3H, s, 4′-$OCH_3$); $^{13}$C NMR )125 MHz, acetone-$d_6$ ($\delta$ 177.5 (C-4), 165.0 (C-7), 162.1 (C-5), 157.9 (C-4′), 151.6 (C-8a), 146,6 (C-2), 136.9 (C-3), 130.3 (C-2′), 130.3 (C-6′), 124.4 (C-1′), 114.9 (C-3′), 114.9 (C-5′), 104.2 (C-4a), 99.1 (C-6), 94.0 (C-8), 55.8 (4′-$OCH_3$); HR-ESI-TOFMS: (+ve): m/z 301.0712 (calcd. for $C_{16}H_{12}O_6$+H: 301.0706).

Dillenetin (**2**): yellow needles; mp 292 - 294 °C [mp 291-292°C (Le Mai DeSilva & Bahorun, 2009)]; $R_f$ 0.42 (30% acetone - hexane); $\lambda_{max}^{MeOH}$ nm (log $\varepsilon$) : 249 (3.12), 299 (3.11), 359 (3.06), 393 (3.06); ATR-FTIR $cm^{-1}$: 3430 (OH), 1649 (conjugated C=O), 1251 (C-O); $^1$H NMR )400 MHz, DMSO-$d_6$( $\delta$ 12.42 (1H, s, 5-OH, H-5), 7.79 (1H, dd, *J* = 6.8, 1.2 Hz, H-6′), 7.74 (1H, s, H-2′), 7.13 (1H, d, *J* = 6.8 Hz, H-5′), 6.49 (1H, d, *J* = 1.2 Hz, H-8), 6.19 (1H, d, *J* = 1.2 Hz, H-6), 3.84 (3H, s, 3′-$OCH_3$), 3.84 (3H, s, 4′-$OCH_3$); $^{13}$C NMR )125 MHz, DMSO-$d_6$( $\delta$ 175.9 (C-4), 164.0 (C-7), 160.7 (C-5), 156.2 (C-8a), 148.3 (C-3′), 146.1 (C-2), 146.1 (C-4′), 136.2 (C-3), 123.3 (C-1′), 121.4 (C-6′), 111.5 (C-5′), 110.8 (C-2′), 103.0 (C-4a), 98.2 (C-6), 93.6 (C-8), 55.6 (4′-$OCH_3$), 55.6 (3′-$OCH_3$); HR-ESI-TOFMS: (+ve): m/z 331.0812 (calcd. for $C_{17}H_{14}O_7$+H: 331.0812).

Quercetin (**3**): yellow needles mp 310 - 312 °C [mp 313-314°C (Le Mai DeSilva & Bahorun, 2009)]; $R_f$ 0.25 (40% acetone - hexane); $\lambda_{max}^{MeOH}$ nm (log $\varepsilon$): 247 (3.08), 260 (3.08), 297 (3.07), 359 (3.03), 394 (3.02); ATR-FTIR $cm^{-1}$: 3381 (OH), 1660 (conjugated C=O), 1600 (aromatic C=C), 1194 (C-O); $^1$H (400 MHz, acetone-$d_6$( $\delta$ 12.16 (1H, s, 5-OH), 7.82 (1H, dd, *J* = 2 Hz, H-2′), 7.69 (1H, dd, *J* = 6.8, 2 Hz, H-6′), 7.00 (1H, d, *J* = 6.8 Hz, H-5′), 6.52 (1H, d, *J* = 0.8 Hz, H-8), 6.26 (1H, d, *J* = 0.8 Hz, H-6); $^{13}$C-NMR (125 MHz, acetone-$d_6$( $\delta$ 176.6 (C-4), 167.6 (C-7), 165.0 (C-5), 157.8 (C-8a), 146.9 (C-2), 146.9 (C-4′), 145.8 (C-3′), 136.8 (C-3), 121.52 (C-6′), 121.5 (C-1′), 116.2 (C-5′), 115.7 (C-2′), 104.1 (C-4a), 99.2 (C-6), 94.5 (C-8); HR-ESI-TOFMS: (+ve): m/z 303.0503 (calcd. for $C_{15}H_{10}O_7$+H: 303.0499).

Gallic acid (**4**): White solid; mp 246-248°C [mp 248-250ºC (Fernandes & Salgado, 2016)]; C $R_f$ 0.43 (10% ($CH_2Cl_2$- MeOH); ATR-FTIR $cm^{-1}$: 3351(OH), 1688 (conjugated C=O); $^1$H-NMR (400 MHz, DMSO-$d_6$( : $\delta$ 9.15 (1H, s, -COOH), 6.90 (2H, s, H-2,6), 3.33 (3H, br s, 3, 4, 5-OH); HR-ESI-TOFMS: (-ve): m/z 169.0169 (calcd. for $C_7H_6O_5$ -H: 169.0142).

**Inhibition of BSA Denaturation**

The anti-inflammatory activity of the isolated compounds was determined using thef Elisha and co-workers method (Elisha et al., 2016) with minor modifications. All tested compounds were dissolved in DMSO to obtain stock solutions (2000 μg/mL). The reaction mixture consisted of the 100 μL tested compounds (final concentration 1.25–1000 μg/mL) and 100 μL of 5 % aqueous bovine serum albumin (BSA); pH was adjusted by adding a glacial acetic acid. The samples were incubated at 37 °C for 20 min and then heated to 70 °C for 10 min. The mixture was allowed to cool for 10 min, after which turbidity was measured at 416 nm by PerkinElmer VICTOR Nivo™ Multimode Plate Reader. The blank contained the sample and distilled water. Distilled water was used as a negative control. The positive control was diclofenac sodium (final concentration of 1.25–500 μg/mL). The percentage of inhibition was calculated using the following formula:

$$\text{The percentage of inhibition (\%)} = 100 \times \frac{(\text{Abs}_{\text{Sample}} - \text{Abs}_{\text{Blank}})}{\text{Abs}_{\text{control}}} - 1$$

Whereas: Abs is the absorbance. The $IC_{50}$ was calculated from a graph of inhibition against the different concentrations. The experiment was carried out in triplicate.

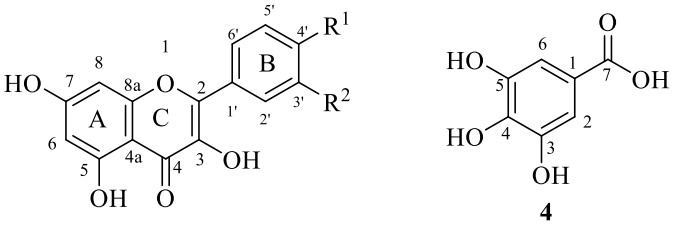
**Molecular Docking Simulation**

The three-dimensional coordinates of BSA were obtained from the Protein Data Bank (PDB IDs: 4JK4). The 4JK4 represents the X-ray crystal structure of bovine serum albumin co-crystallized with 3,5-diiodosalicylic acid (Sekula, Zielinski, & Bujacz, 2013). Molecular docking was performed with the AutoDock 4.2 software. Ligands were constructed using ChemSketch and developed using HF/321G by Gaussian 03 molecular software package. Docking was carried out based on a standard protocol using the Lamarckian Genetic Algorithm (Morris et al., 2009). The one hundred independent docking runs were performed for each ligand. Further, the interaction of the ligand with protein models was evaluated using the Discovery Studio.

## Results and Discussion

### Chemical constituents

Phytochemical investigation of the constituents from acetone extract of the fruits of *D. indica* resulted in the isolation of kaempferide (**1**), dillenetin (**2**), quercetin (**3**), and gallic acid (**4**). Compounds **1**–**4** were characterized by analyses of the UV, IR, Mass, $^{1}$H-NMR, $^{13}$C-NMR, HMQC, and HMBC spectra and comparison of the data with those previously reported in the literature (Nguyen, Shi, Luan, & Wang, 2015, Le Mai DeSilva & Bahorun, 2009, Fernandes & Salgado, 2016). Their structures are shown in Figure 1.




**4**

**1**: $R^1 = OCH_3$, $R^2 = H$
**2**: $R^1$, $R^2 = OCH_3$
**3**: $R^1$, $R^2 = OH$

Figure 1 Chemical structures of compounds **1**–**4**.

### In vitro denaturation of BSA

As shown in Table 1, The inhibition of BSA protein denaturation of **1**-**4** was evaluated. Compound **3** showed maximum inhibition in BSA denaturation with an $IC_{50}$ value of 0.51 uM ($IC_{50}$ value of Diclofenac sodium is 1.9 uM). Kaempferide (**1**) and dillenetin (**2**) demonstrated inhibition activity at 2.18 and 5.07 uM, respectively. In the case of gallic acid (**4**), prevention in protein denaturation with an $IC_{50}$ value of 4.66 uM was shown. This study's result is consistent with several studies that show the interaction with polyphenolic compounds improved the thermal stability of proteins(Moualek, Iratni Aiche, Mestar Guechaoui, Lahcene, & Houali, 2016). Therefore, from the observations of Table 1, compound **3** was selected based on inhibition of BSA protein denaturation activity of the compounds for further molecular docking study.

Table 1 Anti-BSA denaturation of compounds isolated from D. indica

| **Compounds** | **$IC_{50}$ (uM)** |
|---|---|
| kaempferide (**1**) | 2.18 |
| dillenetin (**2**) | 5.07 |

| | |
|---|---|
| quercetin (**3**) | 0.51 |
| gallic acid (**4**) | 4.66 |
| Sodium diclofenac (standard drug) | 1.90 |

**In silico molecular docking analysis**

Quercetin (**3**), the highest active compound in isolated compounds from biological activities, was selected to analyze the crucial interactions in the BSA binding site. The value of the total interaction energies of compound **3** is -8.58 kcal/mol. Our molecular docking studies revealed that compound **3** formed eight hydrogen bond interaction between hydroxyl groups of the ligand with LEU197, ARG198, SER201, SER453, ASN457, LEU480, VAL481, and ARG484. Besides, the five C–H···O interaction between quercetin (**3**) and ALA209, LEU210, SER343, LEU346, and LEU456 residues were observed. Moreover, two hydrophobic interactions between a ligand's carbon atoms with the carbon atom of TRP213 and ARG483 residues were found. Based on the activities and docking studies, compounds **3** were identified as promising anti-inflammatory lead molecules. The docking analysis results were described in Tables 2, and the docking figure was shown in Figure 2.

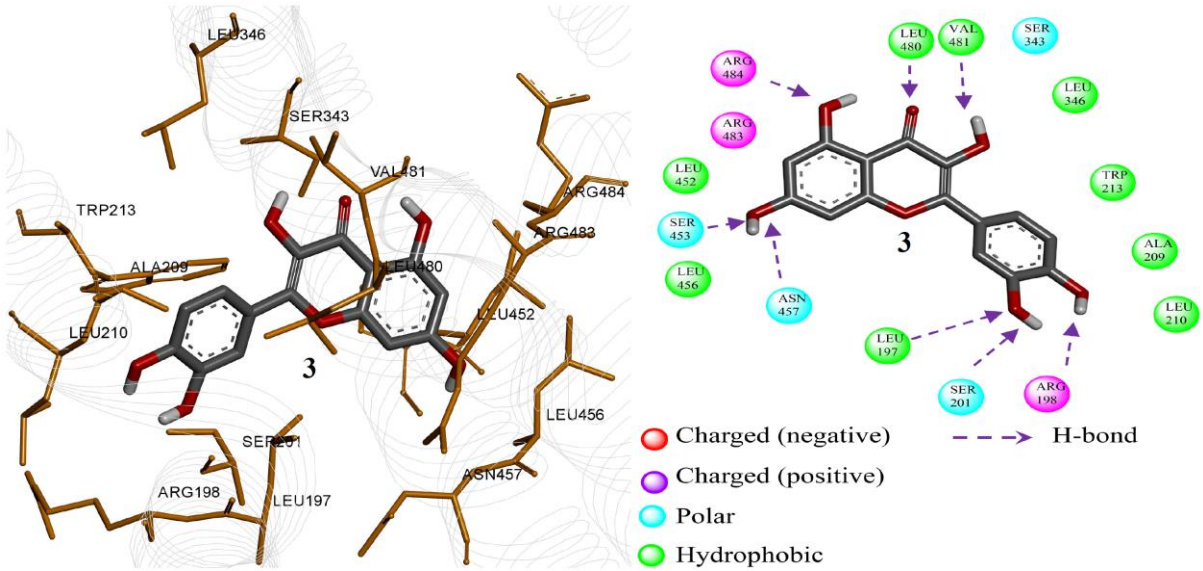



Figure 2 The 3D interaction poses of quercetin (**3**) in the binding pocket of 4JK4

Table 2 Molecular docking experiments: binding of interactions of the quercetin (**3**) with BSA (4JK4)

| **BSA Residual** | **Type of interaction (Amino-ligand)** | **Distance (Å)** |
|---|---|---|
| LEU197 | H-bond | 3.433 |
| ARG198 | H-bond | 3.154 |
| SER201 | H-bond | 2.938 |

| | | |
|---|---|---|
| ALA209 | O···H-C | 3.442 |
| LEU210 | C···H-O | 3.115 |
| TRP213 | C···C | 3.143 |
| SER343 | C-H···O | 3.524 |
| LEU346 | C-H···O | 3.564 |
| SER453 | H-bond | 2.813 |
| LEU456 | C-H···O | 2.897 |
| ASN457 | H-bond | 3.556 |
| LEU480 | H-bond | 3.989 |
| VAL481 | H-bond | 2.933 |
| ARG483 | C···C | 2.952 |
| ARG484 | H-bond | 3.294 |

## CONCLUSION

In this study, we isolated four bioactive compounds, namely, kaempferide (**1**), dillenetin (**2**), quercetin (**3**), and gallic acid (4), from the fruit of *D. indica*. These compounds were evaluated for their BSA denaturation activity. *In vitro* studies have demonstrated that quercetin (**3**) possesses the highest activity with an $IC_{50}$ value of 0.51 mM, three-fold higher than Sodium diclofenac (standard drug, $IC_{50}$ = 1.90 mM). Molecular docking simulation results showed that quercetin (**3**) created efficient interactions with amino acid residues surrounding the BSA binding site. The preliminary result obtained from this study will lead to discovering a new therapeutic agent for the treatment of inflammatory.

## Acknowledgments

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# Drying Kinetics and Quality of Pumpkin Slices Undergoing Different Drying Methods

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## Abstract

The purpose of this study was to make a comparison drying between low-pressure superheated LPSS), vacuum and hot air drying methods for pumpkin slices. The experiments were conducted to examine the drying kinetics and quality of dried products viz. color, shrinkage, rehydration, microstructure, texture (hardness and crispness) and the specific energy consumption (SEC) of the process. Results showed hot air drying would spend least drying time but it have high shrinkage and lowest rehydration when comparing with other method of drying. In aspect of hardness and crispness, LPSS drying would have lower hardness and higher crispness.

**Keywords:** Energy consumption, Low-pressure superheated steam drying, Pumpkin slice

## Introduction

Currently, pumpkin has been processed by various methods due to raise its value and extend its shelf life for a long time such as pumpkin powder manufacturing and pumpkin chip including dried pumpkin in order to take it as breakfast cooking or snack manufacturing. And drying was one of methods regarded as the popular one for a long time. In addition, there were various methods for drying as well which they had their different advantage and disadvantage within themselves. For example, hot air drying was the convenient and fast method and its drying equipments were quite cheap since it used less equipments and technology used by it was not so complicated. But this method also had many disadvantages especially in aspect of nutrient quality of its products after its drying which easily losing when facing the heat and oxygen. It was found that there were many research works identified that hot air drying would cause food getting more damage than other method. But it also had many advantages thus there were many research works, studies and development about pumpkin drying with hot air coming out continuously form past to present such as.

Therdthai and Krajangmathekul et al., (2011) studied the quality of dried pumpkin undergoing drying with hot air and hot air drying combination with microwave and microwave combination with vacuum. The results showed that microwave usage accompanying with hot air drying could reduce more drying time, lightness value, and yellowness value of dried pumpkin. In addition, it was found that hot air drying accompany with microwave at vacuum condition would cause pumpkin's color changing after drying getting least value.

Nawirska et al., (2009) studied pumpkin slices drying with hot air drying, vacuum drying and microwave drying accompanying with vacuum. From the experiment was found to vacuum microwave drying would spend

shorter drying time than hot air drying 10 times which all those drying methods could get better result than hot air drying.

Doymaz (2006) studied pumpkin thin layer drying kinetics with hot air. The results showed that drying ratio was slow when temperature was decreasing and relative humidity was increasing. Moisture ventilation from pumpkin slices could explain with diffusion and there was accuracy of prediction from mathematical model. It could be concluded that logarithmic model and Verma model explained satisfied pumpkin drying characteristic which most closed to experimental result.

Alibas (2006) studied pumpkin slices drying with 3 drying methods i.e. microwave drying, hot air drying and hot air drying accompanying with microwave. From the study was found to microwave drying accompanying with hot air was the best effected drying method by considering from drying time, color value and energy consumption.

Besides hot air drying, which had gained its popularity for a long time from past to present as early mentioned. But it was found that vacuum drying also had gained its popularity by using it for agricultural products since its advantage was usage low drying temperature and there was least oxygen quantity in drying processing. Thus, it could reduce qualities damage in term of color and nutrient which sensitized to heat and oxidation occurrence well. This drying was popularized by using it drying vegetable and fruit products which emphasized special their qualities. But vacuum drying had its disadvantage i.e. its equipment cost was quite expensive and high energy consumption as well. In the past, there were many research works studied on vacuum drying such as:

Junlakan(2014) study effect of drying kinetics on the quality of vacuum dried banana, pineapple and apple slices. It was found that it would spend shortest drying time period at the highest drying temperature. And in term of qualities was found to the dried fruit had given the highest yellowness value, low shrinkage, huge and numerous air hollow structure, high crispness value and high rehydration ability.

Arevalo-Pinedoet al., (2006) who study the drying kinetics of pumpkin (Cucurbita maxima) in nature and pre–treated by freezing and blanching was studied by using a vacuum dryer. It was observed that the applied pre–treatment influence favorably in the kinetic of drying, however freezing showed greater influence than blanching. It was observed that the best values were obtained for the highest temperature and lowest pressure for the samples pre–treated by freezing.

Wua,L. et al.,(2007) study the vacuum drying characteristics of eggplant were investigated. The results showed that increasing drying temperature accelerated the vacuum drying process, while drying chamber pressure did not show significant effect on the drying process within the temperature range investigated. Drying shrinkage of the samples was observed to be independent of drying temperature, but increased notably with an increase in drying chamber pressure.

And the limitation of vacuum drying was that it still had oxygen coming in drying chamber during its working processing. Thus, it would still cause the problem in term of quality damage from oxidation occurrence. But this problem could be solved by using steam feeding into its system replacing the oxygen which could help to reduce the said problem. And this drying method was low pressure superheated steam drying which would have very similarity to vacuum drying such as:

Elustondo et al.,(2001) studied low pressure superheated steam drying using natural materials and food group such as wood slab, shrimp, banana, apple, potato and cassava slices by considering only the drying kinetic by experimental and calculation of the equation by semi –empirical model. It was found that equation that could predict the drying of the sample group was good.

Pimpaporn et al.,(2007) studied effects of combined pretreatments on drying kinetics and qualityof potato chips undergoing low–pressure superheated steam drying. It was found that combined blanching and freezing pretreatment were the best methods in aspect of qualities i.e. beautiful color, lower hardness value,more crispness value and without toughness.

Recently, there were research study and working development on LPSS drying continuously. There were the different advantage and disadvantage of the said 3 drying methods. In any case, users would consider and select them for their purpose suitably. But there were researchers had studied and compared the 3 drying methods especially comparative studies on vacuum with LPSS drying

Devahastinet al.,(2007) studied compare of low–pressure superheated steam and vacuum drying of a heat–sensitive material on kinetics and quality in term volume, shrinkage apparent density, color, and rehydration behavior which using carrot was experiment material. It was found that the LPSS drying takes over for drying time than vacuum drying but in terms of quality LPSS find a better quality of shrinkage has shaped evenness over and there was higher rehydration rate.

Leeratanarak et al., (2006) studied drying kinetics and quality of potato chips undergoing LPSS drying and hot air drying which quality in term of color, texture, and brown pigment.On their experimental procedure,potato would be taken for blanching in hot water by spending different blanching time. These investigators found that the potato undergoing blanching would get faster dried than without blanching one. And also it was found that LPSS drying was getting slower drying than hot air drying. Its exception was hardness value would decrease when potato was undergoing blanching. But when comparing between LPSS drying and hot air drying, The results showed that there was no difference.

Methakhupet at., (2005) studied effects of drying methods and conditions on drying kinetics and quality of Indian gooseberry flake. They found that vacuum drying spent less time than LPSS drying at every experimental conditions. In term of vitamin C quantity preserving, it was found that the two drying methods had given similar result but total color difference of Indian gooseberry flake that drying with vacuum drying was of more value than LPSS drying.

Thomkapanich,(2005) studied of intermittent low – pressure superheated steam and vacuum drying of banana. Intermittent low pressure superheated steam drying would support Moisturereduction rate of sample. Intermittent vacuum drying would spend longer drying time than regular drying. In term of quality of both low pressure superheated steam drying and vacuum drying, The results showed that the color of product would get more change than regular drying. Especially on long vacuum pump closing time, it would cause product's color getting more changing.

However, no data research work which had been taken pumpkin for drying with LPSS drying and experimental comparative study with vacuum drying and hot air drying. Therefore, the objective of this research was to study LPSS drying with vacuum drying and hot air drying on drying kinetics, energy consumption and product quality (in terms of color, shrinkage, rehydration ratio, texture and micro structure).

## Experimental set–up, materials and methods

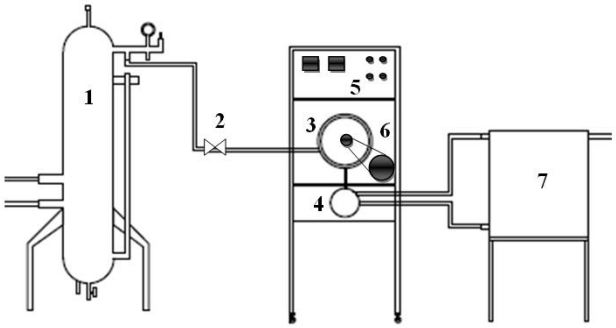



Figure1. Experimental apparatus of the low-pressure superheated steam drying system. 1: boiler; 2: steam value; 3: drying chamber; 4: vacuum pump; 5: control system; 6: electric fan; 7: water cooling tank.

**Experimental set–up**

Experimental apparatus of the drying system is illustrated in figure 1 show the details within drying chamber. The drying system was developed in the Department of Mechanical Engineering at Chiang Mai University Thailand. The system mainly consists of a cylindrical drying chamber dimensions of 30 cm in diameter and 40 cm long, made of stainless steel and insulated with elastomers; a 5 kW boiler, which could produce steam up to 8 kg/hr at slightly above atmospheric pressure; a water ring vacuum pump, whichwas creating vacuum pressure in the drying chamber; an 1.5 kW electric heater, which was used to supply thermal steam. An 0.2 kW electric fan was used to disperse the steam throughout the drying chamber. The change of sample mass during drying was recorded using a load cell (Transtronic, capacity 5 kg, China) with an accuracy of ± 0.2 g. The sample holder was hung in the drying chamber by a wire attached to the load cell. Water cooling tank made of polyethylene and capacity 100 liter was used reduce cooling water temperature of water ring vacuum pump to maintain vacuum pressure in the system. The temperatures within the chamber were measured by the type K thermocouplessending the signal to a PID controller. In case of vacuum drying and hot air drying experimental used the same LPSS drying experiment but do not used steam in the drying process.

**Materials**

Fresh pumpkin fruits (CV.TongAmpai) used in the drying experiments were provided from a provided from a local *market pumpkin in Chiang Rai, Thailand.* Samples were and sliced peeled and sliced to a thickness of 3 ± 0.3 mm using a knife. Then, pumpkin slices were cut into slabs with 30 mm length and 20 mm width. The initial moisture content of pumpkin was in the range of 700 – 900 % d.b., as determined by hot air oven at 103°C for 72 hr.

**Methods**

In all experimental method used a single experimental apparatus for all and perform a LPSS drying and vacuum drying experimental, the pumpkin slices prepared for each experiment, approximately 20 pieces, were placed in a thin layer on the sample holder. Steam valve was opened to allow the saturated steam from

a boiler to flow into the drying chamber. The drying experiments were conducted under sub – atmospheric pressure at the steam temperatures of 80, 90 and 100°C and chamber absolute pressures of 7 and 10 respectively. In part of hot air drying experimental used drying temperatures of 80, 90 and 100°C while the constant inlet air velocity of about 1 m/s. The all experiments were stopped when the pumpkin moisture content of 18% d.b. (Thai community product standard,2003) Before opening up the door of drying chamber and unloading the samples at the end of the drying process, the vacuum break – up valve was opened to allow the air into the chamber to regain atmospheric pressure. Moisture content of samples were measured and the dried products brought to test the quality in terms of color, shrinkage, rehydration ratio and texture (hardness and crispness)

**Drying kinetics of pumpkin**

The drying kinetics of pumpkin with initial moisture content of 700 – 900% d.b. The moisture ratio of pumpkin at any time was then calculated by:

$$\text{Moisture ratio (MR)} = \frac{M_t - M_{eq}}{M_i - M_{eq}} \qquad (1)$$

where MR is the moisture ratio; $M_t$ is the moisture content at any time (kg/kg.db.) ; $M_i$ is the initial moisture (kg/kg.db.); $M_{eq}$is the equilibrium moisture content (kg/kg.db.); k is the drying constant ($min^{-1}$); t is time (min); n is the degree of nonlinearity of the drying curve. In this work, the steam temperature above the normal boiling point was used, so that it might be reasonable to assume the moisture content at equilibrium to be zero

**Evaluation of specific energy consumption**

In this study, three kilowatt–hour meters were connect to vacuum pump, electric heater and electric fan to measure the energy consumption of each component. The energy efficiency of drying process was evaluated in term of specific energy consumption:

$$\text{SEC} = \frac{(E_{vacuum} + E_{heater} + E_{fan})}{m_{water}} \qquad (2)$$

where SEC is the specific energy consumption (kWh/kg $_{water}$), $E_{vacuum}$ is the measured electric energy consumption of vacuum pump (kWh),$E_{heater}$ is the measured electric energy consumption of heater (kWh), $E_{fan}$ is the measured electric energy consumption of fan (kWh) and $m_{water}$ is the amount of water evaporated form dried product (kg).

**Color measurement**

Color–measurement spectrophotometer (Hunter Association laboratory, Inc., model Mini Scan XE Plus, VA, USA) was used to determine the colors of fresh and dried samples in terms of the L, representing lightness from 0 (black) to 100 (white), a, representing redness(+)/greenness(–) and b, representing yellowness(+)/blueness(–) in Hunter Lab color system. For each during experiment the color measurements were performed on five samples at three different positions. The color changes of the samples were calculated by:

$$\Delta L = \frac{(L - L_o)}{L_o} \quad , \Delta a = \frac{(a - a_o)}{a_o} \quad , \Delta b = \frac{(b - b_o)}{b} \qquad (3)$$

where L, a, b represent the lightness, redness and yellowness of the dried samples, respectively, while $L_o$, $a_o$, $b_o$ represent the initial values of the lightness, redness and yellowness of the fresh sample, respectively

**Shrinkage measurement**

The shrinkage of dried pumpkin was measured and analyzed in terms of the percentage change of the volume of the sample, using the volumetric displacement method with vegetable oil as the working liquid. Ten samples were used for a shrinkage measurement for each experimental condition. Shrinkage of the dried pumpkin was expressed in terms of the following formula:

$$\%\ Shrinkage = \frac{V_o - V_f}{V_o} \times 100 \qquad (4)$$

where $V_o$ and $V_f$ are the initial and final volumes of a pumpkin sample, respectively. All tests were performed in duplicate and the average values were reported.

**Rehydration ability**

The rehydration ability of dried pumpkin slices was measured in terms of the mass ratio, evaluated by immersing a dried sample into hot water at 90°C for 10 minutes. The dried pumpkin were then taken out and wiped off with paper towel to eliminate excess water on its surface. The masses of the dried and rehydrated samples were measured by an electric balance with an accuracy of ±0.001 g. The rehydration ratio of the sample was then calculated by:

$$\text{Rehydration ratio} = \frac{m_{after}}{m} \qquad (5)$$

Where $m$ and $m_{after}$ are the masses of the dried and rehydrated samples, respectively. The average values of for sample were reported. All measurements were performed in duplicate.

**Texture analysis**

The texture measurements of the sample were carried out using a texture analyzer (Stable Micro System, TA.XT.Plus, UK). The sample was placed on a hollow planar base and the force was then applied to the sample. A 5 mm spherical probe was set to travel at a constant speed of 2 mm/s until the sample was cracked. The maximum force of break and initial slope of deformation were indicated as hardness and crispness of the sample respectively (Aguilera, Castro, &Cadoche, 2004).All tests were performed in duplicate and the average values were reported.

**Microstructure analysis**

The microstructure of sample was observed by a scanning electron microscope (LEO, Leo 1450 VP, UK) at 190x magnification. The samples were cut and coated with a gold layer using a sputter–coater and the cross–section of dried products was photographed.

## Results and discussion

**Drying kinetics of pumpkin slices undergoing different drying processes**

Fig. 2(a) and 2(b) shows the drying curves of pumpkin slices dried, it was found that LPSS drying spent less drying time than vacuum drying at all pressure and every temperature as well. Since the beginning of drying pumpkin in the boiling water evaporates away, the water moves out faster vacuum drying. But when we compared between LPSS drying and vacuum drying with hot air drying, it was found that hot air was faster drying than the two prior methods at every temperature. This was because hot air drying would use heat from air flow. It would cause simultaneous mass transfer and heat transfer on pumpkin's surface. And when air flow was increasing, it might cause more drying rate. Because of this, hot air drying caused more air speed than LPSS drying and vacuum drying. Due to this, it might definitely make hot air drying having the shortest drying time.

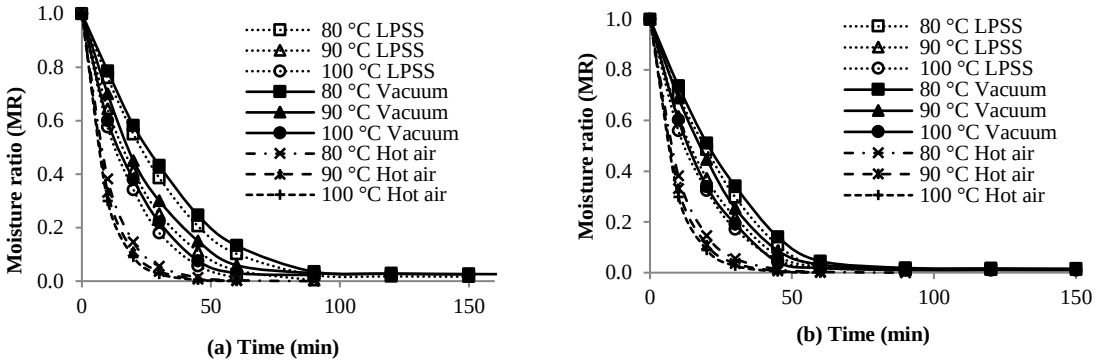



Figure 2. Comparison of drying curves of pumpkin slices undergoing low superheated steam drying and vacuum drying at (a) absolute pressures 7 kPa. (b) absolute pressures 10 kPa.

It can also be seen in Table 1 that lower of drying time were obtained when the absolute pressure of the dryer was decreased. This is because decreasing of an absolute pressure resulted in a lower boiling point of water. The decrease of a boiling point of water resulted in an increase of the driving force for the outward moisture diffusion process. Hence, escaping of water molecules from the drying product became easier and faster. (Methakhup, Chiewchan and Devahastin, 2005)

**Evaluation of specific energy consumption**

When comparing energy consumption of three drying methods as shown in the Table1. The results showed that LPSS drying would have less specific energy consumption than vacuum in the pressure period at 7 kPa and 10 kPa because it spent less drying time. And when comparing LPSS drying and vacuum drying with hot air, it was found that hot air had lower SEC value than the prior two methods. This was because it spent less drying time and one more important thing, hot air did not use vacuum pump which consumed very high energy about 85% of the total consumed energy. Due to this, it would cause hot air having lowest SEC value.

**Quality of color dried pumpkin slices.**

The changes of color parameters of pumpkin undergoing LPSS drying, vacuum drying and hot air drying are listed in Table 3. In case of the lightness value, LPSS drying would have less lightness than vacuum

drying in case which the pressure was increasing and it would obviously have more dark color since gelatinization was occurring in said pressure duration which caused pumpkin getting more dark color. But when comparing with hot air drying, it was found that it had more lightness value than the prior two methods since it spent less drying time because of it let hot air flowing through pumpkin surface which caused its surface getting dried so fast.

Table 1 Specific energy consumption of vacuum drying

| Method | Drying pressure (kPa) | Drying Temperature (°C ) | Drying time (min) | SEC (kWh/kg water) |
|---|---|---|---|---|
| LPSS | 7 | 80 | 70.0 | 111.36 |
| | | 90 | 63.0 | 100.22 |
| | | 100 | 55.0 | 87.49 |
| | 10 | 80 | 72.9 | 115.97 |
| | | 90 | 63.5 | 101.02 |
| | | 100 | 58.5 | 93.07 |
| Vacuum | 7 | 80 | 180 | 361.8 |
| | | 90 | 150 | 340.7 |
| | | 100 | 86 | 186.2 |
| | 10 | 80 | 112 | 222.4 |
| | | 90 | 68 | 147.6 |
| | | 100 | 60 | 134.8 |
| Hot air | | 80 | 37.0 | 28.78 |
| | | 90 | 26.0 | 26.00 |
| | | 100 | 24.0 | 24.75 |

In case of redness value, LPSS drying would have more redness changing occurrence than Vacuum. But when comparing with hot air, it was found that redness value was decreasing. These results were similar to those reported by Devahastin et al. (2007) who compared the color values of drying carrot undergoing LPSS drying and vacuum.

Table 2. Effects of drying temperature and pressure on the changes of lightness of dried pumpkin slices undergoing different drying methods.

| Method | Drying Pressure (kPa) | Drying Temperature (°C) | $\Delta L$ | $\Delta a$ | $\Delta b$ |
|---|---|---|---|---|---|
| LPSSD | 7 | 80 | $-0.160 \pm 0.014^{c}$ | $0.500 \pm 0.095^{g}$ | $-0.129 \pm 0.022^{ef}$ |
| | | 90 | $-0.212 \pm 0.022^{b}$ | $0.508 \pm 0.100^{g}$ | $-0.174 \pm 0.012^{d}$ |
| | | 100 | $-0.289 \pm 0.005^{a}$ | $0.523 \pm 0.093^{g}$ | $-0.300 \pm 0.019^{b}$ |

| | | | | | |
|---|---|---|---|---|---|
| | 10 | 80 | -0.077 ± 0.020$^{f}$ | 0.461 ± 0.156$^{g}$ | -0.100 ± 0.021$^{f}$ |
| | | 90 | -0.121 ± 0.054$^{de}$ | 0.364 ± 0.145$^{f}$ | -0.115 ± 0.066$^{ef}$ |
| | | 100 | -0.156 ± 0.042$^{c}$ | 0.193 ± 0.060$^{e}$ | -0.140 ± 0.067$^{de}$ |
| Vacuum | 7 | 80 | -0.128 ± 0.024$^{f}$ | -0.247 ± 0.051$^{b}$ | -0.247 ± 0.015$^{c}$ |
| | | 90 | -0.164 ± 0.044$^{c}$ | -0.138 ± 0.094$^{c}$ | -0.267 ± 0.066$^{c}$ |
| | | 100 | -0.165 ± 0.042$^{c}$ | -0.130 ± 0.068$^{c}$ | -0.305 ± 0.047$^{b}$ |
| | 10 | 80 | -0.147 ± 0.017$^{cd}$ | 0.097 ± 0.013$^{d}$ | -0.142 ± 0.026$^{de}$ |
| | | 90 | -0.206 ± 0.054$^{b}$ | 0.033 ± 0.004$^{d}$ | -0.164 ± 0.028$^{d}$ |
| | | 100 | -0.148 ± 0.037$^{cd}$ | 0.031 ± 0.010$^{d}$ | -0.139 ± 0.030$^{de}$ |
| Hot air | atm | 80 | -0.102 ± 0.033$^{ef}$ | -0.327 ± 0.074$^{b}$ | -0.111 ±0.039$^{ef}$ |
| | | 90 | -0.080 ± 0.051$^{f}$ | -0.410 ± 0.066$^{a}$ | -0.109 ±0.050$^{ef}$ |
| | | 100 | -0.089 ± 0.028$^{f}$ | -0.436 ± 0.028$^{a}$ | -0.376 ± 0.031$^{a}$ |

Values in the same column with different superscripts mean that the values are significantly different ($p < 0.05$).

It was also found that LPSS drying gave redder and lighter those obtained by vacuum drying but when compare versus hot air found that the redness was reduced. These results were similar to those reported by Leeratanarak et al. (2006) who studied drying kinetics and quality of potato chips undergoing LPSS drying and hot air drying compares the color values which also found that LPSS drying led to smaller increase of a value than hot air drying. In case of yellowness value, it was found that LPSS drying, vacuum drying and hot air drying have nearly same values which were not quite different.

**Shrinkage dried pumpkin slices**

Form Table 3. comparing was pumpkin's shrinkage drying with LPSS drying and vacuum drying, it was found that pumpkin drying with LPSS drying was of less shrinkage at every temperature and pressure period used in drying. These results were similar to those reported by Devahastin et al. (2007) who compared the shrinkage values of drying carrot undergoing LPSS drying and vacuum drying. It was also found that both method smaller difference. This was because LPSS drying would cause water inside pumpkin's flesh boiling in the drying moment at boiling point temperature of that pressure. Due to this, it would affect too many porous occurrences and there was very regular distribution. So it was able to reduce better shrinkage than Vacuum drying which there was no the said boiling manner which can see in figure 3(a) and (b) compare figure 3(c) and (d). But considering among LPSS drying, vacuum drying and hot air drying, it was found that the temperature period 80°C and 90°C Hot air drying was of the very shrinkage. This was because hot air drying would cause more subsidence of inner structure of pumpkin's flesh at the low temperature which the view from the figure 3 (a), figure 3 (c) and 3 (e) it shown SEM photographs to see that the pumpkin slice using hot air drying would have collapsed and packed with a homogeneous than the other method.

**Rehydration ratio**

Form Table 3. when comparing between LPSS drying and vacuum drying, it was found that LPSS drying would have higher rehydration ratio at particular low pressure period i.e. 7 kPa and 10 kPa at the same temperature. These results were similar to those reported by Devahastin et al. (2007) who compared the rehydration values of drying carrot undergoing LPSS drying and vacuum drying.

Table 3. Effects of drying temperature and pressure on shrinkage, rehydration ratio, hardness and crispness of dried pumpkin slices.

| Mothod | Drying pressure (kPa) | Drying temperature (°C) | Volume shrinkage (%) | Rehydration ratio | Hardness (N) | Crispness (N/mm) |
|---|---|---|---|---|---|---|
| LPSSD | 7 | 80 | 90.18 ± 0.98$^{def}$ | 3.66±0.04$^{ef}$ | 14.42 ± 1.56$^{ab}$ | 7.43 ± 0.88$^{a}$ |
| | | 90 | 86.95 ± 1.54$^{ab}$ | 3.70±0.45$^{ef}$ | 14.96 ± 1.77$^{ab}$ | 9.01 ± 0.97$^{a}$ |
| | | 100 | 86.92 ± 1.78$^{cde}$ | 3.86±0.10$^{f}$ | 11.73 ± 1.68$^{a}$ | 11.77 ± 1.34$^{ab}$ |
| | 10 | 80 | 90.48 ± 1.85$^{cdef}$ | 3.33±0.15$^{ab}$ | 27.51 ± 0.61$^{e}$ | 7.60 ± 0.55$^{a}$ |
| | | 90 | 89.37 ± 0.87$^{cd}$ | 3.38±0.10$^{abc}$ | 22.7 ± 1.76$^{d}$ | 8.69 ± 2.54$^{a}$ |
| | | 100 | 88.92 ± 1.23$^{cd}$ | 3.85±0.30$^{f}$ | 20.77 ± 0.69$^{d}$ | 11.15 ± 1.21$^{ab}$ |
| Vacuum | 7 | 80 | 89.60±1.16$^{cde}$ | 3.30±0.24$^{a}$ | 16.52 ± 0.13$^{bc}$ | 7.20 ± 0.99$^{a}$ |
| | | 90 | 89.62±1.34$^{cde}$ | 3.55±0.05$^{bcde}$ | 15.26 ± 1.68$^{bc}$ | 8.11 ± 0.99$^{a}$ |
| | | 100 | 85.88±0.39$^{a}$ | 3.56±0.09$^{cde}$ | 12.02 ± 3.06$^{a}$ | 11.12 ± 0.45$^{ab}$ |
| | 10 | 80 | 91.27±0.74$^{ef}$ | 3.26±0.06$^{a}$ | 28.10 ± 2.72$^{e}$ | 7.22 ± 0.64$^{a}$ |
| | | 90 | 88.52±0.97$^{bc}$ | 3.36±0.12$^{abc}$ | 25.36 ± 2.32$^{e}$ | 8.11 ± 2.65$^{a}$ |
| | | 100 | 89.92±0.63$^{cde}$ | 3.60±0.05$^{de}$ | 21.15 ± 1.79$^{d}$ | 10.14 ± 0.49$^{ab}$ |
| Hot air | atm | 80 | 92.48±1.10$^{f}$ | 3.73±0.06$^{ef}$ | 31.31 ± 1.62$^{f}$ | 4.85 ± 2.68$^{ab}$ |
| | | 90 | 92.34±1.02$^{f}$ | 3.67±0.02$^{ef}$ | 20.50 ± 1.13$^{d}$ | 8.88 ± 2.89$^{c}$ |
| | | 100 | 90.15±1.96$^{cdef}$ | 3.40±0.01$^{abcd}$ | 18.07 ± 1.70$^{cd}$ | 8.91 ± 4.23$^{bc}$ |

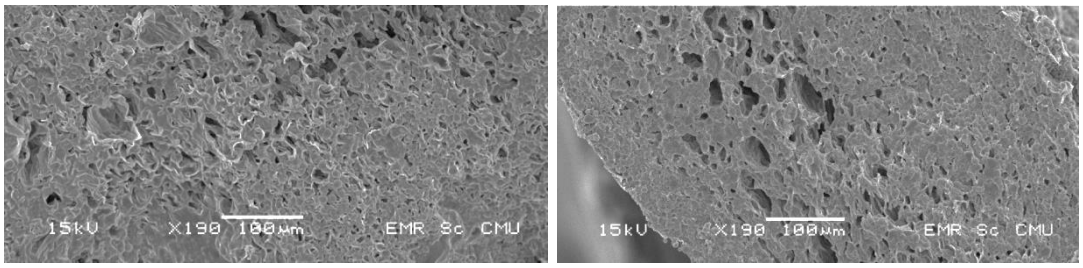
Values in the same column with different superscripts mean that the values are significantly different ($p < 0.05$).

It was also found that LPSS drying had much better rehydration capability than that vacuum drying. Because of pumpkin drying using LPSS drying will pore over night can suck the water back over the vacuum drying which pumpkin flesh is holding tight layer was spread throughout the pumpkin. Since the pumpkin which dried with LPSS drying would cause more pore. It would be able to reabsorb more water than vacuum drying.

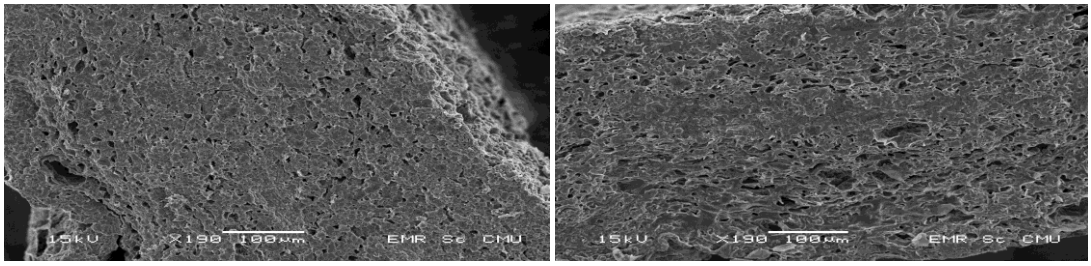
And the inside of pumpkin's flesh would have layered solid aggregation spreading in pumpkin's flesh. It could be seen from the picture SEM images figure 3 (a), (b) and figure 3(c), (d) When comparing with pumpkin's flesh drying with vacuum drying, there was more air hollow manner within its inner structure. It was able to reabsorb water more than low pressure period. But when comparing among 3 methods, it was found that pumpkin's flesh drying with hot air would have lowest rehydration since there was more air flowing through it at the pumpkin's surface. It would cause its surface getting dried so fast and cause hard layer obstructing water reabsorption.

**Hardness and Crispness**

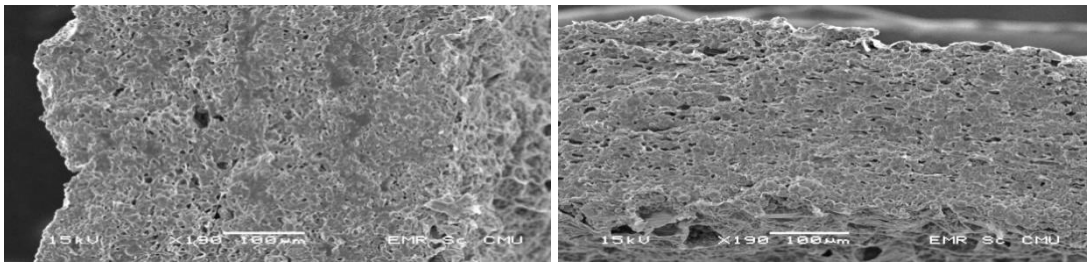
Form the table 3.when comparing LPSS drying, vacuum drying and hot air drying, it was found that LPSS drying would have less hardness value and more crispness all pressure and every temperature period. These results were similar to those reported by Thomkapanich et al. (2006) who studied of intermittent low–pressure superheated steam and vacuum drying of banana. This is because the flesh pumpkin has a total of more porous and evenly distributed. Due to the water in pumpkin boiling to vaporize at low temperatures which there is increasing pressure within the material, thus resulting in a large porous and the number pore over vacuum drying and hot air drying. This similar behavior has also been reported by other workers by Leeratanarak et al. (2006) who studied drying kinetics and quality of potato chips undergoing different drying techniques. It was found that hot air drying has hardness more than LPSS drying. Since there were more air hollows in pumpkin’s flesh and they spread themselves constantly




(a) (b)




(c) (d)




(e) (f)

Figure 3. SEM photographs showing cross section of dried pumpkin slices using hot drying underwent different conditions. (a) lpss drying 7 kPa,80°C; (b)lpss drying7 kPa, 100°C; (c) vacuum drying7 kPa, 80°C; (d) vacuum drying7 kPa, 100°C; (e) hot air drying80°C; (f) hot air drying 100°C.

. This was because it let water inside the product boiling and became steam at the low temperature and there was more pressure inside the product. Due to this, it would cause pore big size and more pore than vacuum drying and hot air drying.

## Conclusions

From the study or drying kinetics and quality of pumpkin slices undergoing from different drying methods, it was found that hot air drying would spend least drying time. But when comparing just only between LPSS drying and vacuum drying, it was found that LPSS drying spent less drying time than vacuum drying. In aspect of energy consumption, hot air drying would consume least energy when comparing with LPSS drying and vacuum drying due to it spent shortest drying time and there was no vacuum pump usage. But when comparing just only between LPSS drying and vacuum drying, it was found LPSS drying would spend more energy than vacuum drying.

Hot air drying would give the most lightness. Since it spent short time which let pumpkin slices touching with more heat and white starch granules were occurred on the surface. LPSS drying would have most changing in aspect of redness. In aspect of yellowness, it was found that drying method did not quite affect to its changing.

In aspect of shrinkage and rehydration, hot air drying would have high shrinkage and lowest rehydration when comparing with other type of drying especially at low temperature including high rehydration since its inside had high air hollow which let it have ability to reabsorb water well.

In aspect of hardness and crispness, hot air drying would have more hardness and least crispness. This was because the surface area of pumpkin would become hard layer which caused from hot air including there was less air hollow in pumpkin's inner flesh.

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