DEVELOPMENT
OF
GREEN MANGO PUFF

BY

SUCHARAHT PIKULTONG

ID 5413651

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A special project submitted to

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Title: Green Mango Puff

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(A.Nootrudee Siriboon)

Advisor

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Abstract

The aim of this project was to preserve 1913 Momchao Sippunparnsanoen Sonakul's mango pie formula in developing of current Thai green mango puff. In a focus group discussion, eight participants agreed with an idea in developing green mango puff from Thai mango variety that should have crispy crust and tender stuffing with high mango aroma and taste. Just-about-right test of green mango puff using Keao, Khieosawoei and Namdokmai mangoes prepared from Monchao Sippubparnsanoen Sonakul's formula showed that Kaeo mango puff needed adjusting on saltiness while the other two mango varieties puffs did not need. Adjusting Kaeo mango puff resulted in increasing salt from 0.5% to 0.6% in the formula. In a selecting of mango variety for green mango puff, Khieosawoei mango was picked as the most suitable mango variety for its high aroma and taste with the preference scores of 7.4 color, 7.3 appearance, 7.2 sweetness, 7.2 saltiness, 7.2 sourness, 7.3 greasiness, 7.3 crispness, 7.3 overall acceptance. Consumer acceptance survey of the prototype product resulted in 92% of consumers accepted the product with the price from 16 to 30 Bath. The consumers rated the prototype product at 6.7±1.1 out of 9-point scale of the preference score.
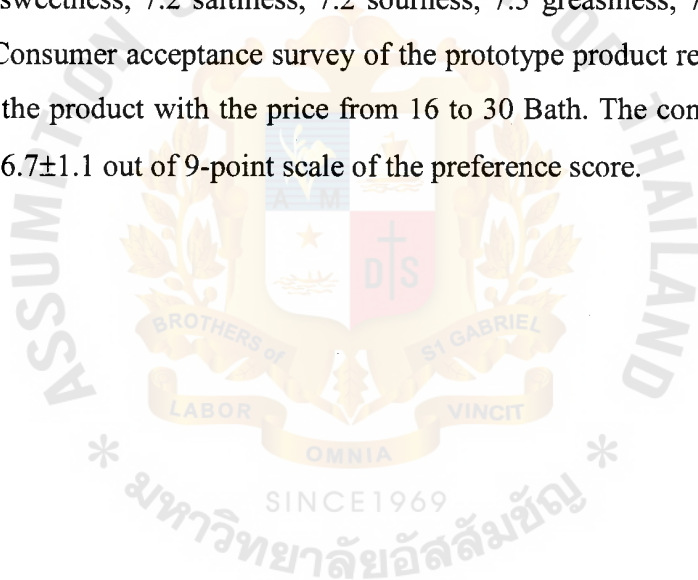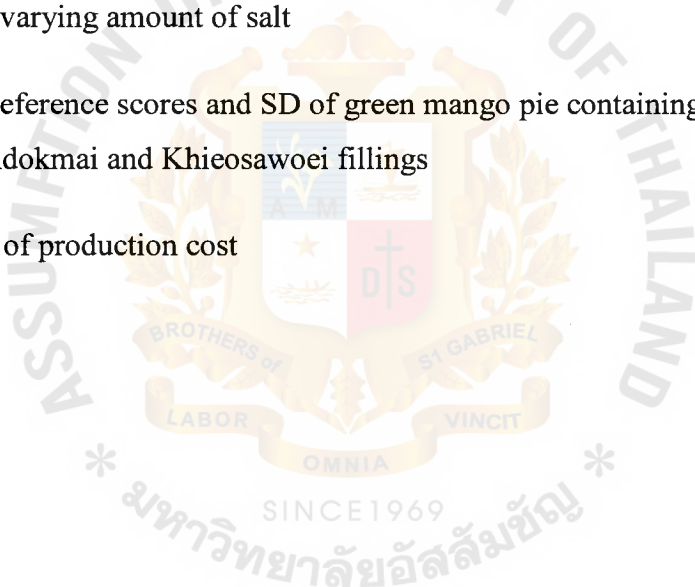
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Introduction

Mango, *Magifera indica* L., is a tropic fruiting tree from a cashew nut Family Anacardiaceae, originated in South Asia or Southeast Asia. It is an important fruit of the tropical area in many countries. Mango is classified as drupe. It bears a stone fruit with fibrous hair flesh (https://en.wikipedia.org/wiki/Mango 10/2/2016). Mango fruit is oval with red to yellow rind and slightly sour and juicy taste. There are about 50 varieties of mango grown in the tropical region from India to the Philippines. In Thailand, records of mango were dated back for hundred years. During King Rama the fifth era, Phraya Srisunthornvoharn (Noi Arayangkul) recorded in his book that there were more than 50 varieties of mango (https://www.gotoknow.org/posts/279892 10/2/2016) in Thailand.   Currently, there are 147 cultivar of mango, recorded in Thailand from more than 790 cultivar in the world (https://th-th.facebook.com/MamwngNanaPhanthu/posts/136714309828108 17/03/2016).

According to an internet survey YouGov® What the world thinks from 7 nations and more than 6,000 respondents in 2015, mango is number one popular fruit in Asia (14%), followed by durian (11%) and watermelon (10%) (https://ap.yougov.com/th/news/ 2015/07/01/ favourite-fruit-th/ 17/03/2016). The survey also indicated that taste and nutritive value were two main factors that the respondents chose mango.

As Thailand's economic crop, the country is ranked number three for mango exporting country in the world, following the Philippines and Mexico. Mango is classified according to their usage into three categories (https://tearm123.wordpress.com/ 17/03/2016).

1. Mango consumed in ripened stage e.g. Okrong, Namdokmai, Nangklangwan
2. Mango consumed in unripe stage e.g. Kwieosawoei, Raet, Nongsaeng, Phimsen
3. Mango for industrial use e.g. Kaeo, Sampi, Talapnak

Kaeo mango is popular mango in processing for export. This mango can grow well in dry condition and requires less caring, suitable to cultivate in Northeastern part of the country. It is used in mango in syrup and dried preserved mango for export and fermented mango for consumption in the country (https://tearm123.wordpress.com/ 17/03/2016).

Thais like to consume mango from different stages of its ripening process. For the mature unripe mangoes, people prefer the shape taste and crisp texture. Depending on variety,

Kwieosawoei, Phimsennum, Thongdam, Khiakhaika, or Phayasawoei is consumed at mature unripe while Saiphon, Suanthip, Phalun, Nomhsang and Haeo are small with less tart taste are also consumed unripe. However, these mangoes continue to ripe after harvesting in few days. The acid content in the fruit declines and eventually loses its tastefulness (https://tearm123. wordpress.com/ 17/03/2016).

In a book 'Tamra Aharn Farung Nga Nga' by Momchao Sippanparnsanoe Sonakul, printed in 1913 had described a recipe on a preparation of mango filling made from the unripe mango or green mango. This mango filling was aimed to use as pie filling in open top pie. Thus, the aim of this project is to introduce this old recipe to current consumers and modify it to develop today Thai green mango pie.

Objectives

1. To determine the variety of Thai mango, suitable for making green mango pie using the recipe from Momchao Sippanparnsanoe Sonakul
2. To formulate and optimize Thai green mango pie recipe
3. To determine consumer acceptance of the developed Thai green mango pie.

Literature Review

Cultivar of mango

As mentioned before there are hundreds of mango cultivar in the world. Wild mango cultivar Thailand includes these following species

1. *Mangifera caloneus* Kruz. is a wild mango in Rachburi province such as Thepparot, Khitai, etc.
2. *Mangifera camptosperma*, Pierre in Nakornrachsrima
3. *Mangifera duperreana*, Pierre var. Siamensis craib from Chiangmai such as Khiya
4. *Mangifera longipes*, griff from the west such as Kraseng
5. *Manifera syivatica*, roxb from the east such as Changyiap, Paep, Somwanklua

Commercial mangoes belong to *Mangifera indica* L. including Khiawsawoei mango, Okrong mango, Kaeo mango, Mahachanok mango, and Raet mango.

Thai commercial mango

1. Namdokmai mango or golden mango is a popular mango in Thailand. Namdokmai is mono embryonic variety, producing single gametic embryo. The mango bears fruit moderately. The fruit size is range from medium to large, approximately 400 gm in its weight. Fruit shape is rather round with big head and narrowing down at the tip. Fruit skin is thin and smooth. Unripe Namdokmai mango is green in color with thick flesh and very sour taste. Ripe mango is smooth juicy flesh with deliciously mild flavor. The seed is very small in comparison to its flesh. The mature fruit is covered with cuticle. As the fruit is ripe, the skin turns yellow and flesh is sweet (https://armadrenalineup.wordpress.com/2013/02/04/%E0%B8%9B%E0%B8%A3%E0%B8%B0%E0%B8%A7%E0%B8%B1%E0%B8%95%E0%B8%B4%E0%B8%A1%E0%B8%B0%E0%B8%A1%E0%B9%88%E0%B8%A7%E0%B8%87/ 10/3/2016).
2. Reat mango grows quicker than other mangoes. Unlike Namdokmai mango, Reat mango is polyembryonic variety that develops multiple embryos, except one from nucellar tissue. The mango tree has thick bush leaves, bears the medium size fruits. The fruit is round, large base and narrow tip. Fruit skin is not smooth like Namdokmai. Unique character of Reat mango has small protruded part on a dorsal side. Immature fruit is very

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sour after maturing the fruit has sweet and sour taste. Ripe fruit is yellow in skin and flesh with high fiber

(https://armadrenalineup.wordpress.com/2013/02/04/%E0%B8%9B%E0%B8%A3%E0% B8%B0%E0%B8%A7%E0%B8%B1%E0%B8%95%E0%B8%B4%E0%B8%A1%E0% B8%B0%E0%B8%A1%E0%B9%88%E0%B8%A7%E0%B8%87/ 10/3/2016).

3. Kwieosawoei mango is also polyembryonic variety. The mango tree contains thick bushes with deep green leaves. The fruit is consumed unripe and ripe. Fruit weighs approximately 350 grams. The skin is dark green with thick and bur with visible spots of lenticle. The mature mango develops white cuticle cover the skin. The flesh is white and crispy when unripe and turns yellow when ripe. The flesh of the unripe mango is starchy with slightly sour taste. After ripening, the flesh turns yellow with bland taste while the skin turns yellow in the head and green in the body. In addition, ripe mango develops specific aroma of Khiawsawoei cultivar

(https://armadrenalineup.wordpress.com/2013/02/04/%E0%B8%9B%E0%B8%A3%E0% B8%B0%E0%B8%A7%E0%B8%B1%E0%B8%95%E0%B8%B4%E0%B8%A1%E0% B8%B0%E0%B8%A1%E0%B9%88%E0%B8%A7%E0%B8%87/ 10/3/2016).

4. Kaeo mango is the most popular the people like to eat in Thailand, a short tree, wide canopy. Fruit has thick skin with green color that is covered with cuticle when is mature. Unripe fruit flesh is dense crisp texture with sweet aroma. Ripe fruit is sweeter. (http://www.thairath.co.th/content/387936 10/3/2016)

Processing of Green mango

Mango is consumed fresh or processed product. This fruit can be processed into variety of products. The range of mango products includes raw mango powder, raw mango slices, mango jam and jelly, mango juice, dehydrated mango, pickled mango, mango sheet, mango toffee, as part of breakfast cereal, fruit bars, and mango powder etc.

A. Raw mango processing

Raw mangoes are used as raw materials for raw mango powder, pickles, chutney, and etc. in different processing methods.

1. Dehydration

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The raw mangos are dried under the sun or in a cabinet dryer and powdered to use as a souring agent in Indian cuisine. The mango with 10 weeks maturity had high acid and starch and low sugar and phenolic compounds. This stage is found to be the most suitable stage of mango for preparing raw mango powder. SO_2 is sometime used to preserve the solar-dried in order to obtain a better flavor product than those obtained from the hot air drier.

2. Preservation of raw mango slices

   Raw mango slices are the basic materials used in pickling process. Unpeeled raw mango slices are dipped in 1.5% KMS solution and preserved in 20% salt. The preserved mango slices are packed in polyethylene pouch for 2 months. For 6 months storage, the mango slices are preserved in 12.5% brine solution with 200 ppm of sulfur dioxide.

3. Pickling

   Peeled or unpeeled raw mango slices are mixed with 10-20% salt to remove some moisture from the slices. The whole mixture is filled into a clean jar and covered with mustard oil. If the mango variety is not sour enough, it is added with a small amount of acetic acid.

4. Mango sauce or Chutney

   Mango sauce or chutney is a kind of spicy jam. Mango sauce contains 55°- 60°Brix TSS and 1.0-1.5% acidity. The spice extract is added to the boiling mixture of chutney. The hot chutney is filled into the clean jars and is sealed for longer storage.

5. Green mango beverage or Panna

   Green mango beverage is very popular mango product in northern India. For preparation of panna, the prescribed recipe contains mango slices, sugar, water, salt, cumin seed, black pepper, and citric acid. The mixture is boiled in water for 20-30 min and filtered and hot filled

Pies

Ancient Egyptian knew how to make pie for a long time. As early as Roman era, the first pies were made by Greeks in reeds to carry pie stuffing. Romans spread pies all over their empire. The first pie recipe was published by the Romans. Its crust called coffin. In 14th century, the word 'pie' was a popular word in Europe, according to Oxford English Dictionary. English was

credited for the first fruit pies or tarts or pasties in the 1500s, Queen Elizabeth I's cherry pie. Americans received pies from the British and, ever since, it has become the most traditional America dessert up till now.

Flour

Flour, a powder made from grinding or milling grains, nuts, roots or tubers, is main ingredient in many foods. Flour from cereal, especially wheat, is an important ingredient in all bakery products, especially bread. Flour proteins are responsible for creating structure in the bakery products. In bread, wheat proteins – gliadin and glutenin – combine to form protein network, called gluten. Gluten has a unique characteristic of elasticity that can be stretch and able to withstand pressure from gas produced by yeast during dough fermentation. Flour can be classified in many ways, generally by per cent protein and protein strength into bread flour, cake flour and all-purposed flour. Another classification is based on degree of extraction of the flour from the wheat grain into short extraction, medium extraction and long extraction. Puff pastry, one kind of bakery products, does not require flour that has high elasticity as bread. A suitable flour for puff pastry should have moderate strength such as all-purpose flour or mixture of bread flour and cake flour.

Salt

Salt is used for seasoning, preservative and flavor enhancer. Salt improves the balance of flavor in sweet baking goods and most recipes will include some. It is thought that the salt used in the starter is used to suppress yeast growth and provide an environment more conducive for the microbes to grow, enhancing the distinct flavors which predominate over the more typical yeast flavors. Salt is a natural antioxidant and not only adds taste but especially helps bring out the flavors and aromas present in the flour and other ingredients. Salt slows down fermentation and enzyme activity in dough. The salt crystals draw water away from their environment (salt is 'hygroscopic'). When salt and yeast compete for water, salt wins and the yeast is slowed down.

Sugar

Sugar is a common sweetener. It provides several function in bakery products from sweet taste, soften and tenderizing cake crumb. Without water, flour will not form dough. It contributes to color development on the crust. It absorbs water and maintains it in the baked products. The common sugar used in bakery product is sucrose or table sugar.

Butter

The butter that is the emulsified shortening are soft and quickly coated sugar and flour particles. It can holds large amount of liquid and sugar while produces smooth and fine texture and moisten.

Water

Intermediate hard water or tap water is suitable for bread making. Hydrate the flour protein and form gluten. It can control temperature of the dough. Cold water or ice is added during dough development, especially in a large scale production.

Egg

An egg that is the structure of protein contributes to structure of baked product like gluten. Egg is emulsifying fats and liquid from egg yolk is natural emulsifier that helps smoothen batter, contributing to volume and texture.

Momchao Subpunparsanern Sunakul (1894 – 1985)

Momchao Subpunparsanern Sunakul, a daughter of Phraongchao Sonabunthi Kramakhun Thipyalapphruthi and Mon Am Sonakul Na Audhaya, was a teacher in Rachinee School during 1935 to 1948 before World War II. There, she taught history, citizen roles, ethics, and Thai and, later, cooking. She had produced the first Tea Time dessert book to teach her students. In one of her books, Tamra arhar nga nga, Monchai Subpabparsanere had included one recipe for mango pie which was used in this research.

MATERIALS AND METHODS

Puff pastry dough formula and preparation (Source: FT4114 Bakery Technology Laboratory Manual)

Table 1   Pastry dough formula

Ingredient	Weight/volume	Percentage on flour weight base
Flour	500	100
Margarine	75	15
Egg	½	1/10
Salt	5	1
Cold water	250	50
Puffing margarine	300	60

Method

The process starts with dissolving salt in cold water and adds it to a mixture of flour rubbed margarine, kneads till the dough is formed. The dough is let stand for 15 minutes to allow water to be absorbed in the flour, then, it is rolled into a rectangular sheet of 1.5 centimeter thick on a flour dusted working bench. Puffin margarine is spotted on the surface of the sheet covering two-thirds of the area, leaving about 2.5 centimeter along the edge. The remaining sheet is, then, folded over the margarine and sealed the edge. Another fold is done to cover all margarine inside the sandwich dough. The dough is put in a refrigerator for 15 minutes to relax the dough and firm margarine. The relaxed dough is taken from the refrigerator and placed on the working bench. It is rolled lengthwise into a rectangular sheet again before the first three-fold is performed. The rolled folded dough is returned in the refrigerator and repeated to process again for the second three-fold. The final roll and fold is done with four fold. The pastry margarine is kept in a flour dusted plastic bag and stored in the refrigerator for further use. It is recommended to not store the dough for more than two days.

Before using the puff pastry dough, it is left so that the temperature reaches room temperature. Then, it is rolled into 60 cm × 45 cm ×¼ cm sheet, cut to a desired shape, filled

with pie stuffing, sealed and placed on a baking sheet. The prepared pie is let to stand from 15 minutes and, lastly, brushed the surface with an egg wash before baking at 200°C for 25 minutes.

<u>Green mango formula and preparation</u> (Source: Momchao Sippunparnsaneon Sonakul, 1942)

<u>Table 2</u>   Green mango pie formula (Momchao Sippunparnsaneon Sonakul, 1942)

Ingredient	Weight	Percentage
Green mango, chopped	200	38.00
Sugar	300	57.01
Salt	2.25	0.43
Butter	24	4.56

Method

The green mango blend is heated with sugar in a sauce pan to melt the sugar. Butter and salt is added to adjust the taste and develop glossiness. The mango paste is transferred into a clean container and let cool to room temperature before storing in a refrigerator for further use.

Experimentation

1. Focus group discussion

   Focus group discussion was carried out with eight participants who were the fourth year students, studying FT4113 (Food Product Development) in 2015. Seventeen questions (Appendix A.1) were asked to obtain information concerning type of pie and desirable pie characteristics, Thai mango on variety and preferable taste and, lastly, the mango pie.

2. Consumer survey on a development of green mango pie

   A consumer survey was conducted in Assumption University, Hua Mak campus with one hundred consumers. They were asked to answer a questionnaire concerning their eating behaviors on pie consumption and opinions for Thai green mango pie.

3. Formulation of green mango pie with varying mango variety

   Three varieties of Thai mango were selected in the experiment. These mangoes were common mango varieties in Chachoengsao province and Bangkok.

   a. Preparation of green mango pie from Kaeo mango

i. Just-about-right test

The green mango pie was tested in just-about-right test on five attributes – sweetness, saltiness, sourness, greasiness, and crispiness (Appendix A.2) using 30 untrained test panelists. Two batches of samples were prepared on separated days to create blocks.

ii. Adjusting the formula

The result from just-about-right test was used in adjusting the formula by varying the ingredient that received less than 50% of the just right level. At least two variations were determined in comparison with control (the non-adjusted formula). The samples were tested in a 9-point hedonic scale preference test using 30 untrained test panelists. Eight attributes included color, appearance, sweetness, saltiness, sourness, greasiness, crispness, and overall acceptance (Appendix A.3). Two batches of samples were prepared on separated days to create blocks.

b. Preparation of green mango pie from Namdokmai mango

i. Just-about-right test

The green mango pie was tested in just-about-right test on five attributes – sweetness, saltiness, sourness, greasiness, and crispiness (Appendix A.2) using 30 untrained test panelists. Two batches of samples were prepared on separated days to create blocks.

ii. Adjusting the formula

The result from just-about-right test was used in adjusting the formula by varying the ingredient that received less than 50% of the just right level. At least two variations were determined in comparison with control (the non-adjusted formula). The samples were tested in a 9-point hedonic scale preference test using 30 untrained test panelists. Eight attributes included color, appearance, sweetness, saltiness, sourness, greasiness, crispness, and overall acceptance (Appendix A.3). Two batches of samples were prepared on separated days to create blocks.

c. Preparation of green mango pie from Khieosawoei mango

i. Just-about-right test

The green mango pie was tested in just-about-right test on five attributes – sweetness, saltiness, sourness, greasiness, and crispiness (Appendix A.2) using 30 untrained test panelists. Two batches of samples were prepared on separated days to create blocks.

ii. Adjusting the formula

The result from just-about-right test was used in adjusting the formula by varying the ingredient that received less than 50% of the just right level. At least two variations were determined in comparison with control (the non-adjusted formula). The samples were tested in a 9-point hedonic scale preference test using 30 untrained test panelists. Eight attributes included color, appearance, sweetness, saltiness, sourness, greasiness, crispness, and overall acceptance (Appendix A.3). Two batches of samples were prepared on separated days to create blocks.

d. Selection of mango variety for green mango pie

The formula with highest preference score from (a), (b), and (c) containing three varieties of mango: A – Khieosawoei, B – Namdokmai, C - Kaeo Mango were used in determining the most suitable mango variety in a prototype formula. The samples were tested in 9-point hedonic scale preference test with 30 untrained test panelists. Eight attributes included color, appearance, sweetness, saltiness, sourness, greasiness, crispness, and overall acceptance (Appendix A.3). Two batches of samples were prepared on separated days to create blocks.

e. Consumer acceptance test

The prototype formula was tested in the consumer acceptance test using 100 consumers around Assumption University, Hua Mak campus.

f. Experimental design:

Randomized Completely Block Design was used in all experiments. Treatments were variety of mango or variation of the ingredients. Blocks were two preparation times.

g. Statistical analysis:

Word Excel program was used in analysis of variance at $p \leq 0.05$. Duncan's Multiple Range test to determine the significant treatment.

    h. Location:

        School of Biotechnology, Assumption University, Hua Mak campus

Experimental design

    Completely Randomized Block Design or RCBD was used where

- o Experimental units were untrained test panelist
- o Treatment was ingredients and variety of mango.
- o Block was production batch.

Budget

    Total 4,500 baht

        Raw Material = 1,500 baht

        Ingredient = 1,000 baht

        Plastic ware = 1,000 baht

        Office supply =1,000baht

Experimental schedule

1. Researching information (1 month)
2. Planning experiment (1 week)
3. Experimentation and collecting data (4 months)
4. Analysing data (1 month)
5. Writing report (2 months)
6. Presenting research results (1 week)

Table 3   Gant chart of experimental schedule

Task	Time									
	November 2014	December 2014	January 2015	February 2015	March 2015	June 2015	April 2016	May 2016	June 2016	July 2016
1. Researching information	▓									
2. Planning experiment		▓								
3. Experimentation and collection data			▓	▓	▓	▓				
4. Analysing data							▓	▓		
5. Writing report									▓	
6. Presenting result										▓

Result and Discussion

1. Focus group discussion on potential in making mango pie

Table 4   Focus group discussion results

Question	Results
1. Do you like to eat pie?	Yes, 8
2. What characteristics of pie do you want?	* One bite size (3/8) * Mac' crispy pie (2/8) * Crisp crust and tender inside (3/8)
3. What kind of pie do you like?	* Mac's pie (2/8) * Small tart size (2/8) * Puff pastry pie similar to S&P or 7/11 (4/8)
4. Do you like to eat fruit pie?	* Yes (6/8) * No (1/8) * N/A (1/8)
5. What kind of fruit pie do you like?	* Apple pie * Pineapple pie * Corn pie * Lemon pie * Palm toddy pie
6. What taste of the fruit pie do you like?	* Sweet and sour taste
7. Do you like to eat Thai fruit?	* Yes (8/8)
8. What kind of Thai fruit do you like?	* Ripe mango * Longan * Watermelon * Durian
9. Do you like to eat mango?	* Yes (8/8)
10. What taste of mango do you like?	- Ripe sweet (4/8)

	- Unripe sweet and sour (2/8) - Ripe sour but not sweet (2/8) มะม่วงมัน
11. Do you not different variety of Thai mango?	- Yes (8/8)
12. What variety of mango do you like?	- Namdokmai mango - Radt mango - Ok-rong mango
13. If mango is used in the product, what kind of mango do you like in the pie?	- Namdokmai mango - Ok-rong mango Because they said that these two varieties gave high aroma and flavor of mango.
14. What taste do you expect this product should have?	- Strong mango aroma - No too sweet nor too sour, mellow taste
15. What kind of pie do you think it should be?	- Puff pastry pie (5/8) - Tartlet (2/8) - Open pie (1/8)
16. Do you want to have meringue on top of mango pie?	No, they said that it would not go with the mango pie.
17. In the same pie what texture of pie do you like?	Crisp crust and tender inside

The focus group was carried with eight test panelists who were the fourth year students, taking FT4113 (Food Product Development) in the Department of Food Technology, School of Biotechnology, Assumption University, Hua Mak campus in 2015. From Table 1, all of the test panelists liked to eat pie. They said that the pie should have crisp crust and tender stuffing, and one bite size. In addition, they preferred puff pastry pie similar to S&P's pie. More than half of them liked fruit pie and preferred to eat apple pie, pineapple pie or corn pie. These fruit pies should have sweet and sour taste. Apart from liking the pie, they also liked to eat Thai fruits, especially mango, the sweet ripe one. They knew different varieties of Thai mango, Namdokmai, Radt and Okrong. For suggestion of mango to make green mango pie, Namdokmai and Okrong

mango were their choices for its high aroma and taste. They expected that the green mango pie should also have high mango aroma, not too sweet or too sour but rather mellow flavor. Type of pie for the mango pie should be puff pastry pie rather than tartlet or opened top pie without meringue and this pie should have crisp crust and tender stuffing.

2. Formulation of green mango pie

Three varieties of Thai mango were selected in the experiment. They were Keao, Namdokmai and Khieosawoei. These mangoes were common mango varieties found in Chachoengsao province and Bangkok. Though, the focus group discussion resulted in Namdokmai, Radt and Okrong mango. Radt mango was difficult to find in the market and Okrong is a seasonal fruit that can be found in the market only during the summer. On the other hand, Kaeo and Khieosawoei varieties were selected because they were easy to find in the market and not seasonal fruits that could be bought all year round.

i. Preparation of green mango pie from Kaeo mango

In the preliminary experiment, Kaeo mango was selected to prepare green mango pie. After preparing pie filling from raw Kaeo mango fresh using Momchao Sippunparnsanoen Sonakul's formula in Table 2, the mango filling was white, shape sour taste and crisp but with low mango aroma. Adding the pie filling in puff pastry and baked caused the Kaeo mango pie filling to change its appearance to slightly translucent yellow with glossy appearance. Heat caused sugar to caramelize and developed its color. Moreover, it is known that immature mango contains higher pectin than ripe mango. Pectin in raw Kaeo mango could introduce glossiness and translucent appearance to the pie filling. However, the taste was similar to pineapple filling with shape sour taste.

i. Just-about-right test

The green mango pie, made from Kaeo mango, was tested in just-about-right test on five attributes – sweetness, saltiness, sourness, and greasiness (Appendix A.2) using 30 untrained test panelists. Two batches of samples were prepared on separated days to create blocks. Results from JAR test on four attributes were shown in Figure 1 to 4
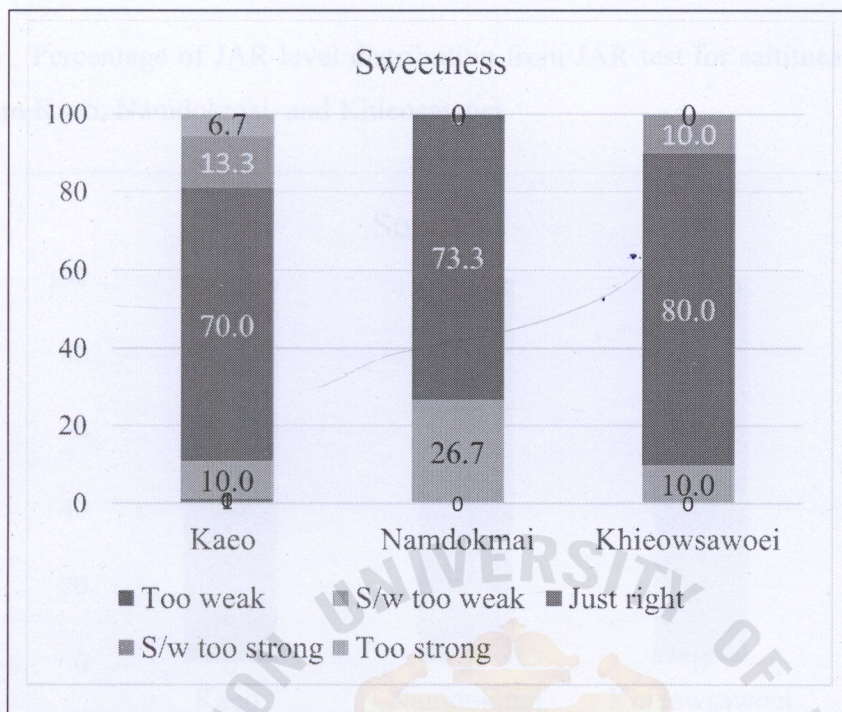
<u>Figure 1</u>   Percentage of JAR level distribution from JAR test for sweetness of green mango
pie made from Kaeo, Namdokmai, and Khieosawoei
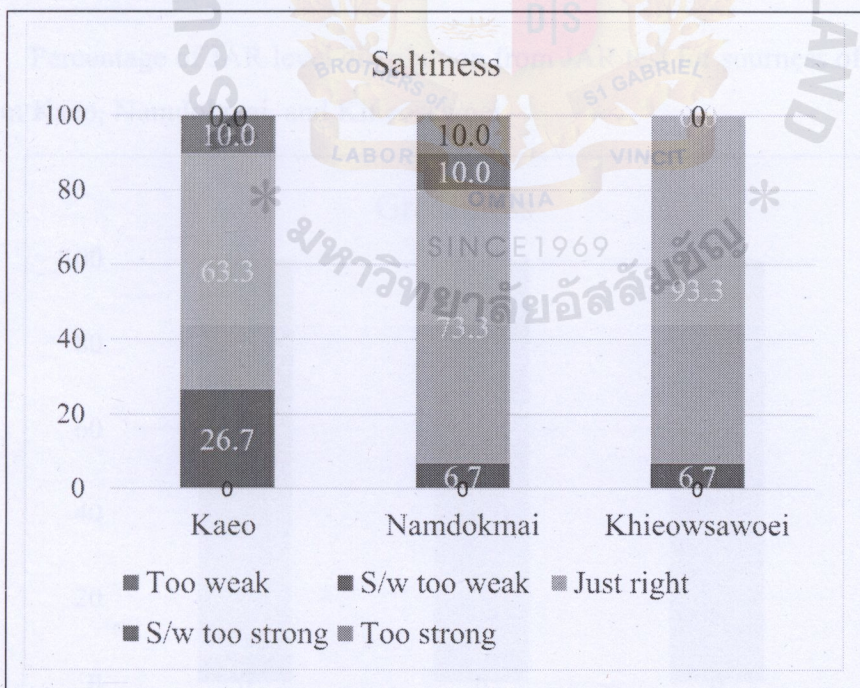
Figure 2   Percentage of JAR level distribution from JAR test for saltitness of green mango pie made from Kaeo, Namdokmai, and Khieosawoei

Sourness

	Kaeo	Namdokmai	Khieowsawoei
	0.0		0
	13.3	16.7	
	73.3	76.7	96.7
	13.3	6.7	3.3
	0		

■ Too weak   ■ S/w too weak   ■ Just right
■ S/w too strong   ■ Too strong
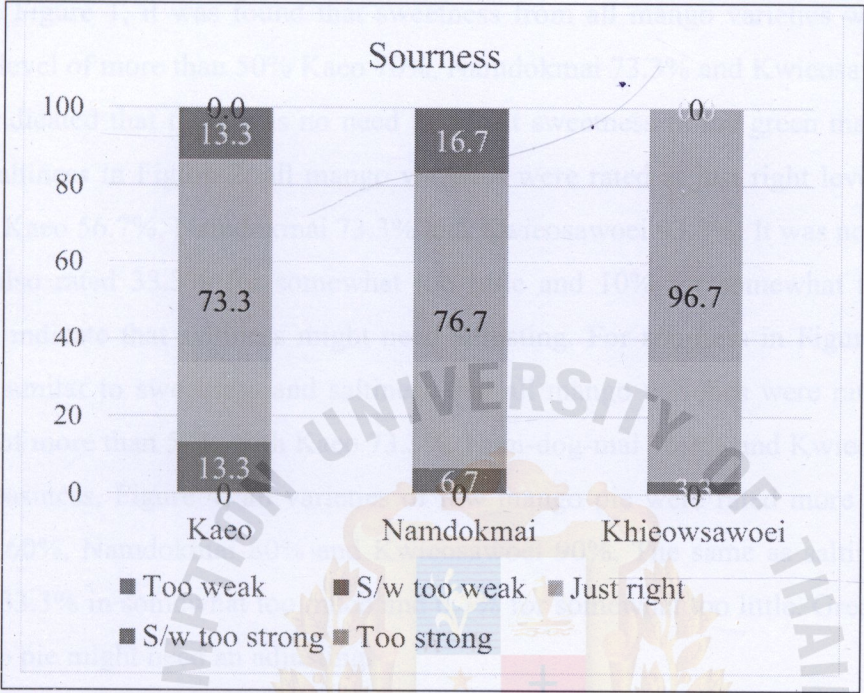
Figure 3   Percentage of JAR level distribution from JAR test for sourness of green mango pie made from Kaeo, Namdokmai, and Khieosawoei

Greasiness

	Kaeo	Namdokmai	Khieowsawoei
	0.0	0.0	0
	33.3	20.0	10.0
	60.0	80.0	90.0
	6.7	0.0	0.0

■ Too little   ■ S/w too little   ■ Just right
■ S/w too much   ■ Too much

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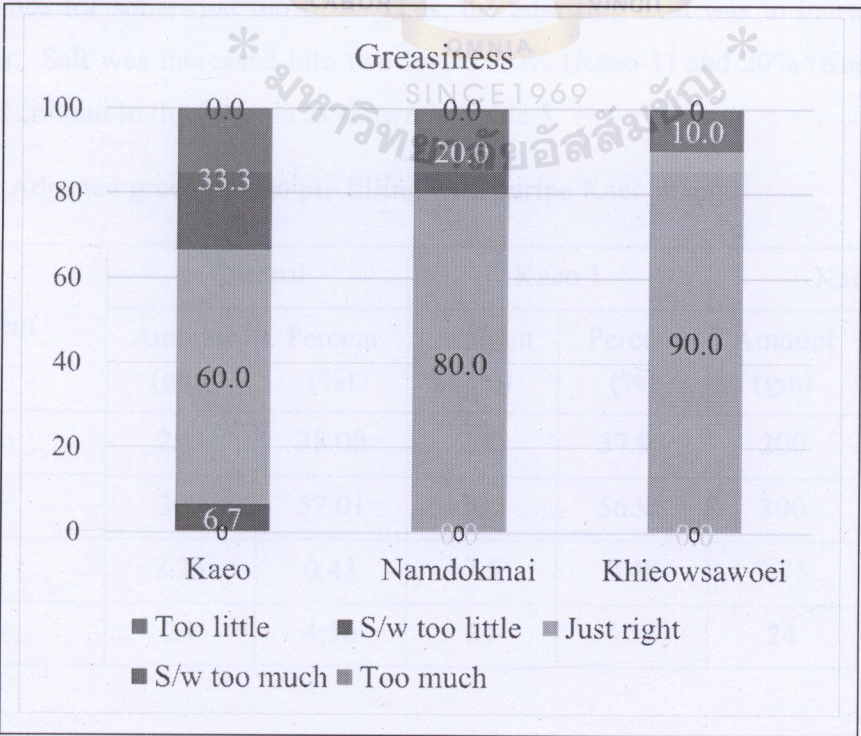
Percentage of JAR level distribution from JAR test for greasiness of green mango pie made from Kaeo, Namdokmai, and Khieosawoei

From Figure 1, it was found that sweetness from all mango varieties was rated at just right level of more than 50% Kaeo 70%, Namdokmai 73.3% and Kwieosawoei 80%. JAR test indicated that there was no need to adjust sweetness in the green mango pie filling. For saltiness in Figure 2, all mango varieties were rated at just right level of more than 50%, Kaeo 56.7%, Namdokmai 73.3% and Kwieosawoei 93.3%. It was noticed that Kaeo was also rated 33.3% for somewhat too little and 10% for somewhat too much. This could indicate that saltiness might need adjusting. For sourness in Figure 3, the results were similar to sweetness and saltiness that all mango varieties were rated at just right level of more than 50% with Kaeo 73.3%, Nam-dog-mai 76.3% and Kwieosawoei 96.7%. In greasiness, Figure 4, all varieties of raw mango pie were rated more than 50% with Kaeo 60%, Namdokmai 80% and Kwieosawoei 90%. The same as saltiness, Kaeo was rated 33.3% in somewhat too much and 6.7% for somewhat too little. Greasiness in Kaeo mango pie might need an adjusting.

ii. Adjusting the formula

From just-about-right test showed, saltiness was adjusted. It was rated 56.7% just right and 33.3% for somewhat too little. Thus, the adjusting tend was to increase salt in the formula. Salt was increased into two levels, 10% (Kaeo 1) and 20% (Kaeo 2) from the original content in the formula as shown in Table 5.

Table 5 Adjusted green mango pie filling with unripe Kaeo mango

Ingredient	Control		Kaeo 1		Kaeo 2	
	Amount (gm)	Percent (%)	Amount (gm)	Percent (%)	Amount (gm)	Percent (%)
Mango	200	38.00	200	37.98	200	37.97
Sugar	300	57.01	300	56.98	300	56.95
Salt	2.25	0.43	2.5	0.48	2.75	0.52
Butter	24	4.56	24	4.56	24	4.56

The samples were tested in a 9-point hedonic scale preference test using 30 untrained test panelists. Result of the average preference scores and standard deviation of eight attributes - color, appearance, sweetness, saltiness, sourness, greasiness, crispness, and overall acceptance were shown in Table 6.

Table 6   Average preference scores and SD of Kaeo mango pie filling containing varying amount of salt

Attribute	Average preference score ± SD		
	Control	Kaeo 1	Kaeo 2
Color	6.9±0.7	6.8±0.7	7.0±0.8
Appearance	7.1±0.5	7.2±0.4	7.2±0.5
Sweetness	6.7±0.7^b	7.2±0.6^a	6.7±0.7^b
Saltiness	7.5±0.6	7.5±0.5	7.2±0.5
Sourness	7.1±0.7^{ab}	7.3±0.6^a	6.9±0.7^b
Greasiness	6.6±1.0^b	7.3±1.2^a	6.1±1.4^c
Crispness	7.5±0.6	7.6±0.6	7.6±0.6
Overall acceptance	7.4±0.6	7.5±0.5	7.2±078

Note: Treatment means with different superscripted letters were significantly different at $p < 0.05$.

From the Table5, Kaeo1 with 0.48% salt received the highest mean preference scores in all attributes except appearance. The scores were significantly higher than control 0.43% salt and Kaeo 2 with 0.52% salt in sweetness, sourness and greasiness. Though, there were no significant differences in the preference scores in color, appearance, saltiness, crispness and overall acceptance from all samples, Kaeo 1 was selected from further study because of its high preference scores.

iii Selecting mango variety

Three mango varieties Kaeo, Namdokmai and Khieosawoei were used in the study to select mango variety for making green mango pie. The formula obtained from ii was used in preparation of Kaeo green mango pie while Namdokmai and Khieosawoei green

mango pie were prepared using the reference formula . The samples were tested with thirty untrained test panelists in the 9-point hedonic scale preference test. The results were shown in Table 7.

Table 7   Average preference scores and SD of green mango pie containing Kaeo, Namdokmai and Khieosawoei fillings

Attribute	Preference mean scores ± SD		
	Kaeo	Namdokmai	Kwieosawoei
Color	7.3±0.6	7.3±0.6	7.4±0.6
Appearance	7.1±0.5	7.2±0.6	7.3±0.6
Sweetness	7.4±0.6[a]	5.2±1.0[b]	7.2±0.8[a]
Sourness	7.2±0.7[a]	5.4±0.9[b]	7.2±0.7[a]
Saltiness	7.5±0.6[a]	6.7±0.7[b]	7.2±0.5[a]
Greasiness	7.4±0.7	6.7±0.7	7.3±0.6
Crispness	7.5±0.5	7.0±0.6	7.3±0.5
Overall acceptance	7.5±0.5[a]	6.4±0.6[b]	7.3±0.6[a]

Note: Treatment means with different superscripted letters were significantly different at $p<0.05$.

From Table 7, four attributes – sweetness, sourness, saltiness and overall acceptance – were significantly different ($p<0.05$). Kaeo and Khieosawoei pie samples received significantly higher preference scores than Namdokmai. Between Kaeo and Kkieosawoei, Kaeo gained slightly higher preference scores than Khiosawoei but Khiosawoei was selected for green mango pie prototype formula for its better aroma than Kaeo which taste liked pineapple puff.

3. Consumer acceptance survey on green mango pie

Consumer survey with 100 consumers in Assumption University, Hua Mak campus, was conducted to determine consumer's behavior on the consumption of green mango pie and their opinion on the green mango pie.

The results from demographic information of one hundred participants were shown in Figure 1 to 5.

Figure 5: Gender of the participants
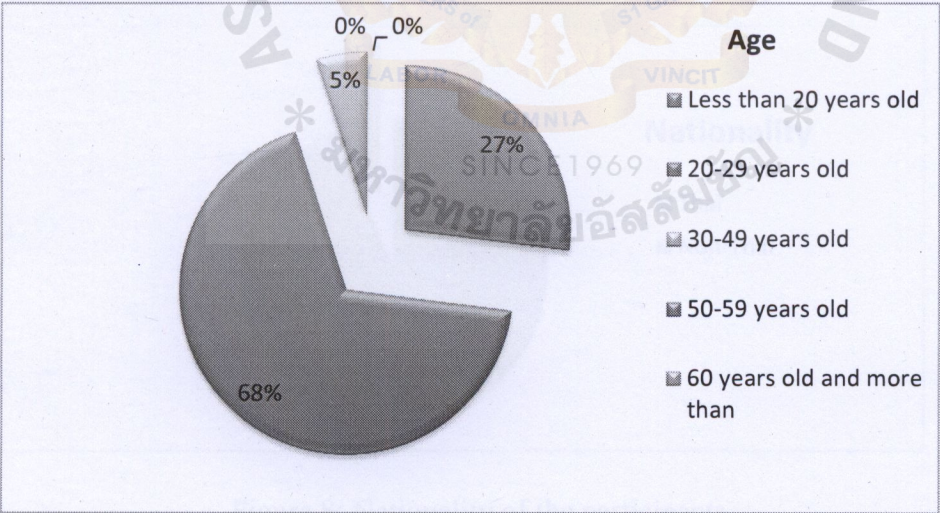
Figure 6: Age of the participants

From Figure 5 and 6, the participants composed of 42% male and 58% female. The majority of the participants had the age between 20 to 29 years old, 68%, followed by an

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age group of less than 20 years old for 27%. The remaining 5% had the age 30-49 years old.
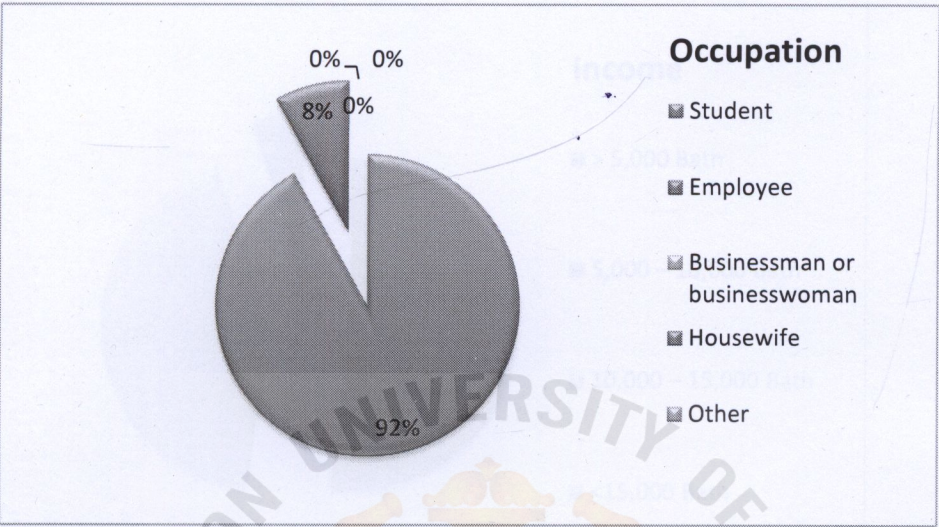
Figure 7: Occupation of the participants

It could be seen from Figure 7 that the majority of the participants was students with 92% and 8% was employers. The results agreed with the age of the participants in Figure 2 since the location of the survey was Assumption University. In addition, the result also implied that there were more female students than male students in the studied location.
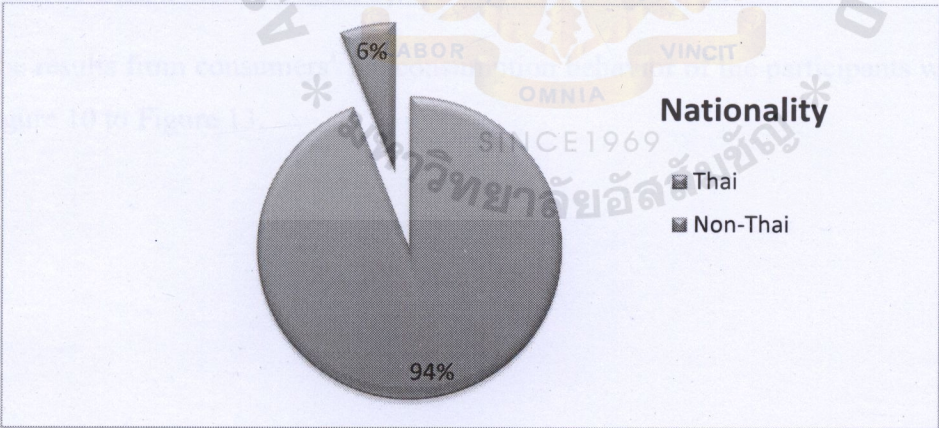
Figure 8: Nationality of the participants

Figure 8 showed that among the participants in the survey there were 94% Thais and foreigners were accounted for only 6%. This is under our expectation since Assumption University is known as an international university in Thailand but the result showed a lot more Thai than foreigner. It could be that the campus used in the survey was Hua Mak

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campus where there were only three undergraduate schools left while most schools had moved to Suvarnabhumi campus and most of the international students also studied there.
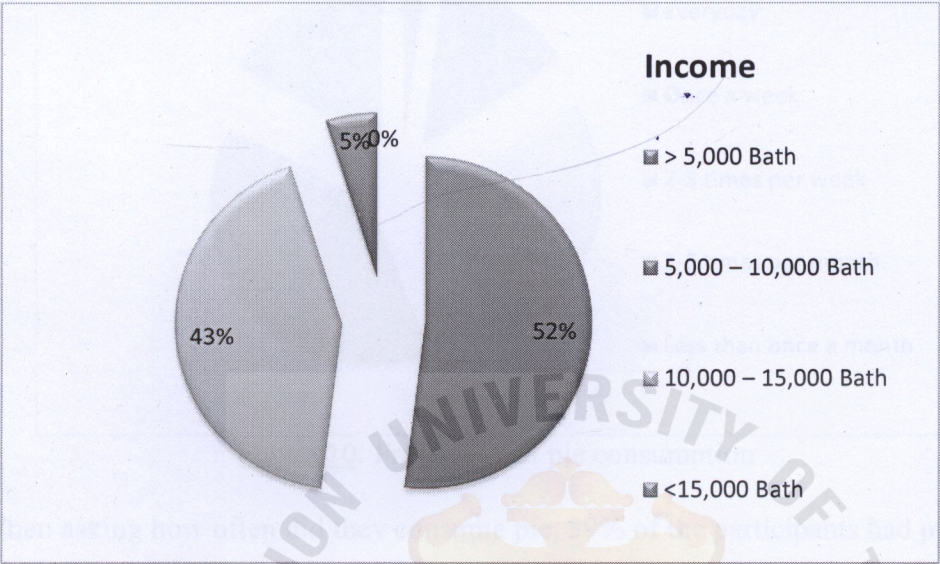
Figure 9: Income of the participants

As the majority of the participants were students, their incomes were ranged from 5,000 – 15,000 Baht which comprised of 52% of 5,000 - 10,000 Baht a month and 43% of 10,000 – 15,000 Baht a month (Figure 9).

The results from consumers' pie consumption behavior of the participants were shown in Figure 10 to Figure 13.

How often do you consume pie?

- Everyday — 2%
- Once a week — 14%
- 2-3 times per week — 28%
- 2-3 times per month — 39%
- Less than once a month — 17%
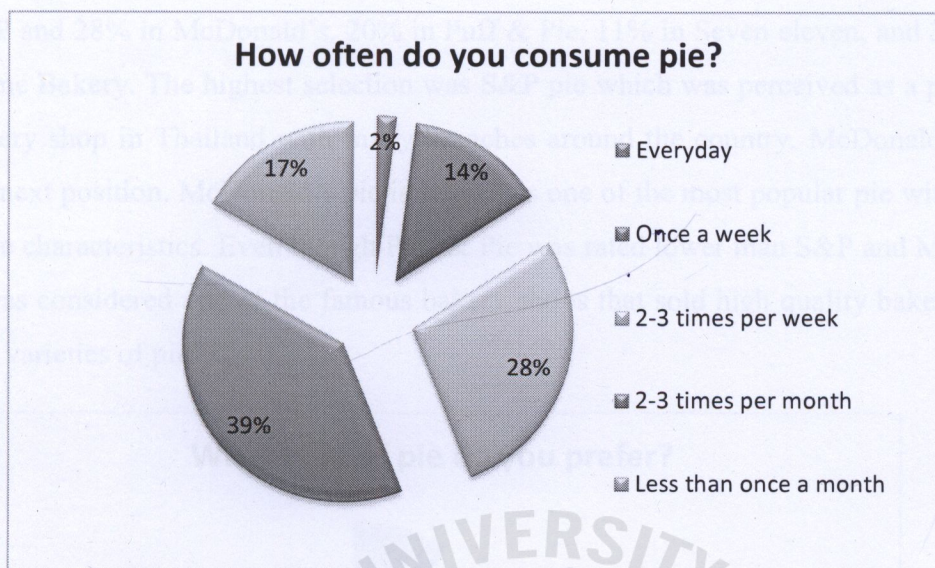
Figure 10: Frequency of pie consumption

When asking how often did they consume pie, 39% of the participants had pie 2 – 3 times a month, followed by 28% consumed pie 2 – 3 times a week, 17% had less than one time a month and 14% had pie one time a week in Figurer 6. It could be seen that 42% of the participants liked to eat pie.

From which store do you normally buy pie?
(Can choose more than1)

- Puff &pie — 20%
- Bakery Land by 7-11 — 11%
- McDonald's — 28%
- S&P — 38%
- Little Home Bakery — 3%
- Other, please specify — 0%
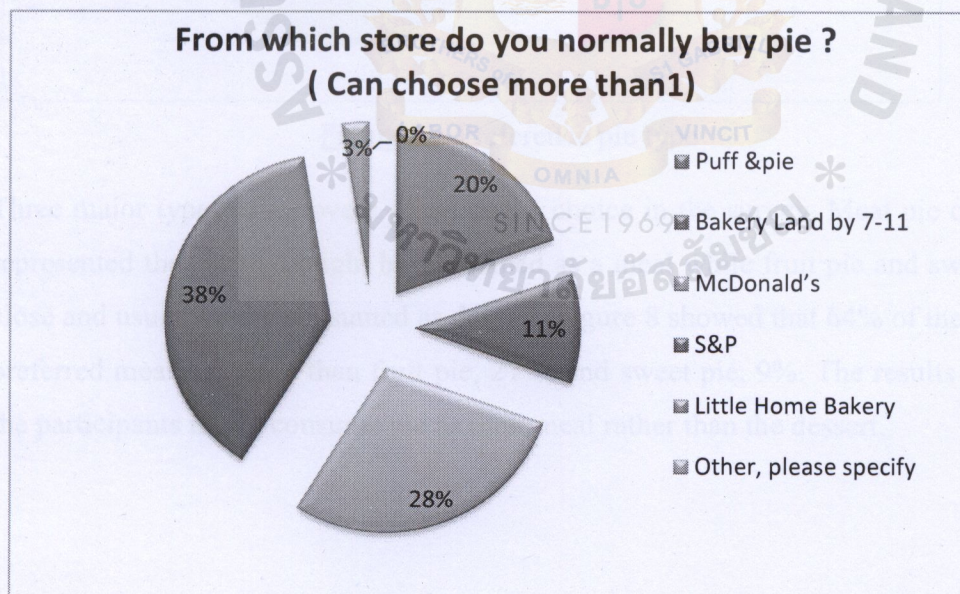
Figure 11: Location to buy pie

Several locations from bakery shop, fast food restaurant to convenience store were given as choices for buying pie. Figure 7 showed that 38% of the participants bought pie in

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S&P and 28% in McDonald's, 20% in Puff & Pie, 11% in Seven eleven, and 3% in Little Home Bakery. The highest selection was S&P pie which was perceived as a professional bakery shop in Thailand with many branches around the country. McDonald's pie held the next position. McDonald's pie is known as one of the most popular pie with its crispy flake characteristics. Even though Puff & Pie was rated lower than S&P and McDonald's, it was considered one of the famous bakery shops that sold high quality bakery products and varieties of pie.
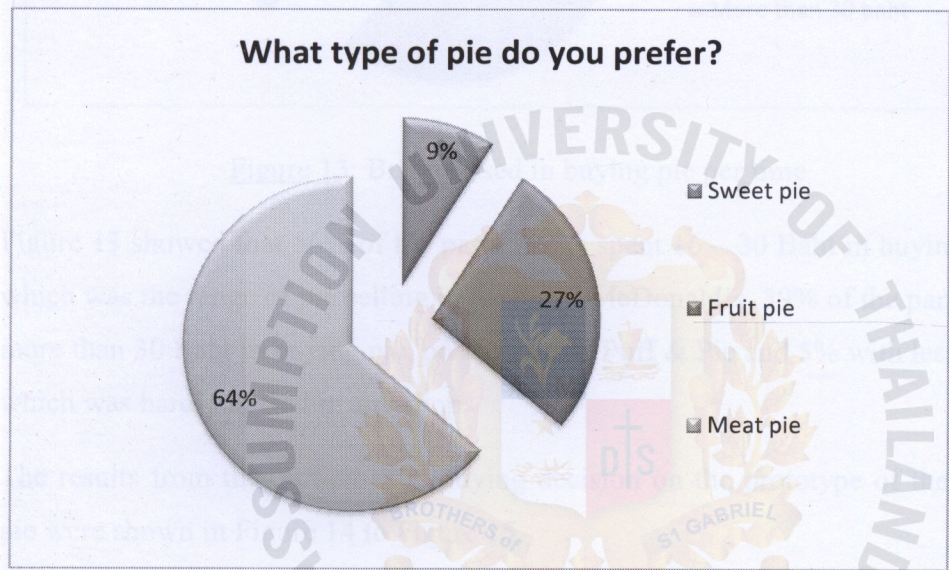
Figure 12: Preference pie type

Three major types of pie were given as the choice in the survey. Meat pie or savory pie represented the pie that might be consumed as a meal while fruit pie and sweet pie were close and usually were consumed as dessert. Figure 8 showed that 64% of the participants preferred meat pie more than fruit pie, 27%, and sweet pie, 9%. The results implied that the participants might consume pie as their meal rather than the dessert.

How much do you spend in buying pie per time?

- Less than 15 baht
- 16-30 baht
- More than 30 baht

5%
39%
56%
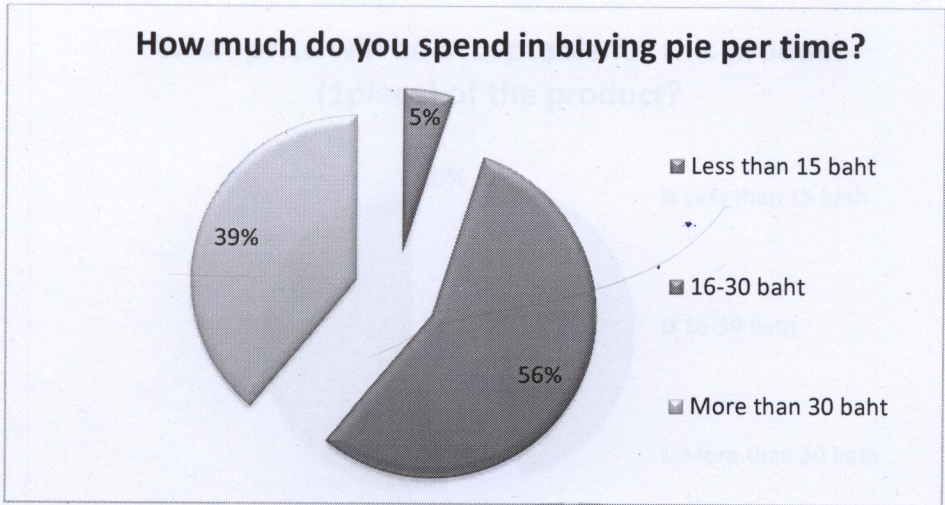
Figure 13: Budget used in buying pie per time

Figure 13 showed that 56% of the participants spent 16 – 30 Baht in buying pie per time which was the range of pie selling in S&P and McDonald's. 39% of the participants spent more than 30 Baht in buying pie, possible from Puff & Pie and 5% with less than 15 Baht which was hardly to find in any shop.

The results from the participants' buying decision on the prototype of the green mango pie were shown in Figure 14 to Figure 15.

Do you accept this product?

- Accept
- Not accept

8%
92%

Figure 14: Participants' acceptance of the green mango pie

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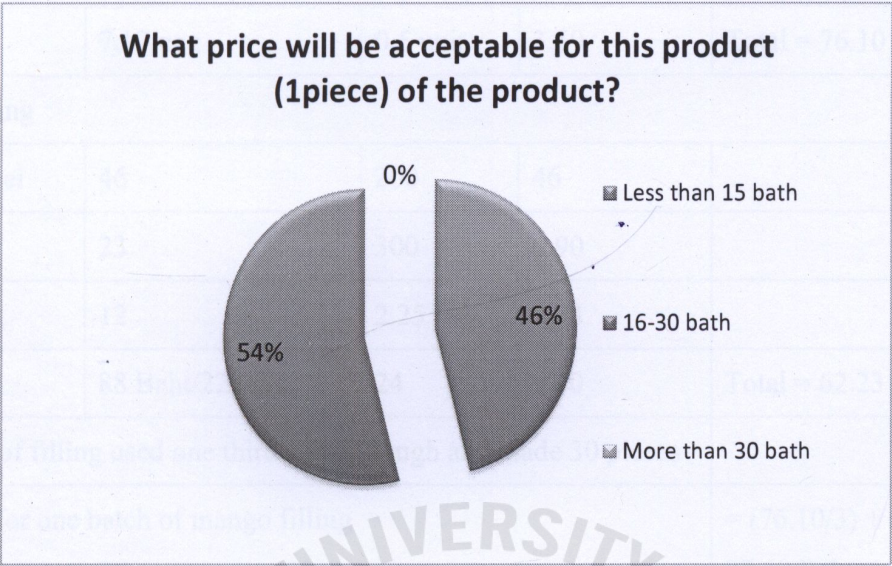
Figure 15: Participants' acceptable price of one piece pie

The result from Figure 14 showed that 92% of the participants accepted the green mango pie and only 8% did not. This had shown high potential of the green mango pie in the market. Figure 15 showed that the most acceptable price of one piece pie was range from 16 to 30 Baht with 54% of the participants and another 46% selected the price of more than 30 Baht. The consumers were asked to test the green mango pie sample and give the liking score based on 9-point scale. The green mango pie was rated as 6.7±1.1, indicated that it was slightly preferred by the consumers.

Table 8   Estimation of production cost

Ingredient	Price (Baht) per kg	Formula	Cost (Baht)	
Puff pastry dough				
Flour	34	500	17.00	
Margarine	75	75	5.63	
Salt	12	5	0.06	
Cold water	7.33	250	1.83	
Puffin margarine	80	300	48	

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Egg	7.17/egg	0.5 unit	3.59	Total = 76.10 Baht
Mango filling				
Khieosawoei	46	200	46	
Sugar	23	300	6.90	
Salt	12	2.25	0.03	
Butter	88 Baht/227 gm	24	9.30	Total = 62.23 Baht
One batch of filling used one third pastry dough and made 30 pieces				
Total cost for one batch of mango filling				= (76.10/3) + 62.23 87.60 Baht
Raw material cost per one piece of green mango pie				2.92 Baht
Production cost 20%				0.58 Bath
Raw material cost + Production cost				3.50 Baht
Promotion cost (20% top-up)				0.70 Baht
Total cost				4.20
Benefit from selling at 16 Baht				280.95 %
Benefit from selling at 30 Baht				614.29%

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Conclusion

1. Focus group discussion indicated a potential to produce green mango pie from Thai mango. The mango pie should have crisp crust and tender stuffing. The mango stuffing should possess mango flavor and aroma.

2. Momchao Sippunparnsanoen Sonakul's formula (1913) was used as reference formula in the experiment with Kaeo, Khieowsawoei and Namdokmai mangoes.

3. Formulation of green mango stuffing for puff pastry pie obtained the prototype product formula that contained 38.0% unripe Khieowsawoei mango, 57.0% sugar, 0.4% salt and 4.6% butter.

4. Ninety-two per cent of the consumers accepted the prototype product with 6.7±1.1 out of 9-point scale of the preference score. The suitable price for one piece puff pastry was 16 – 30 Baht.

5. Estimate cost of raw material, production and promotion per one piece pie was 4.20 Baht. Benefits gained from selling at 16 to 30 Baht were 280.95% to 614.29%.

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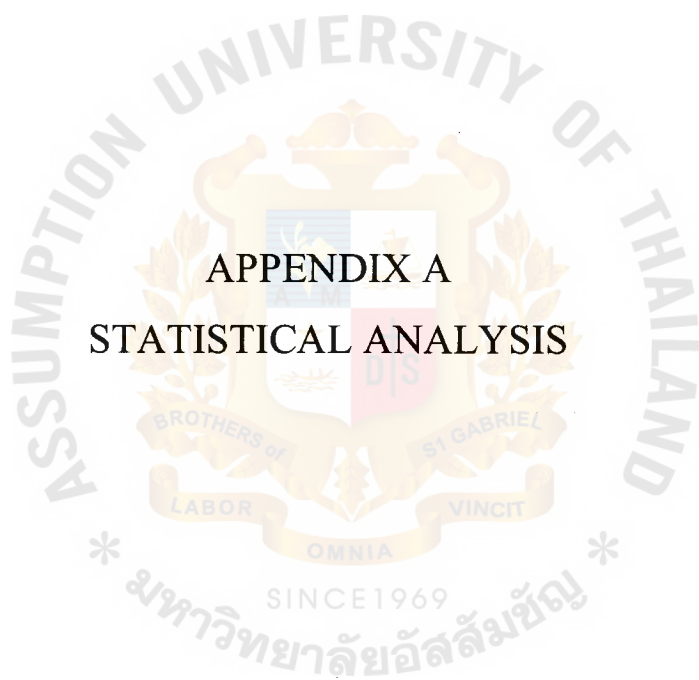
APPENDIX A
STATISTICAL ANALYSIS

The ANOVA Procedure

* Statistical analysis use ANOVA at $\alpha = 0.05$ and test treatment means with Duncan's multiple range test at $\alpha = 0.05$

1.1 Kaew test: varying % salt

- Dependent Variable: Color

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	18.21111111	0.58745520	1.13	0.3407
Error	58	30.24444444	0.52145594		
Corrected Total	89	48.45555556			

R-Square	Coeff Var	Root MSE	Color Mean
0.375831	10.43190	0.722119	6.922222

Source	DF	Anova SS	Mean Square	F Value	Pr > F
Sample	2	0.42222222	0.21111111	0.40	0.6689
Panel	29	17.78888889	0.61340996	1.18	0.2939

- Dependent Variable: Appearance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	6.77777778	0.21863799	0.88	0.6414
Error	58	14.37777778	0.24789272		
Corrected Total	89	21.15555556			

R-Square	Coeff Var	Root MSE	Appearance Mean
0.320378	6.936524	0.497888	7.177778

Source	DF	Anova SS	Mean Square	F Value	Pr > F
Sample	2	0.28888889	0.14444444	0.58	0.5616
Panel	29	6.48888889	0.22375479	0.90	0.6098

- Dependent Variable: Sweetness

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	20.64444444	0.66594982	1.57	0.0696
Error	58	24.64444444	0.42490421		
Corrected Total	89	45.28888889			

R-Square	Coeff Var	Root MSE	Sweetness Mean
0.455839	9.431866	0.651847	6.911111

Source	DF	Anova SS	Mean Square	F Value	Pr > F
Sample	2	4.68888889	2.34444444	5.52	0.0064
Panel	29	15.95555556	0.55019157	1.29	0.1991

- Dependent Variable: Sourness

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	15.13333333	0.48817204	1.12	0.3469
Error	58	25.26666667	0.43563218		
Corrected Total	89	40.40000000			

R-Square	Coeff Var	Root MSE	Sourness Mean
0.374587	9.252678	0.660024	7.133333

Source	DF	Anova SS	Mean Square	F Value	Pr > F
Sample	2	2.06666667	1.03333333	2.37	0.1023
Panel	29	13.06666667	0.45057471	1.03	0.4442

- Dependent Variable: Saltiness

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	11.04444444	0.35627240	0.99	0.5023
Error	58	20.91111111	0.36053640		
Corrected Total	89	31.95555556			

R-Square	Coeff Var	Root MSE	Saltiness Mean
0.345619	8.089853	0.600447	7.422222

Source	DF	Anova SS	Mean Square	F Value	Pr > F
Sample	2	0.80000000	0.40000000	1.06	0.3527
Panel	29	9.73333333	0.33563218	0.89	0.6259

- Dependent Variable: Crispness

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	9.04444444	0.29175627	0.73	0.8276
Error	58	23.17777778	0.39961686		
Corrected Total	89	32.22222222			

R-Square	Coeff Var	Root MSE	Crispness Mean
0.280690	8.366725	0.632153	7.555556

Source	DF	Anova SS	Mean Square	F Value	Pr > F
Sample	2	0.15555556	0.07777778	0.19	0.8237
Panel	29	8.88888889	0.30651341	0.77	0.7796

- Dependent Variable: Overall accept

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	9.81111111	0.31648746	0.78	0.7729
Error	58	23.57777778	0.40651341		
Corrected Total	89	33.38888889			

R-Square	Coeff Var	Root MSE	Overaccept Mean
0.293844	8.628957	0.637584	7.388889

Source	DF	Anova SS	Mean Square	F Value	Pr > F
Sample	2	1.75555556	0.87777778	2.16	0.1246
Panel	29	8.05555556	0.27777778	0.68	0.8673

Duncan's Multiple Range Test

Control   = 313

Treatment 1 = 325

Treatment 2 = 375

- Color

Means with the same letter are not significantly different.

Duncan Grouping	Mean	N	Sample
A	7.0000	30	375
A			
A	6.9333	30	313
A			
A	6.8333	30	325

- Appearance

Means with the same letter are not significantly different.

Duncan Grouping	Mean	N	Sample
A	7.2333	30	325
B	6.7667	30	313
B			
B	6.7333	30	375

- Saltiness

Means with the same letter are not significantly different.

Duncan Grouping	Mean	N	Sample
A	7.5000	30	313
A			
A	7.5000	30	325
A			
A	7.2667	30	375

- Crispness

Means with the same letter are not significantly different.

Duncan Grouping	Mean	N	Sample
A	7.6000	30	325
A			
A	7.5667	30	375
A			
A	7.5000	30	313

- Overall accept

Means with the same letter are not significantly different.

Duncan Grouping	Mean	N	Sample
A	7.5333	30	325
A			
A	7.4333	30	313
A			
A	7.2000	30	375

1.2 Test 1of 3 Varity of Green mangos pie filling

- Dependent Variable: Color

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	6.91111111	0.22293907	0.50	0.9798
Error	58	25.71111111	0.44329502		
Corrected Total	89	32.62222222			

R-Square	Coeff Var	Root MSE	Color Mean
0.211853	9.051717	0.665804	7.355556

Source	DF	Anova SS	Mean Square	F Value	Pr > F
Treatment	2	0.28888889	0.14444444	0.33	0.7232
Panel	29	6.62222222	0.22835249	0.52	0.9730

- Dependent Variable: Appearance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	8.07777778	0.26057348	0.56	0.9581
Error	58	26.91111111	0.46398467		
Corrected Total	89	34.98888889			

R-Square	Coeff Var	Root MSE	Appearance Mean
0.230867	9.446037	0.681164	7.211111

Source	DF	Anova SS	Mean Square	F Value	Pr > F
Treatment	2	0.42222222	0.21111111	0.45	0.6367
Panel	29	7.65555556	0.26398467	0.57	0.9500

- Dependent Variable: Sweetness

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	104.4777778	3.3702509	5.94	<.0001
Error	58	32.9111111	0.5674330		
Corrected Total	89	137.3888889			

R-Square	Coeff Var	Root MSE	Sweetness Mean
0.760453	11.39417	0.753281	6.611111

Source	DF	Anova SS	Mean Square	F Value	Pr > F

Treatment	2	81.75555556	40.87777778	72.04	<.0001
Panel	29	22.72222222	0.78352490	1.38	0.1470

- Dependent Variable: Sourness

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	79.1111111	2.5519713	4.70	<.0001
Error	58	31.5111111	0.5432950		
Corrected Total	89	110.6222222			

R-Square	Coeff Var	Root MSE	Sourness Mean
0.715147	11.09326	0.737085	6.644444

Source	DF	Anova SS	Mean Square	F Value	Pr > F
Treatment	2	62.48888889	31.24444444	57.51	<.0001
Panel	29	16.62222222	0.57318008	1.06	0.4200

- Dependent Variable: Saltiness

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	15.31111111	0.49390681	1.17	0.2987
Error	58	24.51111111	0.42260536		

43

Corrected Total	89	39.82222222

R-Square	Coeff Var	Root MSE	Saltiness Mean
0.384487	9.084984	0.650081	7.155556

Source	DF	Anova SS	Mean Square	F Value	Pr > F
Treatment	2	8.15555556	4.07777778	9.65	0.0002
Panel	29	7.15555556	0.24674330	0.58	0.9419

- Dependent Variable: Crispness

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	10.01111111	0.32293907	0.93	0.5720
Error	58	20.04444444	0.34559387		
Corrected Total	89	30.05555556			

R-Square	Coeff Var	Root MSE	Crispness Mean
0.333087	8.077635	0.587872	7.277778

Source	DF	Anova SS	Mean Square	F Value	Pr > F
Treatment	2	3.28888889	1.64444444	4.76	0.0122
Panel	29	6.72222222	0.23180077	0.67	0.8787

- Dependent Variable: Overall accept

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	31.54444444	1.01756272	3.49	<.0001
Error	58	16.91111111	0.29157088		
Corrected Total	89	48.45555556			

R-Square	Coeff Var	Root MSE	Over accept Mean
0.650997	7.629132	0.539973	7.077778

Source	DF	Anova SS	Mean Square	F Value	Pr > F
Treatment	2	19.75555556	9.87777778	33.88	<.0001
Panel	29	11.78888889	0.40651341	1.39	0.1401

Duncan's Multiple Range Test

Treatment 1 = 313

Treatment 2 = 414

Treatment 3 = 537

- Color

Means with the same letter
are not significantly different.

Duncan Grouping	Mean	N	Treatment
A	7.4333	30	537
A			
A	7.3333	30	414
A			
A	7.3000	30	313

- Appearance

Means with the same letter
are not significantly different.

Duncan Grouping	Mean	N	Treatment
A	7.3000	30	537
A			
A	7.2000	30	414
A			
A	7.1333	30	313

- Sweetness

Means with the same letter
are not significantly different.

Duncan Grouping	Mean	N	Treatment

A	7.3667	30	313
A			
A	7.2000	30	537
B	5.2667	30	414

- Sourness

Means with the same letter are not significantly different.			
Duncan Grouping	Mean	N	Treatment
A	7.2667	30	537
A			
A	7.2000	30	313
B	5.4667	30	414

- Saltiness

Means with the same letter are not significantly different.			
Duncan Grouping	Mean	N	Treatment

A	7.5000	30	313
A			
A	7.2000	30	537
B	6.7667	30	414

- Crispness

Means with the same letter
are not significantly different.

Duncan Grouping		Mean	N	Treatment
	A	7.5000	30	313
	A			
B	A	7.3000	30	537
B				
B		7.0333	30	414

- Overall accept

Means with the same letter
are not significantly different.

Duncan Grouping	Mean	N	Treatment

A	7.5333	30	313
A			
A	7.2667	30	537
B	6.4333	30	414

1.3 Test2 of 3 Varity of Green mangos pie filling

Dependent Variable: Color

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	9.87777778	0.31863799	0.63	0.9162
Error	58	29.24444444	0.50421456		
Corrected Total	89	39.12222222			

R-Square	Coeff Var	Root MSE	Color Mean
0.252485	9.786717	0.710081	7.255556

Source	DF	Anova SS	Mean Square	F Value	Pr > F
Sample	2	1.42222222	0.71111111	1.41	0.2523
Panel	29	8.45555556	0.29157088	0.58	0.9451
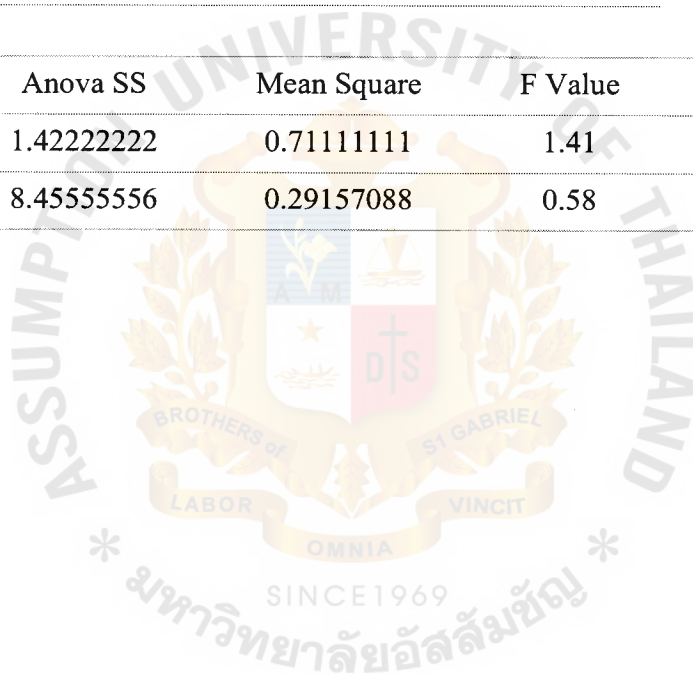
- Dependent Variable: Appearance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	12.07777778	0.38960573	1.19	0.2820
Error	58	19.04444444	0.32835249		
Corrected Total	89	31.12222222			

R-Square	Coeff Var	Root MSE	Appearance Mean
0.388076	7.897679	0.573020	7.255556

Source	DF	Anova SS	Mean Square	F Value	Pr > F
Sample	2	0.28888889	0.14444444	0.44	0.6462
Panel	29	11.78888889	0.40651341	1.24	0.2410

- Dependent Variable: Sweetness

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	56.51111111	1.82293907	3.05	0.0001
Error	58	34.64444444	0.59731801		
Corrected Total	89	91.15555556			

R-Square	Coeff Var	Root MSE	Sweetness Mean
0.619941	11.32862	0.772864	6.822222

Source	DF	Anova SS	Mean Square	F Value	Pr > F
Sample	2	41.35555556	20.67777778	34.62	<.0001
Panel	29	15.15555556	0.52260536	0.87	0.6458

- Dependent Variable: Sourness

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	67.6444444	2.1820789	3.85	<.0001
Error	58	32.8444444	0.5662835		
Corrected Total	89	100.4888889			

R-Square	Coeff Var	Root MSE	Sourness Mean
0.673153	11.55745	0.752518	6.511111

Source	DF	Anova SS	Mean Square	F Value	Pr > F
Sample	2	55.82222222	27.91111111	49.29	<.0001
Panel	29	11.82222222	0.40766284	0.72	0.8314

53

- Dependent Variable: Saltiness

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	22.37777778	0.72186380	1.52	0.0846
Error	58	27.57777778	0.47547893		
Corrected Total	89	49.95555556			

R-Square	Coeff Var	Root MSE	Saltiness Mean
0.447954	9.882083	0.689550	6.977778

Source	DF	Anova SS	Mean Square	F Value	Pr > F
Sample	2	15.08888889	7.54444444	15.87	<.0001
Panel	29	7.28888889	0.25134100	0.53	0.9682

- Dependent Variable: Crispness

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	19.00000000	0.61290323	2.14	0.0061
Error	58	16.60000000	0.28620690		
Corrected Total	89	35.60000000			

R-Square	Coeff Var	Root MSE	Crispness Mean
0.533708	7.362152	0.534983	7.266667

Source	DF	Anova SS	Mean Square	F Value	Pr > F
Sample	2	7.40000000	3.70000000	12.93	<.0001
Panel	29	11.60000000	0.40000000	1.40	0.1384

- Dependent Variable: Overall accept

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	31	39.51111111	1.27455197	2.88	0.0002
Error	58	25.64444444	0.44214559		
Corrected Total	89	65.15555556			

R-Square	Coeff Var	Root MSE	Overaccept Mean
0.606412	9.746682	0.664940	6.822222

Source	DF	Anova SS	Mean Square	F Value	Pr > F
Sample	2	25.68888889	12.84444444	29.05	<.0001
Panel	29	13.82222222	0.47662835	1.08	0.3940
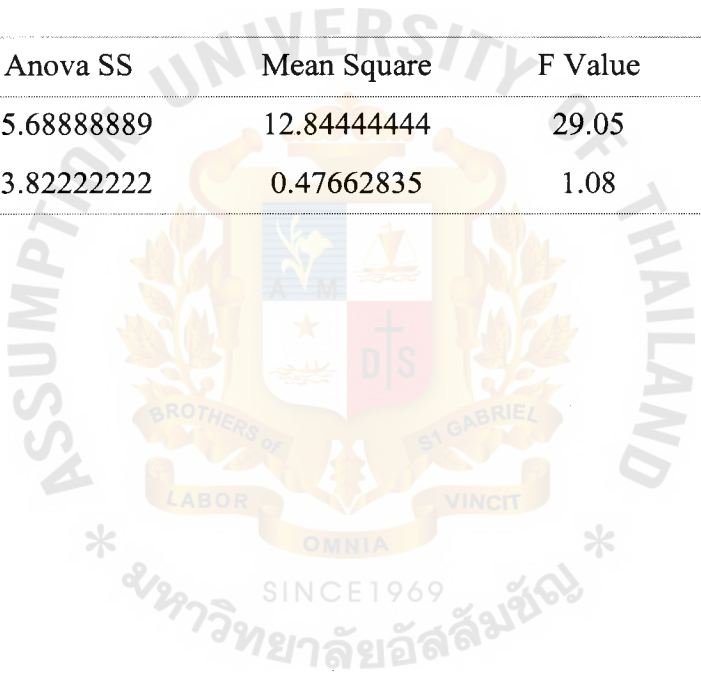
Duncan's Multiple Range Test

Treatment 1 = 313

Treatment 2 = 414

Treatment 3 = 537

- Color

Means with the same letter are not significantly different.

Duncan Grouping	Mean	N	Sample
A	7.4333	30	537
A			
A	7.1667	30	414
A			
A	7.1667	30	313

- Appearance

Means with the same letter are not significantly different.

Duncan Grouping	Mean	N	Sample
A	7.3333	30	313
A			
A	7.2333	30	537
A			
A	7.2000	30	414

- Sweetness

Means with the same letter are not significantly different.

Duncan Grouping	Mean	N	Sample
A	7.3667	30	537
A			
A	7.2333	30	313
B	5.8667	30	414

- Sourness

Means with the same letter are not significantly different.

Duncan Grouping	Mean	N	Sample
A	7.1333	30	537
A			
A	7.0000	30	313
B	5.4000	30	414

- Saltiness

Means with the same letter are not significantly different.

Duncan Grouping	Mean	N	Sample
A	7.3000	30	313
A			
A	7.2333	30	537
B	6.4000	30	414

- Crispness

Means with the same letter are not significantly different.

Duncan Grouping	Mean	N	Sample
A	7.6000	30	313
B	7.3000	30	537
C	6.9000	30	414

- Overall accept

Means with the same letter are not significantly different.

Duncan Grouping	Mean	N	Sample
A	7.2000	30	313
A	7.2000	30	537
B	6.0667	30	414

APPENDIX A1

Focus group

Question

1. Do you like to eat pie?

2. What characteristics of pie do you want?

3. What kind of pie do you like?

4. Do you like to eat fruit pie?

5. What kind of fruit pie do you like?

6. What taste of the fruit pie do you like?

7. Do you like to eat Thai fruit?

8. What kind of Thai fruit do you like?

9. Do you like to eat mango?

10. What taste of mango do you like?

11. Do you not different variety of Thai mango?

12. What variety of mango do you like?

13. If mango is used in the product, what kind of mango do you like in the pie?

14. What taste do you expect this product should have?

15. What kind of pie do you think it should be?

16. Do you want to have meringue on top of mango pie?

17. In the same pie what texture of pie do you like?

APPENDIX A2

Just about right test

Attributes	Too little	Somewhat too little	Just right	Somewhat too much	Too much
Sweetness					
Saltiness					
Sourness					
Crispness					

Comment:

_____

_____

_____

_____

APPENDIX A3

9-point hedonic scale

Gender

_____ Male   _____ Female

Please test the different samples and score each each sample following the preference test of 9-point hedonic below

The of 9-point hedonic scale of preference test

9 = Like extremely   4 = Dislike Slightly

8 = Like Very Munch   3 = Dislike Moderately

7 = Like Moderately   2 = Dislike Very Much

6 = Like Slightly   1 = Dislike Extremely

5 = Neither Like or Dislike

The preference the preference test of 9-point hedonic scale of each sample

Attributes	Sample No.		
	_____	_____	_____
Color	_____	_____	_____
Appearance	_____	_____	_____
Sweetness	_____	_____	_____
Sourness	_____	_____	_____
Saltiness	_____	_____	_____
Crispness	_____	_____	_____
Overall acceptance	_____	_____	_____

1.   Dose the pie have a proper size

_____ Yes   _____ No

APPENDIX B

Consumer Acceptance survey

Consumer Acceptance survey

"Thai Green Mango Pie"

This survey is a part of a special project (FT 4190) under a title "Development of flavor green mango pie" for Bachelor's degree. This survey will do in order to study the consumer's behaviors, attitudes, and needs toward a development of a new flavor pie. Please kindly complete question by checking √ in the provided spaces. .

Part1: Demographic information

1. เพศ (Gender)

☐ Male   ☐ Female

2. อายุ (Age)

☐ Less than 20 years old   ☐ 40-49 years old

☐ 20-29 years old   ☐ 50-59 years old

☐ 30-39 years old

☐ 60 years old and more than

3. อาชีพ (Occupation)

☐ Student   ☐ Businessman or businesswoman

☐ Employee   ☐ Housewife

☐ Other_____

____

4. สัญชาติ (Nationality

☐ Thai

☐ Non-Thai

5. รายได้ต่อเดือน(Income)

☐ 5,000 บาท

☐ 5,000 – 10,000 บาท

☐ 10,000 – 15,000 บาท

☐ <15,000 บาท

Part2: Basic information of consumer's behavior on pie in the market

6. ปกติแล้วคุณซื้อพายจากที่ไหน สามารถเลือกได้มากกว่า1ข้อ From which store do you normally buy pie ? (Can choose more than1)
   ☐ Puff &pie
   ☐ Bakery Land by 7-11
   ☐ McDonald's
   ☐ S&P
   ☐ Little Home Bakery
   ☐ Other, please specify_____

7. คุณรับประทานพายบ่อยแค่ไหน? (How often do you consume pie?)
   ☐ Everyday
   ☐ Once a week
   ☐ Once a month
   ☐ 2-3 times per week
   ☐ 2-3 times per month
   ☐ Less than once a month

8. โดยปกติแล้วคุณใช้เงินในการซื้อพายเท่าไหร่? (How much do you spend in buying pie per time?)
   ☐ Less than 15 baht
   ☐ 16-30 baht
   ☐ More than 30 baht

9. What type of pie do you prefer?
   ☐ Sweet pie
   ☐ Fruit pie
   ☐ Meat pie

Part3: Information of consumer's product behavior on product

Instructions: Please taste the product and answer the following questions.

10. Would you rate the product using p-point Hedonic scale below

9 = Like extremely	4 = Dislike Slightly
8 = Like Very Munch	3 = Dislike Moderately
7 = Like Moderately	2 = Dislike Very Much
6 = Like Slightly	1 = Dislike Extremely

5 = Neither Like or Dislike

Score: _____

11. คุณยอมรับโปรดักนี้หรือไม่? (Do you accept this product?)

☐ ยอมรับ(Accept)

☐ ไม่ยอมรับ (Not accept)

12. ราคาเท่าไหร่ที่คุณจะสามารถจ่ายได้สำหรับโปรดักนี้ ต่อ1ชิ้นWhat price will be acceptable for this product (1piece) of the product?

☐ ต่ำกว่า15 บาท (Less than 15bath)

☐ 16-30 บาท (16-30 bath)

☐ มากกว่า 30 บาท (More than 30 bath)

13. Will you buy this product if it is sold in the market with the market price

☐ Yes (ซื้อ)

☐ No (ไม่ซื้อ)

Suggestion:

_____

_____

_____