

DEVELOPMENT OF BUTTERFLY PEA
(*Clitoria ternatea* Linn.) SORBET
ICE CREAM

BY
NARITSORN TONGPRADITH
5016430

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Title: Development of Butterfly pea (*Clitoria ternatea* Linn.)
Sorbet Ice Cream

Name: Naritsorn Tongpradith

Project advisor: A. Nootrudee Siriboon

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Abstract

This special project was aimed to develop Butterfly pea (*Clitoria ternatea* Linn.) sorbet ice cream from dried butterfly pea flower. Extraction condition of butterfly pea color was studied at 50°, 60°, and 70°C in 5, 10, and 15 minutes with 2, 4 and 6% butterfly pea solution. The highest absorbance was obtained from 2% butterfly pea solution extracted at 70°C for 15 minutes. Three commercial fruit juices – 100% apple juice, 100% pineapple juice, and 100% guava juice – were selected for incorporating with butterfly pea extract. There were slightly change of pH and °Brix after mixing with butterfly pea extract. Butterfly pea affected mostly in color of the juice due to its high color of anthocyanin in the extract. Basic sorbet ice cream containing 170 g sugar, 400 mL fruit juice, 2 g acid, 1 white egg and 330 mL water was used to develop butterfly pea sorbet ice cream. First, 11.5% of water was substituted with 2% butterfly pea extract solution. Three sorbet ice creams containing different commercial fruit juices were tested with 10 test panelists in a preference test. The result showed that apple juice sorbet incorporated with 2% butterfly pea extract was received significantly ($p < 0.05$) high average score in color 6.92 ± 0.64 (mean \pm SD), appearance 6.85 ± 0.49 , flavor 6.08 ± 0.49 , texture 6.92 ± 0.38 , sweetness 8.54 ± 0.52 , and overall liking 7.15 ± 0.68 . The amount of 2% butterfly pea extract was varied from 5 to 10 and 15% of the total water in the basic formula. JAR test indicated that apple flavor, texture, sweetness, sourness, color, and appearance were just right for all treatments except 15% butterfly pea extract sorbet ice cream that 50% of the test panelists considered it had somewhat too strong color. Thus butterfly pea sorbet ice cream containing 10% butterfly pea extract had selected as a final formula in consumer acceptance test. 88.5% of 200 consumers accepted the product with 61.5% willing to buy when it was launched at the price of 13 – 15 Bath per 70g cup. The final formula of the butterfly pea sorbet as percentage (based on total weight) were sugar 17%, apple juice 40%, water 33%, and 2% butterfly pea extraction 10%.

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Introduction

Color is as common in our environment as the air about us. Color is important as a mean of identification, as a method judging quality and for its basic esthetic value. Basically, we add color to products to make them recognizable and pleasing to the consumer.

Butterfly pea is the one of example that many production use to produce food product such as ice cream, soft drink, flied butterfly pea flower and etc.. Many productions use butterfly pea to do with food product because butterfly pea has medical properties that make good health and provide antioxidant. Not only butterfly pea has many useful properties but also have low price and available in Thailand.

Sorbet is a frozen fruity dessert usually made with fruit juice and sweetener. It contains no animal products which makes the dessert low in fat content. Sorbet's name derived from sherbet, a cooled drink served widely in the Middle East. Cooks brought sherbet to Europe and began experimenting. Sorbet is dense and even in texture, it is made by slowly freezing down the ingredients while churning them to consistent texture. Sorbet is usually serves in summer as a dessert or fresher. The term sorbet is usually confused with sherbet, in American terminology; sorbet is different than sherbet in that sherbet includes dairy ingredients with the milk fat content between 1% - 2%(Smith S.E., 2003).

Objectives

1. To study extraction process of dried butter fly pea petals (percent of petal to water, temperature, and time)
2. To determine factors affecting butter fly pea extract color from– pH and °Brix
3. To screen a suitable combination of fruit juice with the butter fly pea extract
4. To formulate sorbet ice cream containing butter fly pea extract and fruit juice
5. To evaluate sensory characteristics of the product and conduct consumer acceptance test

Literature Review

Butterfly pea

Characteristics of nature herb

Normally, nature herb is means plant or part of plants that use for seasoning of food or use to cure disease in business. The products of nature herb are used for flavor ingredient or nourishing of body.

Origin and distribution

Butterfly Pea most likely originated in tropical Asia. Origin is obscured by extensive cultivation and naturalization around the globe widely distributed too many tropical and subtropical countries where it has become naturalized. Some text said, it can found in glove, India. It was depend on the type of plant. The flowers are used to give a blue tinge to rice cakes and boiled rice. Leaves are also used to dry food or are eaten as a pot herb.

Plant Description

There are at least 12 other species recognized in this genus. They are *C. albiflora*, *C. bracteata*, *C. coelestris*, *C. parviflora*, *C. pilosula*, *C. purpurea*, *C. ternatensium*, *Lthyrusspectabilis*, *Ternateaternatea*, *Ternatea vulgaris*, *C. ternatea* and *C. purpurea*. (<http://www.ildis.org>)

The butterfly peas in Thailand are 2 genuses:

1. *Clitoriaternatea* Linn. Give the blue, violet color.
2. *Clitoriamacrophylla* Wall. Give white color.

Common name: Butterfly pea, Blue pea, Mussel-shell Creeper, Shankupushpam.

Scientific Name: *Clitoriaternatea* Linn.

Family: Fabaceae.

Sub Family: Papilionaceae, Leguminosae. (www.echonet.org)

Chemical composition

The levels of crude protein and crude fibre in the leaves were 21.5% and 21.5-29% respectively. (Kalamani and Gomez, 2001) Total plant protein ranges from 14-20%. Seed contain 25-38% protein, 5% total sugar and 10% oil (echo@echonet.org). Nitrogen concentration of whole tops range from 1.7-4.0% and amino acid composition as percentage of crude protein in seed. In flower have anthocyanin that the chemical gives blue and red color that has properties as indicator as litmus paper. In anthocyanins group consists of aglycon that called Delphinidin.

The composition of sugar in this flower is D-glucose. The chemical found in butterfly pea by Japanese researcher are Ternatins (A3, B2, B3, B4, C1-5, D2, D3), preternatins (A4, C4). It can soluble in water and the color of butterfly pea can change by acid-base condition, depending on the balance of ion. (ชญ.ดร.จุไรพจน์หวังสินทวีกุลภาควิชาเภสัชเวทและเภสัชพฤกษศาสตร์)

Medicinal Value

Butterfly pea commonly known as Shankupushpam, is widely used in traditional Indian system of medicine as a brain tonic and is believed to promote memory and intelligence. *C. ternetea* root extract increases acetyl choline content and acetyl choline esterase activity in a similar fashion to the standard cerebro drug pyritinol (Taranalli and Cheeramkuzhy, 2003).

Brain tonic is useful for throat and eye infections, skin diseases, urinary troubles (Malabodi and Nataraja, 2011). Beside its medicinal property butterfly pea is also a good source of phytochemical substances. It contains antifungal proteins and has been shown to be homologous to plant defenses (ct-AMP1) (Thevissen et al., 2000). Moreover, it can be used for its beautiful hedges. It can also be used to cover fences or to accentuate the beauty of hedges.

Benefits of Butterfly Pea

- Nourish and strengthen the hair and hair roots
- Prevent skin bruising and keep skin healthy
- Treat urinary dysfunction
- Improve eyesight
- Treat opthalmitis and eye infections
- Stimulate blood circulation
- Detoxificate
- Provide antioxidant
- Slow ageing process
- Enhance body immunity
- Relieve thirst and debility

Anthocyanin

- **Structure**

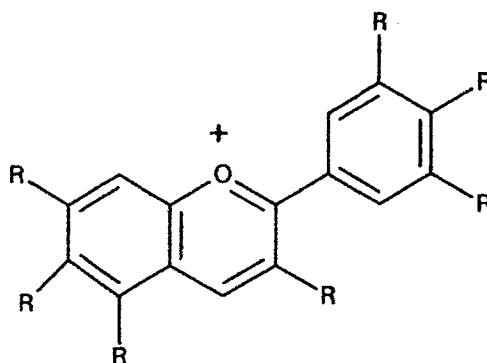


Figure 1: Structure of Anthocyanin

Anthocyanins: Stability

Anthocyanins are thought to be subjected to physiochemical degradation in vivo and in vitro. It is generally known that structure, pH, temperature, light, oxygen, metal ions, intramolecular association, and intermolecular association with other compounds (co-pigments, sugars, proteins, degradation products, etc.) affect the color and stability of anthocyanins. B-ring hydroxylation status and pH mediate the degradation of anthocyanins to their phenolic acid and aldehyde constituents. Indeed, significant portions of ingested anthocyanins are likely to degrade to phenolic acids and aldehyde in vivo, following oral consumption. This characteristic confounds scientific isolation of specific anthocyanin mechanisms in vivo.

- **Factors affecting color of anthocyanin**

As with most natural colorants, anthocyanins suffer from inherent instability. Factors governing anthocyanin stability and putative degradation mechanism are vital to the efficient extraction/purification of anthocyanins and to their use as food colorants.

The major factors influencing anthocyanin stability are pH, temperature and the presence of oxygen, but enzymatic degradation and interaction with other food components (e.g. ascorbic, metal ion, sugars, copigments) are no less important (Hendry and Houghton, 1996).

1. Structure and pH

At neutral or slightly acidic pH the anthocyanins exist predominantly in their non-colored forms. Stabilization of the colored species, especially the quinonoidal base, may be conferred by the presence of acyl groups linked to sugar moieties of the pigment molecule by intramolecular co-pigmentation. Anthocyanins containing two or more acyl groups display excellent color stability throughout the entire pH range. Deacylated pigments fade immediately after their dissolution in neutral or slightly

acidic media, similar to the behavior of non-acylated anthocyanins. Monoacylated anthocyanins do not display the color stability as do diacylated anthocyanins or polyacylated anthocyanins, indicating that at least two constituent acyl groups are required for good color stability/retention in neutral or slightly acidic media (Brouillard, 1982).

Anthocyanin containing solutions generally display their most intense red coloration at acid pH (<3.0) with increasing pH aqueous anthocyanin extracts normally fade to the point where they may appear colorless before finally changing to the purple or blue at high pH (e.g. >6.0). The pH dependent structural transformations should be exploited in the analysis of anthocyanins and in the manufacture of anthocyanin-containing food products. Unless some stabilizing factor is present to augment the color or promote formation of the color species, the use of anthocyanins as food colorants would appear to be ineffective since most food products have a pH in range of 3.0 to 7.0 (Hendry and Houghton, 1996).

2. Temperature

As with most chemical reactions the stability of anthocyanins and the rate of their degradation, in natural and model systems is markedly influenced by temperature. The thermal stability of anthocyanins varies with their structure, pH, and the presence of oxygen and interactions with other components in the system. In general, structural features that lead to increased pH-stability also lead to increase thermal stability, while methoxylation, glycosylation and acylation have the opposite effect.

Coumarin glycoside has been identified as a common product of thermal degradation of anthocyanidin 3,5-diglycosides. While deglycosylation may not be required for anthocyanins to undergo thermally induced degradation, it occurs readily at temperatures approaching 100°C and higher and is facilitated by the activity of certain enzymes.

3. Oxygen and hydrogen peroxide

Oxygen and temperature have been referred to as the most specific accelerating agents in the destruction of anthocyanins. Oxygen may cause degradation of anthocyanins by a direct oxidation mechanism and/or by indirect oxidation whereby oxidized constituents of the medium react with the anthocyanins to yield colorless or brown-colored products. Precipitate and haze development in fruit juices may result from direct oxidation of the carbinol base (Hendry and Houghton, 1996).

4. Light

Anthocyanins are generally unstable when exposed to UV or visible light or other sources of ionizing radiation. Their decomposition would appear to be mainly photo-oxidative since *p*-hydroxybenzoic acid has been identified as a minor degradation product. Anthocyanins substituted at the C-5 hydroxyl group, which are

known to fluoresce, are more susceptible to photochemical decomposition than those unsubstituted at this position. The ability of light to yield an anthocyanin excited state via electron transfer would appear to predispose these pigments to photochemical decomposition. (Hendry and Houghton, 1996)

5. Enzymes

Several enzymes that are endogenous in many plant tissues have been implicated in the oxidative decoloration of anthocyanins. These enzymes have been generally termed anthocyanases, but based on their activities two distinct groups of enzymes have been identified.

5.1 Glycosidases, which hydrolyze the glycosidic bond of anthocyanin to yield free sugar and aglycone, the instability of the latter chromophores resulting in their spontaneous transformation to colorless derivatives.

5.2 Polyphenol oxidase (PPO) acts on anthocyanins in the presence of *o*-diphenols via a coupled oxidation mechanism. In addition to glycosidase and PPO, Grommeck and Markakis have reported peroxide-catalyzed anthocyanin degradation (Hendry and Houghton, 1996).

6. Sugar

It is obvious that anthocyanin synthesis requires the presence of free sugar. It has been found that the presence of sugar has a triggering effect on anthocyanin accumulation. Measuring the changes of sugar and anthocyanins in the skin of developing grape berries, a close relationship between sugar and anthocyanin content was found, the accumulation of sugar preceding the rise in anthocyanin content. In litchi, the sugar metabolism contributed to the red pigmentation. Rhamnose was detectable in the peel in high amounts during active ripening, while in over-ripe fruits it was not detected, probably having been utilized during the biosynthesis of the respective glycoside (Gross, 1987).

7. Nitrogen

The effect of nitrogen is associated with poor anthocyanin accumulation in fruits. It is not known whether the effect is indirect, producing increasing vegetative growth which hinders the penetration of light, delaying fruit maturity; or direct, as more synthesized, interfering with the biosynthesis of sugar and anthocyanins (Gross, 1987).

Applications of anthocyanins. (Hendry and Houghton, 1996)

1. **Soft drinks.** The principal use of anthocyanin color is in soft drinks. Clear drinks with a pH below 3.4 and not containing SO₂ as a preservative present an ideal application.
Anthocyanins are not usually suitable for use in cloudy beverage. The presence of the cloud causes a very noticeable “blueing” of the color because of adsorption onto the cloudifier and the “thin layer” effect.
2. **Fruit preserves.** Anthocyanins are also used in fruit preparations, jams and preserves. The nature and quality of the fruit is important fresh or frozen being preferable to sulphited or canned fruit.
3. **Sugar confectionery.** Acid sugar confectionery, particularly high boiling, and pectin jellies are an ideal application for anthocyanins where a variety of red shades can be obtained.
4. **Dairy products.** It is uncommon to color dairy products with anthocyanins since their pH is such that a violet to grey color would be achieved. In addition, the presence of the suspended fat particles increases the visual blueness of the color. Acid dairy products such as yogurt can be successfully colored although the shade achieved is distinctly purple.
5. **Frozen products.** Ice cream is not usually colored with anthocyanins because its pH is too high, beetroot red being the preferred red color. However, although water ice with a pH of around 3.0 would seem an ideal application, when frozen it is distinctly bluer than the red solution before freezing.
6. **Dry mixes.** A variety of acid dessert mixers and drink powders can be successfully colored with spray-dried anthocyanin extracts.
7. **Other applications.** It is also technically possible to color alcoholic drinks and products containing vinegar with anthocyanins, although commercial applications are limited.

Ice cream

Ice cream is a frozen dessert composed of fat, sweeteners, stabilizers, and emulsifiers. These ingredients are mixed, churn and freeze to a soft, smooth volume called ice cream.

Ice cream and related products are generally classified as frozen desserts which include ice cream, frozen custard, ice milk, sherbet, water ice(sorbet), frozen confections, and mellorine and parevine type products.

Ice cream is defined by Federal Standards in the United States. It must contain not less than 10% milk fat and 20% total milk solids, except in the case of bulky flavors, the weight of the fat and total milk solids shall not be less than 8 and 16%, respectively. It shall weigh not less than 4.5 lbs. per gallon, contain no more than 0.5% stabilizer, and contain not less than 1.6 lbs. of food solids per gallon (Arbuckle 1984, p.1).

Energy Value and Nutrients of Ice Cream

The energy value and nutrients of ice cream depend up on the food value of the products from which it is made. The milk products which go into the mix contain the constituents of milk, but in different amounts. Ice cream contains 3-4 times as much fat, and about 12-16% more protein than milk does. In addition, it may contain other food products such as fruit, nuts, eggs, candies, and sugar which enhance its nutritive value. Ice cream contains about 4 times as much carbohydrates as milk. Ice cream is an excellent source of energy. The fact that these constituents that make up ice cream are almost completely assimilated makes ice cream an especially desirable food for growing children and for persons who need to put on weight (Arbuckle 1984, p.14).

Composition of Ice Cream

Milk fat

Milk fat is an ingredient of major importance in ice cream. The correct percentage of milk fat is essential not only to balance the mix properly, but also to satisfy legal standards. Fat particles concentrate toward the surface of the air cell during the freezing process. This perhaps accounts, in part, for milk fat imparting a rich characteristic to the flavor. Milk fat does not lower the freezing point but tends to retard the rate of whipping. High fat content may limit consumption, will have a high caloric value, and will increase the cost. The fat content of commercial ice cream is 10-12%.

Sweeteners

Sweeteners are classified into two types, either as nutritive or nonnutritive.

a. Nutritive Sweeteners

Nutritive sweeteners are sweeteners that not only sweeten but also provide calories. Examples of nutritive sweeteners are sugar, lactose, dextrose, fructose, corn syrup, and sugar alcohols.

Table 1: Comparison of the Properties of Nutritive Sweeteners

| Sweetener | Relative Sweetness | Solubility (g/100g) @ 25°C | Chemical Type |
|--------------------------|--------------------|----------------------------|----------------|
| Sucrose | 1.0 | 67 | Disaccharides |
| Glucose | 0.6 | 51 | Monosaccharide |
| Sorbitol | 0.6 | 72 | Sugar alcohol |
| Mannitol | 0.7 | 18 | Sugar alcohol |
| High fructose corn syrup | 1.2 | 67 | Mixtures |

Sugar (sucrose) Sugar provides sweetness, contributes to total solids, depresses freezing points, enhances flavor, and affects body and texture. In general the equivalent of 15% sucrose is considered an optimum sweetness in ice cream.

Sugar Alcohols Examples of sugar alcohols are Sorbitol, mannitol, and xylitol. These sugar alcohol depress freezing point to a greater extent than sugar but also have lower relative sweetness comparing to sugar.

Table 2: Effect of Nutritive Sweeteners on Freezing Point Depression

| Sweetener | Relative Effect |
|------------------------------|------------------------|
| Sucrose | 1.0 |
| Lactose | 1.0 |
| Dextrose | 1.82 |
| Fructose | 1.82 |
| 55% High fructose corn syrup | 1.85 |
| Sorbitol | 1.90 |
| Glycerol | 3.70 |
| Alcohol | 7.40 |

Other Nutritive Sweeteners Honey is also used as sweetener. Honey is made up of glucose and fructose, therefore it depresses freezing point to a greater extent than sugar at equivalent concentrations.

Maltodextrin is a polysaccharide produced from starch by partial hydrolysis. It is easily digestible, being absorbed rapidly as glucose. In some low fat mix as well as no sugar added mixes, maltodextrins of 5 or 10 DE are used to provide solids in the mix without adversely affecting the freezing point of the mix. Typically the DE ranges from 5 to 15 for maltodextrins.

b. Non-nutritive Sweeteners.

Ice cream or frozen desserts that use no sugar rely on nonnutritive sweeteners to provide the sweet taste needed without giving many calories. The nonnutritive sweeteners include sucralose, aspartame, saccharin, cyclamates, Acesulfame-K, and many others.

Table 3: Comparison among Nonnutritive Sweetener

| Sweetner | Relative Sweetness | Solubility (g/100g) 25°C |
|-----------------|---------------------------|-------------------------------------|
| Saccharin | 250-550 | 125 |
| Cyclamate | 30-50 | Not known |
| Aspartame | 120-200 | 1 |
| Acesulfame-K | 100-130 | 27 |
| L-sugars | 1.0 | 67 |
| Sucralose | 500-700 | 30 |

(Kilara A. and Chandan R.C. 2007, p.602)

Flavoring and Coloring Materials

Frozen desserts are valued mainly for their pleasing flavor and their cooling and refreshing effects. Since there are so many kinds of flavoring material and since they are sold under so many brands and grades, it is well to understand their sources and to select and buy with great care.

Flavoring substances can be either natural or chemically-produced. Included among the natural flavorings are (1) fruit flavors; (2) citrus fruit; (3) tropical fruit flavors; (4) sugar free fruit flavors; (5) natural flavors from botanicals; (6) spices; (7) cocoa and chocolate; (8) coffee; (9) natural flavorings from vanilla beans; and (10) nuts. The synthetic flavorings include aromatic chemicals and imitation flavors. Liqueurs flavorings are also included: (1) alcohol; (2) whiskey and other distilled beverages; (3) fruit brandy distillate and brandy flavor essence; and (4) fruit liqueurs (Arbuckle 1984, p.107).

Ice cream should have a delicate, attractive color which suggests or is readily associated with the flavors. Only colors certified by U.S. FDA should be used.

Almost all flavors of ice cream should be slightly colored. Enough yellow color is generally added to vanilla ice cream to give it the shade of natural cream produced in the summer months. Fruit ice creams need to be colored because about 15% fruit, the maximum commonly uses, produces only a slight effect on color.

Stabilizers

Stabilizers are substances that stabilize the structure of the ice cream by doing two things; reduce iciness and extending shelf-life (Goff D, 1995).

There are two general types of stabilizer: (1.) The gelatin type of stabilizers which come from animal sources, such as calfskin, pork skin, bones, etc., which supplies certain desirable amino acids; and (2) the vegetable stabilizers such as sodium alginate, carrageenan, CMC, and such other gums as tragacanth, etc. All stabilizers have a high water holding capacity effective in smoothening the texture and giving the body to the finished product. Their most important function is to prevent coarsening of texture under temperature fluctuations (Arbuckle 1984, p.39).

Each stabilizer has its own characteristics and often more than one stabilizer is used in combination to achieve the desired properties (Goff D, 1995).

Emulsifiers

Emulsifiers are substances which tend to concentrate in the interface between the fat and the plasma and reduce the surface tension of the system (Arbuckle 1984, p.103). Emulsifiers aid in developing the appropriate fat structure and air distribution necessary for the smooth eating and good meltdown characteristics desired in ice cream. Since each molecule of an emulsifier contains a hydrophilic portion and a hydrophobic portion, they reside at the interface between fat and water. As a result they act to reduce the interfacial tension or the force which exists between the two phases of the emulsion. This causes a desorption of protein from the fat droplet surface, which promotes a destabilization of the fat emulsion (due to a weaker membrane) leading to a smooth, dry product with good meltdown properties.

Apart from sweeteners, stabilizers, and emulsifiers are also important nondairy ingredients. Generally mono- and diglycerides and ethoxylated esters of sorbitol (polysorbates) are the commonly used emulsifiers (Goff D, 1995).

There are two types of emulsifiers used in the manufacture of ice cream. These are the (1) mono- and diglycerides derived by chemical reaction of naturally occurring glycerides and (2) poly oxyethylene derivatives of hexahydric alcohols, glycol, and glycol esters.

The monoglyceries improve fat dispersion and whipping ability and have a moderate effect on stiffness and rate of melting. The polyderivatives are effective in producing dryness, stiffness, and increasing the melting time. Egg yolk products are high in lecithin and have long been used in ice cream. These products produce similar results but not as pronounced as those produced by commercial emulsifiers (Arbuckle 1984, p.103).

Balancing Ingredients (water)

To balance the formula, milk or water may be necessary. Solids such as fruit pulps in the juice and sugar will contribute serum solids. As for sorbet, water is used to dilute the solids; therefore a balancing ingredient is necessary.

Water not only balances the formula but also have an important role in the complicated physicochemical system which ice cream represents, described as containing a gas dispersed in a liquid, a solid or a mixture of liquid and solid. This continuous phase represents a partly frozen emulsion with the ice crystals and the solidified fat globules being embedded in the unfrozen water phase; the structural constituents are separated by various interfaces between the air cells and the serum stabilized by a thin film of the unfrozen material or lamellae or cell wall while solidified fat may be dispersed in the unfrozen serum around the air cell walls.

The source of water in the ice cream mix may be mainly from fluid dairy products or added from the water supply. The water in fluid dairy supply products has passed through the mammary gland and may be expected to have a high degree of purity. The water added from the water supply may vary widely in degree of purity (Arbuckle 1984, p.62).

Structure from the Ice crystals

Also adding structure to the ice cream is the formation of the ice crystals. Water freezes out of a solution in its pure form as ice. In a sugar solution such as ice cream, the initial freezing point of the solution is lower than 0°C due to these dissolved sugars (freezing point depression), which is mostly a function of the sugar content of the mix. As ice crystallization begins and water freezes out in its pure form, the concentration of the remaining solution of sugar is increased due to water removal and hence the freezing point is further lowered. This process is shown here, schematically in Figure 1 (Goff D, 1995).

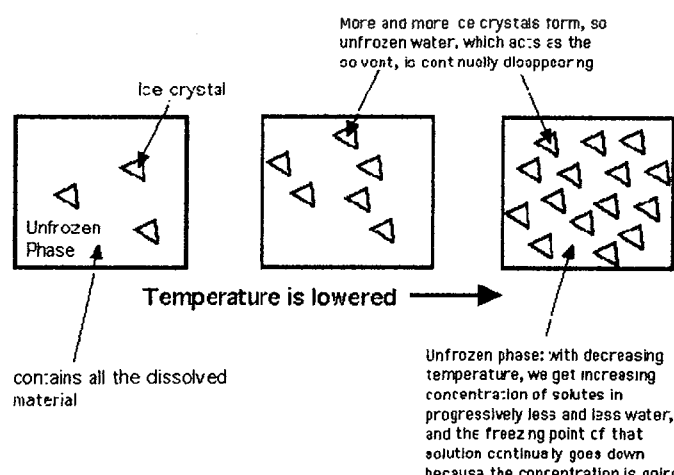


Figure 2: Ice Crystal Formation of Ice Cream (Goff D, 1995)

Type of Ice Cream

Table 4: Ice Cream Types Based on USDA Standard (Anonymous, 2009)

| Type | Description |
|----------------------------|---|
| 1. Super premium ice cream | Tends to have very low overrun and high fat content, and the manufacturer uses the best quality ingredients. |
| 2. Premium ice cream | Tends to have low overrun and higher fat content than standard ice cream, and the manufacturer uses higher quality ingredients. |
| 3. Standard ice cream | Meets the minimum requirements of the ice cream standard of identity in 21 CFR § 135.110. |
| 4. Economy ice cream | Meets the minimum requirements of the ice cream standard of identity in 21 CFR § 135.110 and generally sells for a lower price than standard ice cream. |
| 5. Fat free | Food contains less than 0.5 g fat per reference amount customarily consumed (as specified in 21 CFR § 101.12). |
| 6. No sugar added. | No sugar or sugar containing ingredient is added during processing or packaging. |
| 7. Lite | If ≥ 50 percent calories are from fat, fat must be reduced by at least 50 percent. If > 50 percent of calories are from fat, fat must be reduced by at least 50 percent or calories reduced by at least $1/3$ per reference amount customarily consumed compared to an appropriate reference food. |
| 8. Reduced fat | Food contains at least 25 percent less fat per reference amount customarily consumed than an appropriate reference food. |
| 9. Low fat | Food contains 3 g or less of fat per reference amount customarily consumed. |

Source: The following information is from The U.S. Department of Agriculture Commercial Item Description A-A-20342 for Ice Cream, Sherbet, Fruit and Juice Bars, Ices, and Novelties.

Plain Ice Cream

An ice cream in which the total amount of color and flavoring ingredients is less than 5% of the volume of the unfrozen ice cream. Examples are vanilla, coffee, maple, and caramel ice cream (Arbuckle 1984, p.25).

Granita

A granita is made from a light sugar syrup and flavoring. Ice crystals are allowed to form during freezing giving the ice a grainy, granular texture. It should be served when it is still at slushy, semi-frozen stage (Walden H 1995, p.15).

Sherbet

Sherbet is made of fruit juices, sugar, stabilizer, and milk products. It is similar to sorbet except that milk, either whole, skim, condensed, or powdered, or ice cream mix, is used in place of all or part of the water in an ice. Sherbet must contain between 1% and 2% milk fat. The total milk solids content must be not less than 2% nor more than 5%. A fruit Sherbet must weight not less than 6 lbs. per gallon and must contain a small amount of edible acid such as citric acid which is found in citric fruits (Arbuckle 1984, p.26).

Sorbet

Sorbet is made from concentrated sugar syrup, fruit juice, emulsifiers, stabilizers, water, and with or without flavorings and is beaten several times during freezing process to help break up the ice crystals and create smooth texture. It should be served when it is one stage harder than being slushy, and just capable of being molded.

It is light, fresh tasting and fluffy when consumed fresh on site. The difficulty with sorbet is that it tends to melt quickly and, in cold storage, tends to collapse in to an icy mass, thus having a very limited shelf life (Mehta N. and Paget R., 2005).

Sherbet should contain less than 1% milk fat and no more than 2% milk fat; milk solids-non-fat content should not be less than 2% and no more than 5%. The minimum weight requirement is 6 lb/gallon. A fruit flavored sherbet should have a minimum acidity of 0.35%. Sorbet and other ices have the same standard as sherbet except no milk or egg ingredients are allowed with exception to egg white (Kilara A. and Chandan R.C. 2007, p.595).

There are two basic techniques for freezing sorbet, churn-freezing or still-freezing. Churn-freezing requires an ice-cream maker. The process involves churning and freezing at the same time to get a consistent and even texture. Still-freezing is a machine-less technique. The sorbet mixture is put in a tray and then place in a freezer (Berkoff N, 1998).

Frozen Yogurt

Frozen yogurt has a smooth texture similar to ice cream and a slightly acidic taste that complements fruit particularly well (Elise P., Kershaw M. and Hay D. 2000, p.6).

Iced Mousse

An Ice Mousse is a light-textured but fairly rich dessert based on well-whisked egg yolks, often with the addition of whipped cream and sometimes with egg whites. It is frozen in the fish in which it will be served with a deep collar of greaseproof paper supporting the mousse as it stands above the rim. The collar is removed when the mousse is served and the exposed sides can be decorated with, for example, finely chopped nuts or macaroons (Walden H 1995, p.15).



Materials and Methods

Materials

- Commercial 100% apple juice
- Commercial 100% Guava juice
- Commercial 100% pineapple juice
- Sugar
- Malic acid
- Egg
- Dried butterfly pea

Equipment and Apparatus

- Ice cream makermachine, Fortunate Brand ice cream marker 3 liters
- Cake mixer, Severin Brand Handmixer blender mixer staafmixer
- Balance, Zepper; ES-3000H
- Spectrophotometer, GENESIS 5
- Hot plate, Harmory HTS-1003

Methods

1. Selection of a suitable temperature ,time, and percentage of butterfly pea

The butterfly pea was boiled at different temperature which were 50, 60 and 70°C and different time which were 5, 10 and 15 minutes. The percentage of butterfly pea was varied around 2, 4 and 5 %. The boiled butterfly pea solutions at different percentage, time and temperature were used to measure the OD by spectrophotometer at wavelength 560 nm in order to check the highest intensity for using with the butterfly pea ice cream.

2. Determination of °Brix, pH, and color of pure butterfly pea in different fruit juices

Different types of fruit juice which were apple juice, guava juice, pineapple juice and also the solution of pure butterfly pea were measured °Brix, pH, and color by using refractometer, pH meter, and Munsell book, respectively. The butterfly pea solution was mixed with each type of juice in the ratio of 5% of butterfly pea and 95% of different type of fruit juice. The °Brix, pH, and color were also measured in the mixture between butterfly pea and the fruit juices.

3. Formulation

3.1 Preliminary test

The ice cream was made by using the standard formula of ice cream maker, Fortunate ice cream maker, to check the quality and characteristics of plain sorbet ice cream.

Table 5: The standard formula of ice cream

| Ingredients | Weight |
|-------------|-----------|
| Sugar | 170 grams |
| Juice | 400 mL |
| Malic acid | 2 grams |
| Egg, white | 1 |
| Water | 430 mL |

3.2 Product development step

3.2.1 Determination of the best juice that used with butterfly pea

Butterfly peas ice cream was developed by incorporating with the different types of fruit juice with butterfly pea extract from (2). The standard formula was made by incorporated solution of butterfly pea extract with different type of the fruit juice which was apple, guava and pineapple juice.

Table 6: The standard formula of butterfly pea sorbet ice cream

| Ingredients | Weight |
|---------------------------|-----------|
| Sugar | 170 grams |
| Juice | 400 mL |
| Malic acid | 2 grams |
| Egg, white | 1 |
| Water | 380 mL |
| Butterfly pea extract (2) | 50 mL |

3.2.2 Screening for the most preferable juice

The most preferable formulas from 3 types of the fruit juice which were apple, guava and pineapple juice were compared using 9-point hedonic scale preference test to select the most preferable types of juice. Six attributes were studied as color, flavor, texture, appearance, sweetness and overall acceptance. Test panelists who were students in a School of Biotechnology were used as instrument in the sensory analysis.

3.2.3 Just About Right

The most preferable butterfly pea sorbet, obtained from (3.2.2) was used in the Just About Right (JAR) to determine 7 attributes which were juice flavor, texture, sweetness, sourness, color, appearance and overall acceptance affecting butterfly pea ice cream quality. Test panelists were used as instrument in the sensory analysis. The result from JAR was for further adjustment of the butterfly pea ice cream.

3.3 Consumer test

The consumer test was done using questionnaire (Appendix A: A-1) with the obtained formula from (3.2.3) to do the final product testing for 200 consumers.

4. Sensory evaluation

4.1 The preference test 9-point hedonic scale was used in selecting and screening the most preferable type of juice for developing the butterfly pea ice cream. (Appendix A: A-1)

4.2. The Just About Right (JAR) scale test was used based on the 7 attributes including juice flavor, texture, sweetness, sourness, color, appearance and overall acceptance in order to determine the attribute that needed to be adjusted. (Appendix B: B-1)

4.3 The consumer acceptance test was used on a large group of consumers to study the consumer's behaviors, attitudes and needs toward a development of butterfly pea ice cream. (Appendix C: C-1)

5. Statistical analysis

Microsoft excel was used to analyze the data. ANOVA was conducted to determine whether there was significant difference among treatment @ $p < 0.05$. Duncan multiple range test was used to identify significant different treatment if there was a significant difference in ANOVA.

6. Experimental location

6.1 E1 room, E building Assumption University (Hua Mak Campus)

6.2 E83 room, E building Assumption University (Hua Mak Campus)

6.3 Assumption University (Hua Mak Campus)

Result & discussion

1. Selection of a suitable temperature ,time, and percentage of butterfly pea

Temperature, time, and percent dry butterfly pea flower were studied in order to determine the suitable condition for extraction the color. The flower was boiled at different conditions to check the highest intensity for using in the butterfly pea ice cream. The solutions were cooled before read the absorbance at 560 nm. The result was recorded in Table 7 to Table 9.

Table 7: The absorbance of different percentage of butterfly pea and time at 50°C

| Temperature | 50°C | | |
|--------------------|------------------------------------|-------|--------------|
| Time (min) | Percentage of butterfly pea | | |
| | 2% | 4% | 5% |
| 5 | 0.249 | 0.596 | 0.961 |
| 10 | 0.484 | 1.200 | 1.393 |
| 15 | 0.681 | 1.528 | 1.967 |

Table 8: The absorbance of different percentage of butterfly pea and time at 60°C

| Temperature | 60°C | | |
|--------------------|------------------------------------|-------|--------------|
| Time (min) | Percentage of butterfly pea | | |
| | 2% | 4% | 5% |
| 5 | 0.881 | 1.277 | 1.623 |
| 10 | 1.549 | 2.296 | 2.560 |
| 15 | 1.832 | 2.580 | 2.590 |

Table 9: The absorbance of different percentage of butterfly pea and time at 70°C

| Temperature | 70°C | | |
|--------------------|------------------------------------|-------|-------|
| Time (min) | Percentage of butterfly pea | | |
| | 2% | 4% | 5% |
| 5 | 1.708 | 1.820 | 2.110 |
| 10 | 2.730 | 2.580 | 2.788 |
| 15 | 3.230 | 3.193 | 3.210 |

From Table 7 and Table 8 at temperature 50 and 60°C, respectively, absorbance continually increased as time passed from 5 minutes to 15 minutes and the amount of dry flower increased from 2 to 5%. In contrast, Table 9, heated at 70°C, showed absorbance reached its highest in 15 minutes in all solution with the highest at 2% dry butterfly pea flower as 3.230. Figure 1 showed that the absorbance increased with time and concentration of flower and reached the highest at 70°C. So, 2% of dry butterfly pea flower heated at 70°C for 15 minutes was chosen for the extraction of color from dry butterfly pea flower to use in preparation of sorbet ice cream.

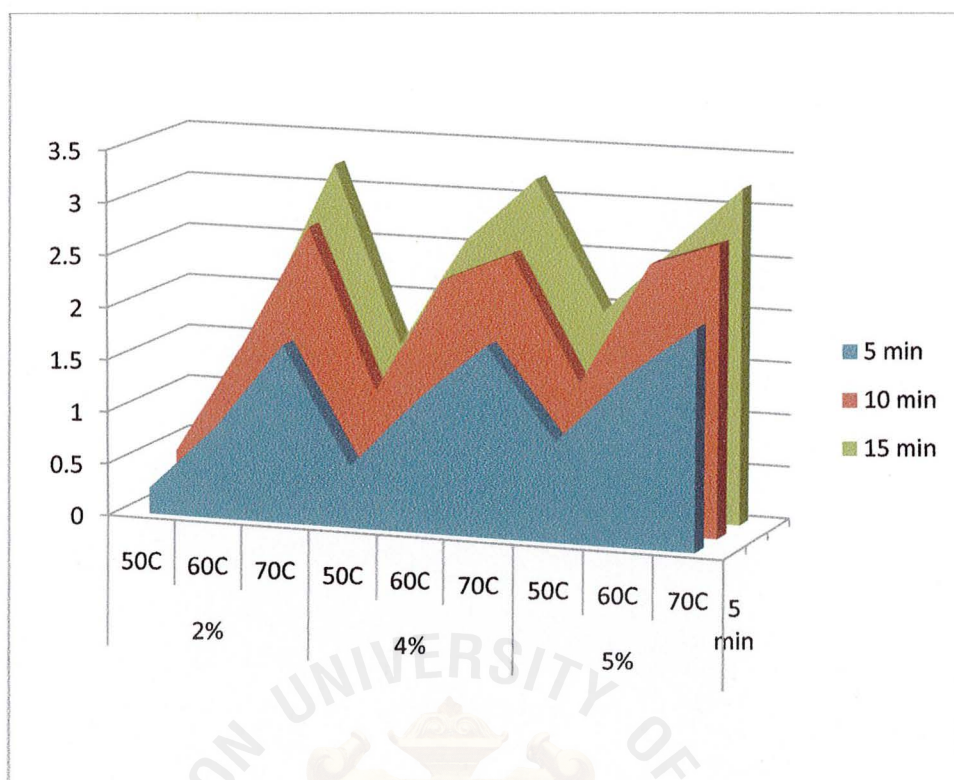


Figure 3: Absorbance reading of butterfly pea solution extracted at different temperature and time from different concentrations

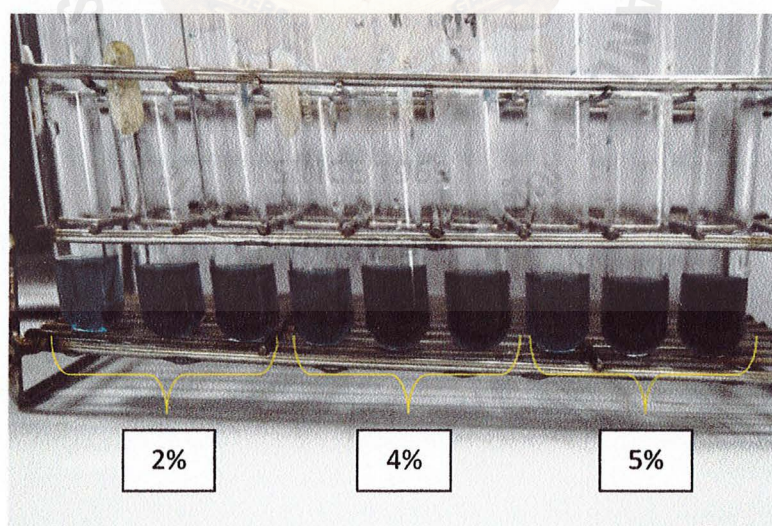


Figure 4: Color of butterfly pea extracted solution from different extraction condition

2. Determination of °Brix, pH, and color of butterfly pea solution in different fruit juices

Table 10: The value of pH, °Brix, and color of different pure juice

| Attributes | Sample | | | |
|------------|---------|------------|-------------|-------------|
| | Control | Apple | Guava | Pineapple |
| pH | 6.14 | 3.82 | 3.21 | 3.77 |
| °Brix | 0 | 12.5 | 9.5 | 13.2 |
| Color | 5PB2/2 | 7.5Y8.5/10 | 10Y9/6 | 5Y8.5/10 |

Note: Control - water

From table 10, guava had the highest acidity due to its lowest pH value as 3.21 following with pineapple and apple. Pineapple had the highest sweetness of 13.2°Brix following with apple and guava. All fruit juices produced different yellow color shades as read by Munsel Book of Color.

Table 11: pH, °Brix, and color of different mixed solution of juice and 2% of butterfly pea solution

| Attributes | Sample | | | |
|------------|---------|-------|-------------|-----------|
| | Control | Apple | Guava | Pineapple |
| pH | 6.14 | 3.83 | 3.24 | 3.77 |
| °Brix | 0 | 11 | 9 | 12 |
| Color | 5PB2/2 | 5P6/6 | 2.5P5/4 | 10PB7/2 |

From table 11, after mixing each juice with butterfly pea solution, the pH value for almost juices were increased slightly with the lowest was from guava and butterfly pea solution. The same as pH, total soluble solid also decreased slightly with the highest Brix in pineapple juice and butterfly pea solution. After mixing with butterfly pea solution, the color of the juices was influenced by the color from the butterfly pea.



Figure 5: Color of commercial fruit juice and mixture of commercial fruit juice and 2% butterfly pea extraction

3. Formulation

3.1 Preliminary test

The ice cream was made by using the standard formula of ice cream in Fortunate ice cream maker. Quality and characteristics of plain sorbet ice cream were checked.

Table 12: The standard formula of ice cream

| Ingredients | Weight |
|-------------|-----------|
| Sugar | 170 grams |
| Juice | 400 mL |
| Malic acid | 2 grams |
| Egg, white | 1 |
| Water | 430 mL |

3.2 Product development step

3.2.1 Determination of the suitable juice to use with butterfly pea in sorbet ice cream

Butterfly peas ice cream was developed by incorporating with different kinds of fruit juice. The standard formula was made by incorporated solution of butterfly pea extract with different type of the fruit juice which was apple, guava and pineapple juice in replacing with a portion of water in the basic formula.

Table 13: The standard formula of ice cream

| Ingredients | Weight |
|--------------------------------------|-----------|
| Sugar | 170 grams |
| Juice | 400 mL |
| Malic acid | 2 grams |
| Egg, white | 1 |
| Water | 380 mL |
| 2% Butterfly pea extraction solution | 50 mL |

From table 13, the formula was adjusted formula from basic formula by adding 50 mL of butterfly pea solution and decreased the amount of water in formula from 430 to 380 mL.

3.2.2 Screening for the most preferable juice

Three sorbet ice creams were prepared using a mixed solution of 2% butterfly pea extraction solution with three kinds of the commercial fruit juices which were apple, guava and pineapple juice. They weretested using 9-point hedonic scale preference test to select the most preferable kinds of fruit juice. Ten test panelists who were student in the School of Biotechnology, Assumption University, were used as a tool in a sensory evaluation test. They were asked to rate the ice cream samples under six attributes which were color, flavor, texture, appearance, sweetness and overall acceptance. The results were analyzed using Microsoft Excel program and demonstrated in Table 13.

Table 14: The average score of 9-point hedonic scale preference test for butterfly pea sorbet in different juice.

| Attribute | Average score of butterfly pea sorbet | | |
|------------|---------------------------------------|--------------------------|--------------------------|
| | Apple | Guava | Pineapple |
| Color | 6.92 ± 0.64 ^b | 4.46 ± 0.76 ^a | 5.00 ± 0.58 ^a |
| Flavor | 6.08 ± 0.49 ^b | 4.85 ± 0.69 ^a | 5.23 ± 0.93 ^a |
| Texture | 6.92 ± 0.49 ^b | 5.85 ± 0.55 ^a | 6.23 ± 0.60 ^a |
| Appearance | 6.85 ± 0.38 ^c | 4.85 ± 0.55 ^a | 5.92 ± 0.49 ^b |
| Sweetness | 8.54 ± 0.52 ^c | 5.77 ± 0.73 ^a | 7.00 ± 0.58 ^b |
| Overall | 7.15 ± 0.68 ^c | 4.00 ± 0.57 ^a | 4.76 ± 0.59 ^b |

Note: Treatment scores with different superscripted letter were significant different at $p < 0.05$

From table 14, there were significant different in all attributes ($p < 0.05$). Mixed apple juice and butterfly pea extract sorbet received the highest average scores in all attributes color as 6.92, flavor as 6.08, texture as 6.92, appearance as 6.85, sweetness 8.54, and overall liking as 7.15. The average scores were significantly different from all the others. So, apple juice was chosen for further study.

3.2.3 Just About Right

To increase color of the sorbet ice cream, different amounts of butterfly pea solution was varied as 5, 10 and 15% in the formula and the test panelists performed Just About Right to determine the extent of just right of six attributes of the sorbet ice cream samples. The table 15, 16, and 17 showed the adjusted butterfly pea sorbet ice cream formulas.

Table 15: The formula of butterfly pea sorbet from 5% of butterfly pea solution

| Ingredients | Weight |
|-------------------------------|-----------|
| Sugar | 170 grams |
| Apple juice | 400 mL |
| Malic acid | 2 grams |
| Egg, white | 1 |
| Water | 380 mL |
| Butterfly pea extraction (2%) | 50 mL |

Table 16: The formula of butterfly pea sorbet from 10% of butterfly pea solution

| Ingredients | Weight |
|-------------------------------|-----------|
| Sugar | 170 grams |
| Apple juice | 400 mL |
| Malic acid | 2 grams |
| Egg, white | 1 |
| Water | 330 mL |
| Butterfly pea extraction (2%) | 100 mL |

Table 17: The formula of butterfly pea sorbet from 15% of butterfly pea solution

| Ingredients | Weight |
|-------------------------------|-----------|
| Sugar | 170 grams |
| Apple juice | 400 mL |
| Malic acid | 2 grams |
| Egg, white | 1 |
| Water | 280 mL |
| Butterfly pea extraction (2%) | 150 mL |

Table 18 to table 20 showed the results from JAR test of three butterfly pea sorbet ice creams containing varied amount of butterfly pea solution mixed with commercial apple juice. 6 attributes, including apple flavor, texture, sweetness, sourness, color, and appearance acceptance were evaluated in the butterfly pea ice cream samples.

Table 18: The percentage of Just-About-Right Test for each attribute of 5% butterfly pea sorbet

| Attributes | Too little | Somewhat too little | Just right | Somewhat too much | Too much |
|-------------|------------|---------------------|------------|-------------------|----------|
| Appleflavor | | 10% | 90% | | |
| Texture | | 10% | 90% | | |
| Sweetness | | | 100% | | |
| Sourness | | | 100% | | |
| Color | | 10% | 90% | | |
| Appearance | | 10% | 90% | | |

Table 19: The percentage of Just-About-Right Test for each attribute of 10% butterfly pea sorbet

| Attributes | Too little | Somewhat too little | Just right | Somewhat too much | Too much |
|-------------|------------|---------------------|------------|-------------------|----------|
| Appleflavor | | | 100% | | |
| Texture | | | 90% | 10% | |
| Sweetness | | | 100% | | |
| Sourness | | | 100% | | |
| Color | | | 100% | | |
| Appearance | | | 90% | 10% | |

Table 20: The percentage of Just-About-Right Test for each attribute of 15% butterfly pea sorbet

| Attributes | Too little | Somewhat too little | Just right | Somewhat too much | Too much |
|-------------|------------|---------------------|------------|-------------------|----------|
| Appleflavor | | | 90% | 10% | |
| Texture | | | 80% | 20% | |
| Sweetness | | | 100% | | |
| Sourness | | 10% | 90% | | |
| Color | | | 50% | 50% | |
| Appearance | | | 70% | 30% | |

From Table 18 to Table 20, more than 50% of the test panelists rated all sorbet ice cream samples at just right in all attributes with exception to 15% butterfly pea sorbet ice cream color that exactly 50% of the test panelists rated it was just right and another 50% rated it as somewhat too much. The result indicated that too much butterfly pea not only created high product cost but also started to have negative impact on the color of the product.

Thus, 10% of butterfly pea solution (resulted from Table 19) was selected for further development of the butterfly pea sorbet ice cream because it got the most just right in each attribute from the test panelists. The final formula was shown again as table 21.

Table 21: The final formula of butterfly pea sorbet ice cream

| Ingredients | Weight |
|---------------------------|-----------|
| Sugar | 170 grams |
| Juice | 400 mL |
| Malic acid | 2 grams |
| Egg, white | 1 |
| Water | 330 mL |
| Butterfly pea extract (2) | 100 mL |

3.3 Consumer test

The final acceptance test was performed by using questionnaire (Appendix C: C-1) to survey of 200 consumers. The questionnaire consisted of basic information of consumer's behavior on sorbet ice cream in the market, information of consumer's behavior on butterfly pea sorbet ice cream and demographic information. All the data and information was shown as the percentage and pie charts in the figure 6 to 8.

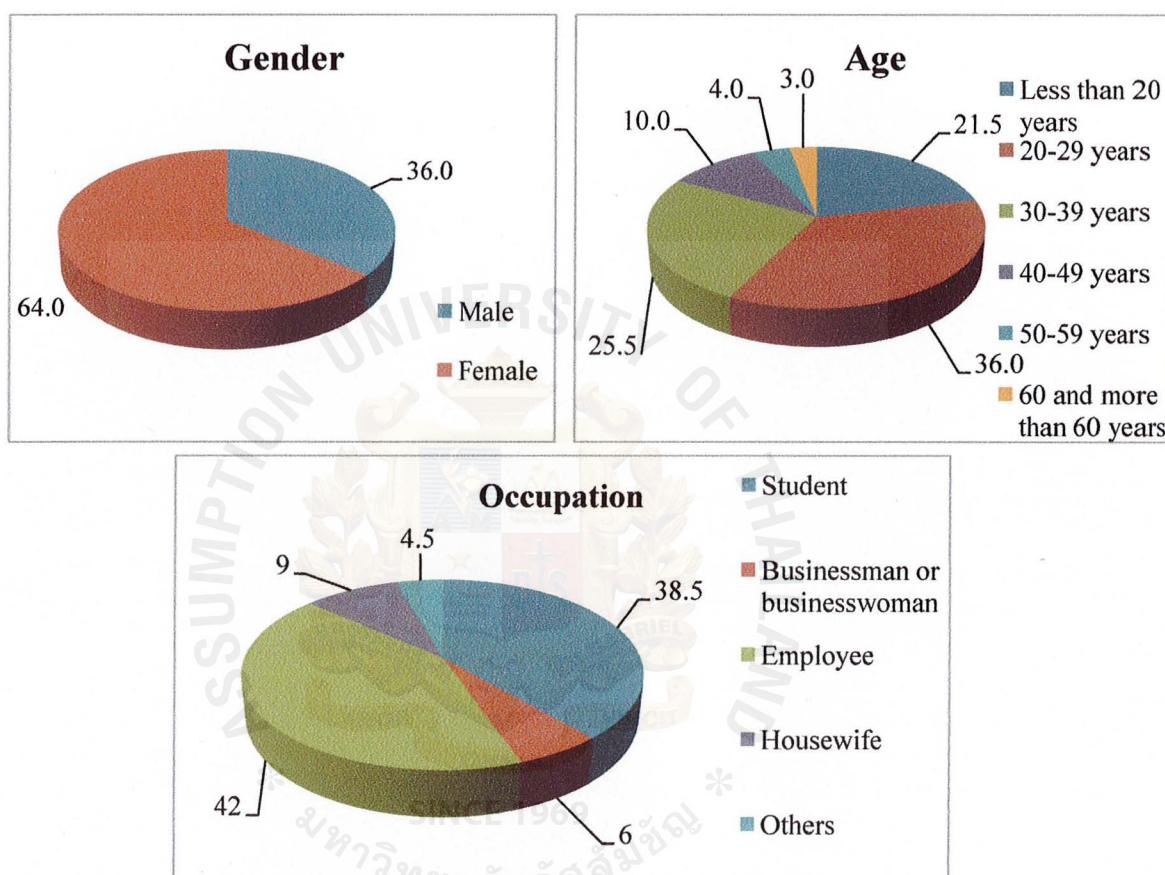


Figure 6: Pie charts of consumer's demographic – gender (upper left), age (upper right), and occupation (lower)

From figure 6 showed the demographic data from 200 consumers, they were all Thai nationality which had 64% of female and 36% of male. Most of consumers had age between 20-29 years old (36%) and worked as employee (42%). The group of consumers is people who live in Tharinporn Villa, Nonthaburi Province.

Next is the consumers' behavior on consumption of sorbet ice cream. The results were shown in Figure 7.

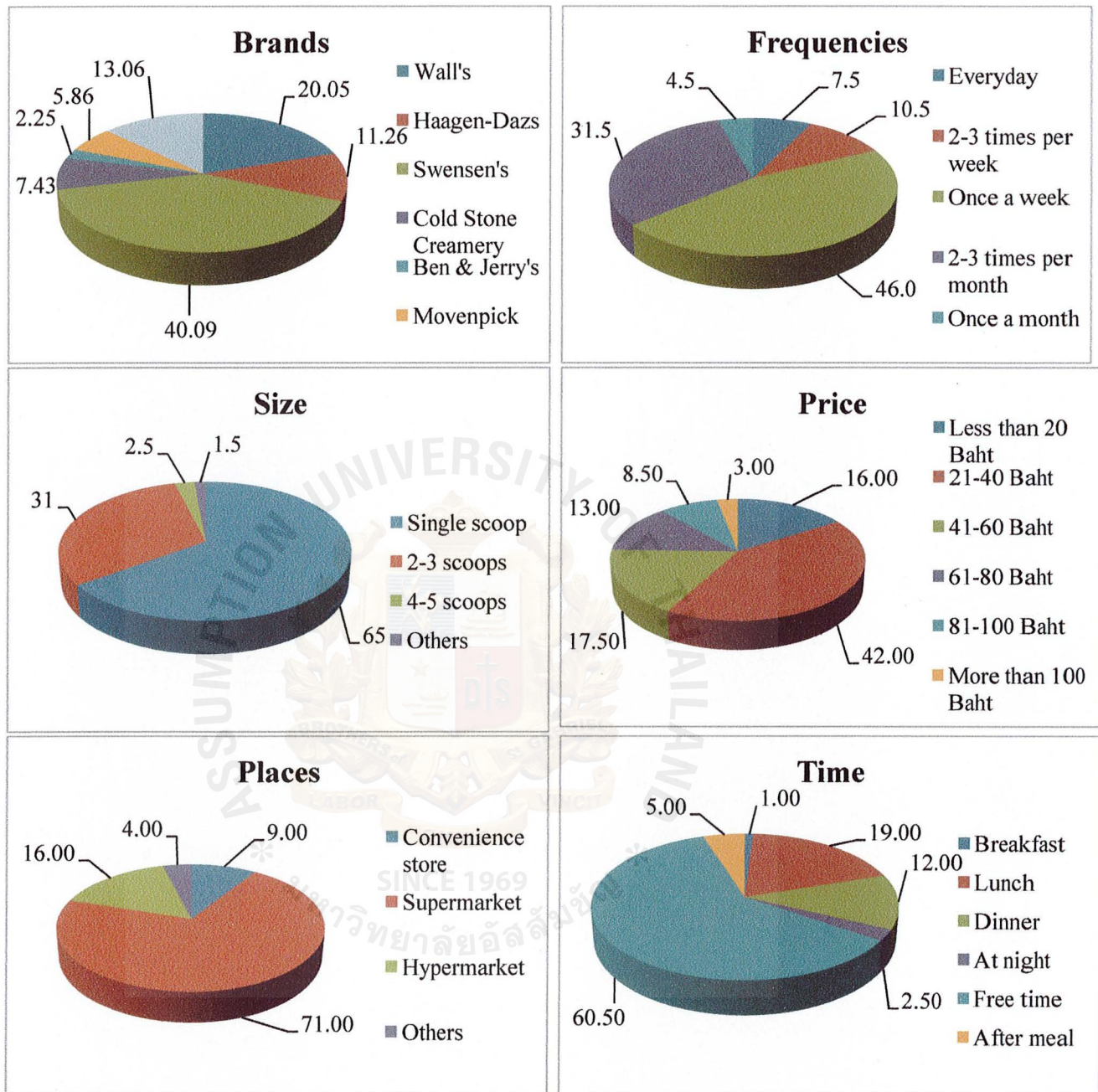


Figure 7: Pie charts of consumer's behavior on sorbet in the market

From figure 7 showed the basic information of consumer's behavior on ice cream in the market, almost consumers preferred the Swensen's brand as 40.09% and followed by Wall's brand as 20.06%. Most of them consumed ice cream once a week as 46.0% in the free time for 60.5%. 65% of consumers bought ice cream as single-scoop at the ice cream parlor in supermarket around 71% with around 42% the price between 21-40 Baht.

Moreover, they were asked about the information of consumer's behavior on butterfly pea sorbet ice cream as shown in Figure 8.

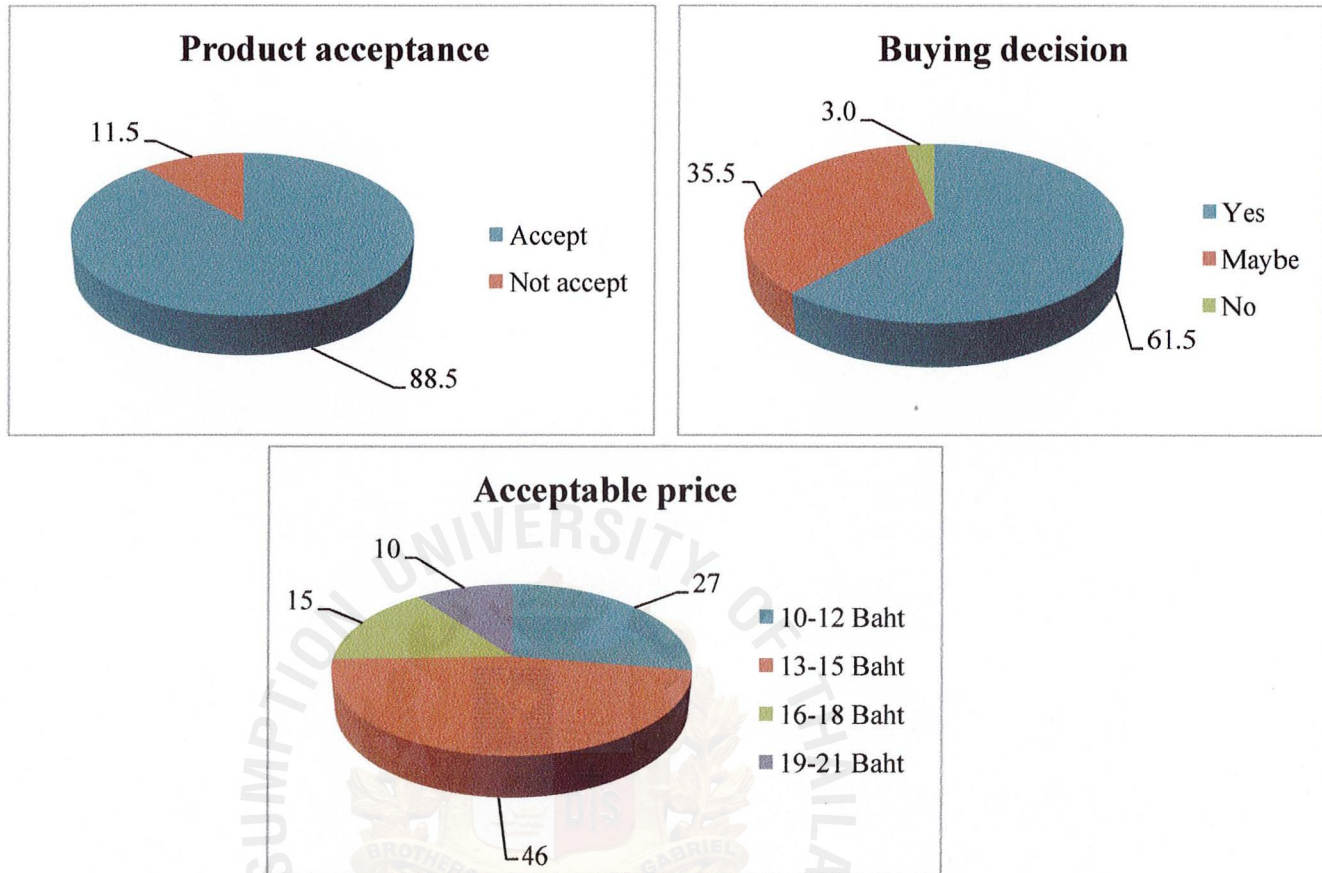


Figure 8: Pie charts of consumer's behavior on butterfly pea sorbet ice cream

From figure 8 showed the basic information of consumer's behavior on butterfly pea sorbet ice cream. 88.5% of consumers' accepted butterfly pea sorbet ice cream product whereas only 11.5% did not accept the product. For the buying decision, 61.5% of the consumers would buy the butterfly pea sorbet ice cream product while only 3% would not buy the product and 35.5% might buy or might not buy the butterfly pea sorbet ice cream. The acceptable price of consumers for single-scoop of 70 grams butterfly pea sorbet ice cream was between 13-15 Bath with 46% consumers' selection the price. Based on 4.12 Baht of production price for the single-scoop butterfly pea sorbet ice cream, the selected price would provide the profit of 215-264%, respectively, as shown in Table 20.

The average preference score from 9-point hedonic scale of 200 consumers was 7.0 ± 10.9 (mean \pm SD) which rated as like moderately (7).

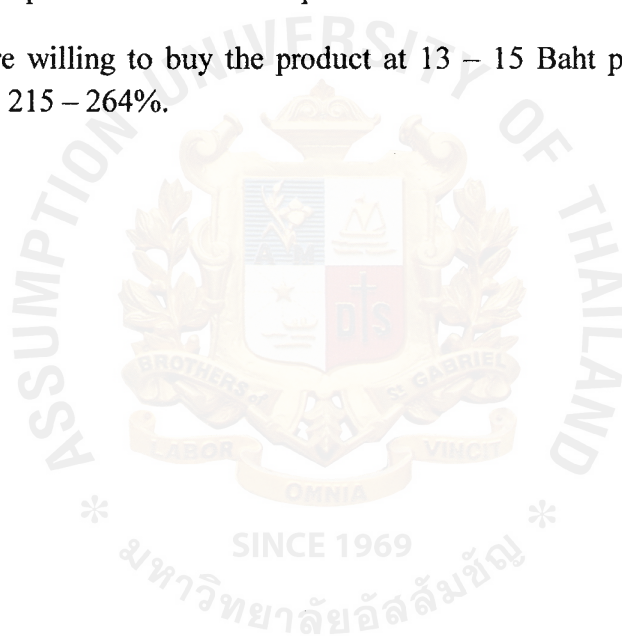
Table 22: Cost calculation of ingredient usage of butterfly pea sorbet ice cream

| Ingredients | Amount | Price/packing (Bath) | Packaging size | Cost (Bath) |
|--|-----------|----------------------|----------------|-------------|
| Apple juice | 400 mL | 72 | 1000 mL | 28.8 |
| Sugar | 170 grams | 23.5 | 1000 grams | 3.995 |
| Egg | 1 | 48 | 12 | 4 |
| Total raw materials cost/batch (1000 grams) | | | | 36.795 |
| Production cost 20% of total raw materials cost (1000 grams) | | | | 7.359 |
| Promotion cost 40% of total raw materials cost (1000 grams) | | | | 14.718 |
| Total raw materials cost + production cost + promotion cost (1000 grams) | | | | 58.872 |
| Total cost of butterfly pea sorbet ice cream product (70 grams) | | | | 4.12 |
| Acceptable price from 200 consumers (70 grams) | | | | 13-15 |
| Profit for 70 grams from selling price 13-15 Bath, respectively | | | | 8.88-10.88 |
| Percentage of profit from selling price 13-15 Bath, respectively | | | | 215-264% |



Conclusion

- Extraction condition of butterfly pea was 2% dry butterfly pea flower, extracted at 70°C for 15 minutes.
- Commercial 100% apple juice was the most preferred juice to mix with butterfly pea extract in sorbet with average preference scores in color 6.92 ± 0.64 , appearance 6.85 ± 0.49 , flavor 6.08 ± 0.49 , texture 6.92 ± 0.38 , and sweetness 8.54 ± 0.52 , overall linking 7.15 ± 0.68 .
- JAR test indicated that butterfly pea sorbet ice cream with 10% butterfly pea extract was rated as just right in apple flavor, texture, sweetness, sourness, color, and appearance.
- Consumer acceptance test from 200 consumers resulted in 88.5% of consumer accepted the product and obtained preference score of 7.04 out of 9
- 61.5% were willing to buy the product at 13 – 15 Baht per 70-g cup, profit gained range from 215 – 264%.



Recommendation

1. Consumers' survey on choice of commercial fruit juice should be conducted to determine the fruit juice choice that should be matched with butterfly pea flower color and taste.
2. There should be a further study on using real fruit juice to make butterfly pea sorbet ice cream to gain more preference from the consumers.
3. There should be a further study on using butterfly pea extract to make milk ice cream.



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Appendix A:
Developing formula

Appendix A-1

Questionnaire

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

Scale of 9-point hedonic of preference test

- | | |
|------------------------------|------------------------|
| 9 = Like extremely | 4 = Dislike slightly |
| 8 = Like very much | 3 = Dislike moderately |
| 7 = Like moderately | 2 = Dislike very much |
| 6 = Like slightly | 1 = Dislike extremely |
| 5 = Neither like nor dislike | |

Table: The preference test of 9-point hedonic scale of each sample

| Attributes and samples | Sample No. | | |
|------------------------|------------|-------|-----------|
| | Apple | Guava | Pineapple |
| Color | | | |
| Flavor | | | |
| Texture | | | |
| Appearance | | | |
| Sweetness | | | |
| Overall liking | | | |

Comments:

THANK YOU

Appendix A-2

ANOVA table of butterfly pea sorbet in different juice.

- Color

| Sov | SS | Df | MS | fcal |
|----------|----------|----|--------|----------------|
| Trt | 43.538 | 2 | 21.769 | 44.30** |
| Panelist | 4.359 | 12 | 0.363 | 0.74 |
| Err | 11.795 | 24 | 0.491 | |
| Total | 59.69231 | 38 | | |

$$f_{\text{tab}} = f_{0.05, 2, 24} = 3.40 \therefore \text{Accept } H_0$$

- Flavor

| Sov | SS | Df | MS | fcal |
|----------|----------|----|-------|---------------|
| Trt | 10.308 | 2 | 5.154 | 9.50** |
| Panelist | 5.897 | 12 | 0.491 | 0.91 |
| Err | 13.026 | 24 | 0.543 | |
| Total | 29.23077 | 38 | | |

$$f_{\text{tab}} = f_{0.05, 2, 24} = 3.40 \therefore \text{Accept } H_0$$

- Texture

| Sov | SS | Df | MS | fcal |
|----------|----------|----|-------|----------------|
| Trt | 7.744 | 2 | 3.872 | 11.25** |
| Panelist | 2.667 | 12 | 0.222 | 0.65 |
| Err | 8.256 | 24 | 0.344 | |
| Total | 18.66667 | 38 | | |

$$f_{\text{tab}} = f_{0.05, 2, 24} = 3.40 \therefore \text{Accept } H_0$$

- Appearance

| Sov | SS | Df | MS | fcal |
|----------|----------|----|--------|----------------|
| Trt | 26.051 | 2 | 13.026 | 52.55** |
| Panelist | 2.359 | 12 | 0.197 | 0.79 |
| Err | 5.949 | 24 | 0.248 | |
| Total | 34.35897 | 38 | | |

$$f_{\text{tab}} = f_{0.05, 2, 24} = 3.40 \therefore \text{Accept } H_0$$

- Sweetness

| Sov | SS | Df | MS | fcal |
|----------|----------|----|--------|----------------|
| Trt | 50.051 | 2 | 25.026 | 75.56** |
| Panelist | 5.590 | 12 | 0.466 | 1.41 |
| Err | 7.949 | 24 | 0.331 | |
| Total | 63.58974 | 38 | | |

$$f_{\text{tab}} = f_{0.05, 2, 24} = 3.40 \therefore \text{Accept } H_0$$

- Overall liking

| Sov | SS | Df | MS | fcal |
|----------|--------|----|--------|----------------|
| Trt | 70.308 | 2 | 35.154 | 81.45** |
| Panelist | 3.641 | 12 | 0.303 | 0.70 |
| Err | 10.359 | 24 | 0.432 | |
| Total | 84.308 | 38 | | |

$$f_{\text{tab}} = f_{0.05, 2, 24} = 3.40 \therefore \text{Accept } H_0$$



Appendix A-3

Duncan's multiple range tests for butterfly pea sorbet in different juice.

- Color

| Guava | Pineapple | Apple |
|----------|-----------|----------|
| 4.5 | 5.0 | 6.9 |
| a | | b |

Note: The average score under the same line was not significant different

- Flavor

| Guava | Pineapple | Apple |
|----------|-----------|----------|
| 4.9 | 5.2 | 6.1 |
| a | | b |

Note: The average score under the same line was not significant different

- Texture

| Guava | Pineapple | Apple |
|----------|-----------|----------|
| 5.9 | 6.2 | 6.9 |
| a | | b |

Note: The average score under the same line was not significant different

- Appearance

| Guava | Pineapple | Apple |
|----------|-----------|----------|
| 4.9 | 5.9 | 6.9 |
| a | b | c |

Note: The average score under the same line was not significant different

- Sweetness

| Guava | Pineapple | Apple |
|----------|-----------|----------|
| 5.8 | 7.0 | 8.5 |
| a | b | c |

Note: The average score under the same line was not significant different

- Overall

| Guava | Pineapple | Apple |
|----------|-----------|----------|
| 4.0 | 4.8 | 7.2 |
| a | b | c |

Note: The average score under the same line was not significant different



Appendix B:

Just-About-right-Test

Appendix B-1

Questionnaire

Please test this sample and score it following the just about right test scale in the table

Table: The just about right test scale

| Attributes | Too little | Somewhat too little | Just right | Somewhat too much | Too much |
|----------------|------------|---------------------|------------|-------------------|----------|
| Apple Flavor | | | | | |
| Texture | | | | | |
| Sweetness | | | | | |
| Sourness | | | | | |
| Color | | | | | |
| Appearance | | | | | |
| Overall Liking | | | | | |

Comments: _____

THANK YOU



Appendix B-2

Frequency of Just-About-Right-Test on butterfly pea sorbet product

- Apple Flavor

| | Frequency | Percentage | Cumulative percentage |
|---------------------|-----------|------------|-----------------------|
| Too little | 0 | 0 | 0 |
| Somewhat too little | 1 | 10 | 10 |
| Just right | 9 | 90 | 100 |
| Somewhat too much | 0 | 0 | 100 |
| Too much | 0 | 0 | 100 |
| Total | 10 | 100 | |

- Texture

| | Frequency | Percentage | Cumulative percentage |
|---------------------|-----------|------------|-----------------------|
| Too little | 0 | 0 | |
| Somewhat too little | 1 | 10 | 10 |
| Just right | 9 | 90 | 100 |
| Somewhat too much | 0 | 0 | 100 |
| Too much | 0 | 0 | 100 |
| Total | 10 | 100 | |

- Sweetness

| | Frequency | Percentage | Cumulative percentage |
|---------------------|-----------|------------|-----------------------|
| Too little | 0 | 0 | 0 |
| Somewhat too little | 0 | 0 | 0 |
| Just right | 100 | 100 | 100 |
| Somewhat too much | 0 | 0 | 100 |
| Too much | 0 | 0 | 100 |
| Total | 10 | 100 | |

- Sourness

| | Frequency | Percentage | Cumulative percentage |
|---------------------|-----------|------------|-----------------------|
| Too little | 0 | 0 | 0 |
| Somewhat too little | 0 | 0 | 0 |
| Just right | 100 | 100 | 100 |
| Somewhat too much | 0 | 0 | 100 |
| Too much | 0 | 0 | 100 |
| Total | 10 | 100 | |

- Color

| | Frequency | Percentage | Cumulative percentage |
|---------------------|-----------|------------|-----------------------|
| Too little | 0 | 0 | |
| Somewhat too little | 1 | 10 | 10 |
| Just right | 9 | 90 | 100 |
| Somewhat too much | 0 | 0 | 100 |
| Too much | 0 | 0 | 100 |
| Total | 10 | 100 | |

- Appearance

| | Frequency | Percentage | Cumulative percentage |
|---------------------|-----------|------------|-----------------------|
| Too little | 0 | 0 | 0 |
| Somewhat too little | 1 | 10 | 10 |
| Just right | 9 | 90 | 100 |
| Somewhat too much | 0 | 0 | 100 |
| Too much | 0 | 0 | 100 |
| Total | 10 | 100 | |

- Overall liking

| | Frequency | Percentage | Cumulative percentage |
|---------------------|-----------|------------|-----------------------|
| Too little | 0 | 0 | 0 |
| Somewhat too little | 0 | 0 | 0 |
| Just right | 100 | 100 | 100 |
| Somewhat too much | 0 | 0 | 100 |
| Too much | 0 | 0 | 100 |
| Total | 10 | 100 | |



Appendix C:
Consumer acceptance test

Appendix C-1

Consumers' Acceptance Survey

“Butterfly Pea Sorbet ice-cream”

This survey is a part of a special project (FT 4190) under a title “Butter Fly Pea Sorbet” for Bachelor’s degree. The survey is aimed to study consumer’s behaviors, attitudes, and needs toward a development of butterfly pea sorbet ice-cream. Please kindly complete the questions by checking ☒ in the provided spaces.

Part 1: Basic information of consumer’s behavior on sorbet ice-cream in the market

1. What brands of sorbet ice-cream do you familiar and normally buy? (Choose three brands)

☐ Wall’s ice cream

☐ Ben & Jerry's

☐ Häagen-Dazs

☐ Mövenpick Ice Cream

☐ Swensen's

☐ Baskin-Robbins

☐ Cold Stone Creamery

☐ Other (please specify) _____

2. How often do you consume sorbet ice-cream?

☐ Everyday

☐ 2-3 times per week

☐ Once a week

☐ 2-3 times per month

☐ Once a month

☐ Less than once a month

3. How many scoop of sorbet ice-cream do you usually buy at one time?

☐ Single scoop

☐ 2-3 scoops

☐ 4-5 scoops

☐ Other _____

4. Where do you usually buy ice-cream?

☐ Convenience store (e.g. 7-11, 108 shop)

☐ Supermarket (e.g. Tops Supermarket, Gourmet Market, Home Fresh Mart)

☐ Hypermarket (e.g. Tesco Lotus, Makro)

☐ Other (please specify) _____

5. How much do you spend for ice-cream product in average per one time purchasing?

_____ Baht

6. What time of the day that you normally consume ice-cream?

☐ Breakfast

☐ Lunch

☐ Dinner

☐ At night

☐ Free time

☐ After meal

☐ Other (please specify) _____

Part 2: Information of consumer's behavior on butter fly pea sorbet ice-cream

Instructions: Please taste this butterfly pea sorbet ice-cream and answer the following questions.

7. How would you rate this product using 9-point Hedonic scale when

9 = Like extremely

4 = Dislike slightly

8 = Like very much

3 = Dislike moderately

7 = Like moderately

2 = Dislike very much

6 = Like slightly

1 = Dislike extremely

5 = Neither like nor dislike

Score _____

8. Do you accept this product?

☐ Accept

☐ Not accept

9. Will you buy this product if it is sold in the market with the market price(12 Baht)?

☐ Yes

☐ Maybe

☐ No, because _____

10. How much will be the acceptable price for the 70 grams of the product?

☐ 10-12 Baht

☐ 13-15 Baht

☐ 16-18 Baht

☐ 19-21 Baht

☐ Other (please specify) _____

Comment:

Part 3: Demographic information

11. Gender

☐ Male

☐ Female

12. Age

☐ Less than 20 years old

☐ 20-29 years old

☐ 30-39 years old

☐ 40-49 years old

☐ 50-59 years old

☐ 60 and more than 60 years old

13. Occupation

☐ Student

☐ Businessman or businesswoman

☐ Employee

☐ Housewife

☐ Other (please specify) _____

Thank you very much for your cooperation



Appendix C-2

Frequency of consumer acceptance test of final product

1. Brands

| | Frequency | Percentage | Cumulative percentage |
|---------------------|-----------|------------|-----------------------|
| Wall's | 89 | 20.05 | 20.05 |
| Haagen-Dazs | 50 | 11.26 | 31.31 |
| Swensen's | 178 | 40.09 | 71.40 |
| Cold Stone Creamery | 33 | 7.43 | 78.83 |
| Ben & Jerry's | 10 | 2.25 | 81.08 |
| Movenpick | 26 | 5.86 | 86.94 |
| Baskin-Robbins | 58 | 13.06 | 100.00 |
| Total | 444 | 100.00 | |

2. Frequencies

| | Frequency | Percentage | Cumulative percentage |
|------------------------|-----------|------------|-----------------------|
| Everyday | 15 | 7.5 | 7.5 |
| 2-3 times per week | 21 | 10.5 | 18.0 |
| Once a week | 92 | 46.0 | 64.0 |
| 2-3 times per month | 63 | 31.5 | 95.5 |
| Once a month | 9 | 4.5 | 100.0 |
| Less than once a month | 0 | 0.0 | 100.0 |
| Total | 200 | 100.0 | |

3. Size

| | Frequency | Percentage | Cumulative percentage |
|--------------|-----------|------------|-----------------------|
| Single scoop | 130 | 65.0 | 65.0 |
| 2-3 scoops | 62 | 31.0 | 96.0 |
| 4-5 scoops | 5 | 2.5 | 98.5 |
| Others | 3 | 1.5 | 100.0 |
| Total | 200 | 100 | |

4. Places

| | Frequency | Percentage | Cumulative percentage |
|-------------------|-----------|------------|-----------------------|
| Convenience store | 18 | 9 | 9 |
| Supermarket | 142 | 71 | 80 |
| Hypermarket | 32 | 16 | 96 |
| Others | 8 | 4 | 100 |
| Total | 200 | 100 | |

5. Price

| | Frequency | Percentage | Cumulative percentage |
|--------------------|-----------|------------|-----------------------|
| Less than 20 Baht | 32 | 16.0 | 16.0 |
| 21-40 Baht | 84 | 42.0 | 58.0 |
| 41-60 Baht | 35 | 17.5 | 75.5 |
| 61-80 Baht | 26 | 13.0 | 88.5 |
| 81-100 Baht | 17 | 8.5 | 97.0 |
| More than 100 Baht | 6 | 3.0 | 100.0 |
| Total | 200 | 100.0 | |

6. Time

| | Frequency | Percentage | Cumulative percentage |
|------------|-----------|------------|-----------------------|
| Breakfast | 2 | 1.0 | 1.0 |
| Lunch | 38 | 19.0 | 20.0 |
| Dinner | 24 | 12.0 | 32.0 |
| At night | 5 | 2.5 | 34.5 |
| Free time | 121 | 60.5 | 95.0 |
| After meal | 10 | 5.0 | 100.0 |
| Others | 0 | 0.0 | 100.0 |
| Total | 200 | 100.0 | |

7. Preference score

Score: 7.05 ± 0.95 (mean \pm SD.)

8. Product acceptance

| | Frequency | Percentage | Cumulative percentage |
|------------|-----------|------------|-----------------------|
| Accept | 177 | 88.5 | 88.5 |
| Not accept | 23 | 11.5 | 100.0 |
| Total | 200 | 100.0 | |

9. Buying decision

| | Frequency | Percentage | Cumulative percentage |
|-------|-----------|------------|-----------------------|
| Yes | 123 | 61.5 | 61.5 |
| Maybe | 71 | 35.5 | 97.0 |
| No | 6 | 3.0 | 100.0 |
| Total | 200 | 100.0 | |

10. Acceptable price (70 grams)

| | Frequency | Percentage | Cumulative percentage |
|------------|-----------|------------|-----------------------|
| 10-12 Baht | 54 | 27 | 27 |
| 13-15 Baht | 92 | 46 | 73 |
| 16-18 Baht | 30 | 15 | 88 |
| 19-21 Baht | 20 | 10 | 98 |
| Others | 4 | 2 | 100 |
| Total | 200 | 100 | |

11. Gender

| | Frequency | Percentage | Cumulative percentage |
|--------|-----------|------------|-----------------------|
| Male | 72 | 36 | 36 |
| Female | 128 | 64 | 100 |
| Total | 200 | 100 | |

12. Age

| | Frequency | Percentage | Cumulative percentage |
|---------------------------|-----------|------------|-----------------------|
| Less than 20 years | 43 | 21.5 | 21.5 |
| 20-29 years | 72 | 36.0 | 57.5 |
| 30-39 years | 51 | 25.5 | 83.0 |
| 40-49 years | 20 | 10.0 | 93.0 |
| 50-59 years | 8 | 4.0 | 97.0 |
| 60 and more than 60 years | 6 | 3.0 | 100.0 |
| Total | 200 | 100.0 | |

13. Occupation

| | Frequency | Percentage | Cumulative percentage |
|------------------------------|-----------|------------|-----------------------|
| Student | 77 | 38.5 | 38.5 |
| Businessman or businesswoman | 12 | 6.0 | 44.5 |
| Employee | 84 | 42.0 | 86.5 |
| Housewife | 18 | 9.0 | 9.0 |
| Others | 9 | 4.5 | 100.0 |
| Total | 200 | 100 | |

