Physical, and Textural Analysis of Soursop (*Annona muricate)* Ice Cream Incorporated with Coconut and Palm Milk

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DECLARATION

I hereby declare that the work embodied in this Report is the result of the research and has not been submitted for a higher degree to any universities and institutions.

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Name : Ang Huan Liang

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I certify that the report of this final year project entitled Physiological, and textural analysis of ice cream incorporated with coconut milk and palm milk substituted with soursop (*Annona muricate)*, Universiti Malaysia Kelantan By Ang Huan Liang, matric number of F15A0015 has been examined and all the correction recommended by examiners have been done for the degree of Bachelor of Applied Science (Product Development Technology) with Honours, Faculty of Agro-Based Industry, Universiti Malaysia Kelantan.

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LIST OF ABBREVIATIONS AND SYMBOLS

%	percent
°C	Degree Celsius
A*	redness
B*	greenness
g	Gram
HHST	Higher heat shorter time pasteurisation
HTST	High temperature short time pasteurisation
Kg	Kilogram
L*	lightness
Mg	milligram
ml	millilitre
M pa	Megapascal
pH	logimetric scale of hydrogen ion

Physical, and textural analysis of soursop (*Annona muricate)* ice cream incorporated with coconut and palm milk

ABSTRACT

Ice cream is a type of dessert made from agitation of ice cream mix, which often is made from dairy milk. Soursops are fruits that nutritious as they contain antioxidants as well as fibre. Vegetable milk emerged as an alternative for dairy milk for ice cream due to the differences on fat content and nutritional value. The lack of dietary fibre in Malaysian diet as well as the lack of initiative on soursop ice cream products in the market initiates the project to conduct soursop ice cream. The objective of the study is to compare the textural properties, colour properties and preparation of the ice cream incorporated with coconut and palm milk as well as the textural properties of addition of soursop into ice cream. The ice creams were made with salt, sugar, dairy milk corn starch and vanilla essence, where 10%, 20% and 30% of palm and coconut milk are substituted in and they were heated until it starts to thickened, blended for 30 minutes and then freeze under the freezing point. Analysis of pH, dripping time, fat content and colour is conducted on the reformulated ice cream. The result showed that ice cream containing 30% substitution coconut milk obtained the highest dripping time, softest in texture as well as reduced fat content compared to other 6 samples. The incorporation of the soursop improves the hardness, dripping time and pH of the ice cream. Colour evaluation showed that ice cream containing 30% substitution coconut milk has yellowness of that is significantly different from other samples. Ice cream that are substituted with 30% coconut milk had proven to be the best mix as it showed the highest dripping time, best pH and lowest softness. Addition of soursop improves colour, pH, as well as increasing overall hardness and dripping time of ice creams.

Keywords: palm milk, coconut milk, soursop, substituted, improved

Analisis fizikal dan tekstur Aiskrim soursop *(Annona muricate*) ditubuhkan dengan kelapa dan sawit susu

ABSTRAK

Ais krim adalah sejenis pencuci mulut yang dibuat daripada pergolakan campuran ais krim, yang sering dibuat daripada susu tenusu. Durian belanda adalah buah yang berkahsiat kerana mengandungi antioksidan serta serat. Susu sayuran muncul sebagai alternatif untuk susu tenusu untuk ais krim kerana perbezaan kandungan lemak dan nilai pemakanan. Kekurangan serat makanan dalam diet Malaysia serta kekurangan perbezaan produk ais krim soursop di pasaran memulakan projek tersebut. Objektif kajian ini adalah untuk membandingkan sifat-sifat tekstur, warna dan cara penyediaan ais krim yang digabungkan dengan santan kelapa dan santan sawit serta sifat tekstur tambahan soursop ke dalam ais krim. Krim ais dibuat dengan garam, gula, susu jagung susu tenusu dan intip vanila, di mana 10%, 20% dan 30% santan sawit dan santan kelapa telah digantikan dan mereka dipanaskan sehingga ia mula menebal, dicampur selama 30 minit dan kemudian membekukan di bawah titik beku. Analisis pH, masa titisan, kandungan lemak dan warna dilakukan pada ais krim yang telah dirumuskan. Hasilnya menunjukkan bahawa ais krim yang mengandungi 30% penggantian santan kelapa diperolehi masa yang menitis tertinggi, paling lembut dalam tekstur serta mengurangkan kandungan lemak berbanding dengan 6 sampel yang lain. Penyatuan soursop meningkatkan kekerasan, masa menetes dan pH ais krim. Penilaian warna menunjukkan bahawa ais krim yang mengandungi 30% penggantian santan mempunyai kandungan yang sangat berbeza daripada sampel yang lain. Ais krim yang digantikan dengan 30% santan telah terbukti menjadi campuran terbaik kerana ia menunjukkan masa titisan tertinggi, pH terbaik dan terlembut. Penambahan soursop meningkatkan warna, pH, serta meningkatkan kekerasan keseluruhan dan masa krim ais krim

Kata kunci: kelapa sawit, santan, soursop, diganti, bertambah baik

CHAPTER 1

INTRODUCTION

1.1 Background of study

Ice cream, is one of the types of frozen desserts that are made with the use of agitation of the ice cream mix that are under cold temperature. The consumption of frozen desserts has been long and the usage of fruits and vegetables are often in ice cream Sudha and Madhvi (2015).

Palm milk is an alternative originally to coconut milk that have low shelf life, high unsaturated fat, which are oleic and palmitic acid. Normally the palm milk is used as an alternative to normal coconut milk, such as on making nasi lemak. But recently palm milk has risen as a healthier option to skimmed or condensed milk in food, such as the use of palm milk in cendol at Tanjung Malim. But the usage of palm milk in industry had seen as lacking as most of the palm milk industry are only used to as either food in the form of milk, or as ingredients such as cream and chocolate. The introduction of palm milk to ice cream can help in diversifying the products that contain palm milk. Currently the Malaysian Palm Oil Board is helping to promote the usefulness of palm milk to the Malaysian market to bolster the economy as well as generating income.

Soursop, is the fruit with the science name of *Annona Muricata*. The fruits can be seen cultivated in the rural parts of the country using traditional methods (Anem, 2014). Soursop is known to have high amounts of minerals and uses as well as there are evidence showing that soursop can deal with some types of cancer. It also helps in replenishing nutrients as it has high amounts of vitamin C, accounts for 77% of daily intake value per 225g and dietary fibre, which also contains 30% of the daily intake value of an adult, the soursop also has multiple types of vitamins and minerals such as Magnesium, Phosphorous, Copper, Vitamin A and Selenium that are all required for daily metabolism.

The products that can be seen on the market that uses soursop as the prime ingredient are lacking, mostly are seen they are either extracted to make juices, condensed cordials, made into purees and stored in cold temperature, the leaves and fruits are dried into teas for consumption, or the fruits are either eaten raw, added into salads or desserts as dressing, or the meat are canned. Soursop tablets can also be obtained with the use of being a supplement (Moghadamtousi et al., 2015). The introduction of the soursop ice cream can increase the variety of the Malaysian soursop market that are lacking in terms of product development. Fibres also can enhance the physiological and nutritional values of the ice cream that was provided by the soursop.(Soukoulis, Lebesi, & Tzia, 2009)

The main point of the study is the differences of the composition of fats to the textural changes of the ice cream. The differences of the fat composition differ to the composition in the mixture, where replacing hydrogenated fat with palm fat in ice cream will alter the melting ranges of the ice cream (Lannes & Maria, 2013). This will make a huge difference on the overall texture of the ice cream.

1.2 Problem statement

The problems associated with ice cream is found within the ingredients that is required to make them, fat. The dairies that are used to make ice cream are high in saturated fat, in the form of triglycerides (Mohan, Hopkinson, & Harte, 2014). The intake of saturated fats will increase risks of high cholesterol and stroke (Huth and Park, 2012). The situation worsens when the high fat intake combine with the sedentary lifestyle of Malaysians contributes to cardiovascular diseases and obesity (Abdullah, Teo, & Foo, 2016).

The ice cream market in Malaysia is large. According to Canadean (2015), the ice cream market in Malaysia in total contributed 40 million gallons of ice cream, both on trade and off trade. The dominated flavours in Malaysia are chocolate, vanilla and strawberry. The fruity ice creams are lacking as the current markets either going for indulgence flavours, like hazelnut chocolate, or going for packaging

Increasing fibre intake is able to reduce insulin intake from the foods to the body (Smith, 1987), making it useful to reducing weight and curing diabetes mellitus.

The soursop haves a high amount of dietary fibre that can help significantly on improving the dietary intake of Malaysians. 225g of raw soursop contains up to 30% of an adult's daily fibre intake value, improving the intake of fibre among Malaysians. The incorporation of soursop or know as *Annona Muricata* in its scientific name and durian belanda in Malay is known to the Malaysian locals as it can be seen on the whole country, but particularly in the more rural areas. The current market lacks diversification for products that involve soursop as the prime ingredient, as the products are only as teas, juices and condensed cordials.

1.3 Hypothesis

H_0= The palm milk has no effect on improving the overall ice cream preparation, colour evaluation, fat content and texture, compared to coconut milk.

H_1= The palm milk added has effect on the overall ice cream preparation, colour evaluation, fat content and texture, compared to coconut milk

H_0= The soursop has no effect on the overall ice cream textural value compared to vanilla flavouring

H_1= The soursop juice has effect on improving the overall ice cream textural, value compared to vanilla flavouring

1.4 Objectives

1. To compare the texture profile properties of ice cream incorporated with palm milk and coconut milk.
2. To determine the texture profile properties of the ice cream incorporated with soursop compare to vanilla ice cream

1.5 Scope of Study

The scope of the study is to investigate the feasibility of the incorporating palm milk into ice cream to improve the quality of ice cream in terms of texture, taste and nutrition. It would also look into the effects of co-operating palm milk in both dairy and

non-dairy based ice cream. The ice cream was conducted with a series of physio-chemical analysis.

The parameters that are taken into the ice cream are: pH, dripping time, fat content, colour analysis and texture analysis, in which comprises of hardness are checked for the physical analysis. The parameters that colour analysis are testing are: lightness, red-blueness and yellow-greenness of the food.

The addition of soursop onto the ice cream are also conducted with physiological test such as pH, dripping time, colour analysis and texture analysis.

1.6 Significant of Study

The significance of the study is the application for palm milk in frozen food market. The incorporation between the palm milk and dairy milk, as well as the incorporation of soy milk and dairy milk be can be observed. The lacking of information of the palm milk in frozen food journals can be answered as the study focuses around the physical aspects of the palm milk.

The study also improves the current database of the soursop application in the food industry as most of the soursop products revolves around beverages, raw fruit and dried concoctions, as well as the properties of the food after processing, I can observe the different types of nutrients, including antioxidants that are affected during the making of the ice cream. The market can understand more about soursop ice cream and the future potential in the Malaysian market.

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CHAPTER 2

LITERATURE REVIEW

2.1 Ice cream

Ice cream, is a known dessert that has evolved for at least 2 thousand years, first appearing in ancient Greece as they added snow with honey and fruits for consumption in the markets of Athens, while the first true ice cream recipe appeared during the 17th century France Goff and Hartel (2013). Ice cream is formed by mixing the ingredients: air, milk, water, flavouring, preservatives, sugar and cream, where sometimes fruits can be added for extra colouring and flavour, as well as texture and nutritional improvements. Ice cream is much favoured from people in all stages of life in Malaysia (Canadean, 2015).

There are many types of varieties of ice cream around the world, that are equally unique and enjoyed by everyone. One of such examples are the Turkish ice cream or Maras ice cream, Maras ice cream is renowned for gooey and sticky texture. The ingredient that gives the texture of the ice cream came from salep, in which is the flour made from the roots of terrestrial orchids *(Orchis anatolica*).(Goff & Hartel, 2013); (Guven & Karaca, 2016); (Icier & Tavman, 2006). This ice cream is renowned and it has sold in the whole world. Soft serve ice cream is ice cream that are made without freezing, has around 4-7% fat content as well as 13-15% sugar content (Goff & Hartel, 2013).

Gelato are Italian ice cream that contains little to no overrun, and also contains no emulsifiers and stabilizers (Alfaifi & Stathopoulos, 2010); (Goff & Hartel, 2013). Artisan ice creams are ice creams that are made in small batches and do not follow the current industrial procedure (Abou et al., 2014).

Canadean (2015) shows that there are more than 50% of consumers in Malaysia are under the age of 30, and many show that they are very interested in ice cream, and there are potentials for opening ice cream markets in many markets. Martins (2011) shows the different types of ways to promote ice cream to elders to Portugal. Vimala and Purwanegara (2013) shows ways to introduce new type of ice cream in Indonesia despite 85% of the surveyed participants do love ice cream while Castro (2017) points out the ways to promote artisan ice cream in Portugal, in which can be taken for artisan development for Malaysia, in which only accounts of about 2% of total ice cream in 2015.

2.2 Manufacturing of ice cream

Manufacturing of ice cream can be split up into different steps in the current ice cream industry, where the main steps are: mixing, pasteurisation, homogenisation, cooling, aging, flavour and air addition, freezing and hardening, and finally, packaging. The different steps of manufacturing are crucial to the formation of the ice cream, in which they can affect the quality of the ice cream.

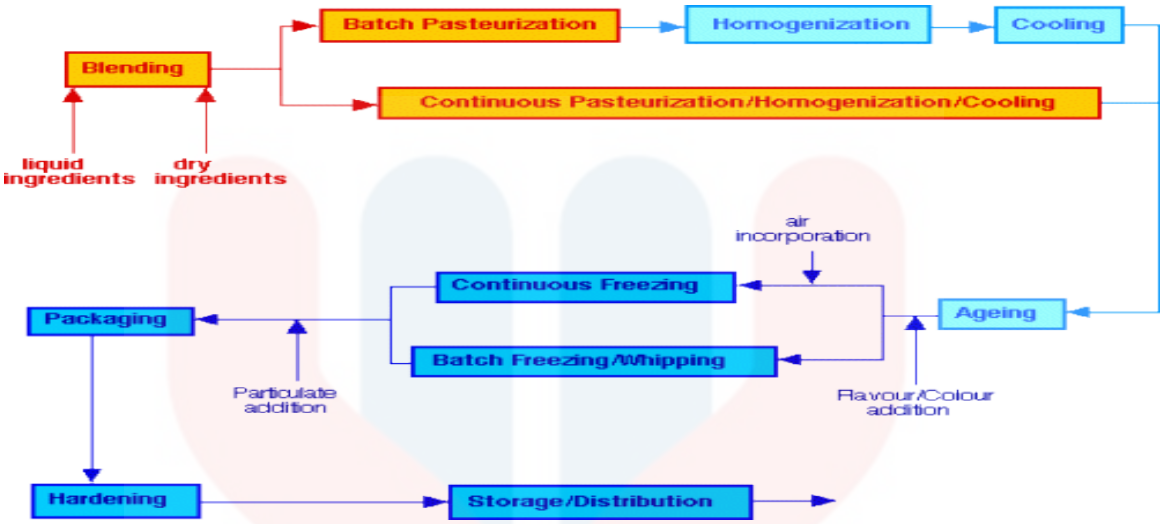

Figure 2.1: the ice cream manufacturing process flow chart Goff & Hartel, (2013)

2.2.1 Mixing the ice cream.

The first steps in the ice cream manufacturing process is the blending of the ingredients, where the wet and dry ingredients are mixed so that the mixture are equally blended, where the ice cream mixture would not be spread one side with too much fibre and another side too little flavouring. During the process of the blending and mixing, agitation starts within the mixing machine, where the machine heats the liquid ingredients, such as cow's milk inside the vat. (Goff & Hartel, 2013) pointed out that the dry ingredients may have to either, dissolved first and then added into the vat before the temperature turns to 50℃, or in case there are only non-fat liquid material inside the vat, the dry materials can be added in. The mixing disperses the material thoroughly so the mixture can proceed with the next step: pasteurisation, either by batch or by continuous.

2.2.2 Pasteurisation of the mixture

Pasteurisation by definition is the process, in which the food, is to be heated within a range of temperatures, for a limited time, with the purpose of either inhibiting microbial growth or killing the bacteria (Goff & Hartel, 2013; Watts & Watts, 2016). The cooked food is then sealed or canned directly so that foods would not be contaminated by the outer environment. There are different types of pasteurisation: Vat Pasteurisation, High temperature short time pasteurisation (HTST), higher heat shorter time pasteurisation (HHST) and ultra-pasteurisation (Watts & Watts, 2016). The difference between the pasteurisation methods are the temperature and the time used for the pasteurisation. The vat pasteurisation uses 63° C and the mixture is cooked for 30 minutes, as high temperature and HHST, the temperature would be much higher but shorter time, while ultra-pasteurisation would reach 138° C cooking temperature for 2 seconds. The ratios between the different temperatures and time are calculated to obtain the same lethality of bacteria so that they can hasten the process without jeopardising the quality (Tobias, Kaufmann, & Tracy, 1955). The viscosity of the ice cream mix changes during the pasteurisation as temperature increases, but then the viscosity changes with the different amounts of stabilizers, fats and sugars as well as the time of resting your ice cream mixture within the desired temperature (Goff, Davidson, & Cappi, 1994).

As for continuous pasteurisation, the methods used for the ice cream mix are the high temperature short time method, where the ice cream are pasteurised within a range of temperatures, where the duration differs from 2 seconds to 0.02 seconds (Watts & Watts, 2016). In some cases, there are necessity for preheating where the batches are preheated till 30° C-40° C to allow solubilization of the ice cream mix (Goff & Hartel, 2013) . The mixes are processed user high pressure where the machine processes the ice cream max continuous, where the machine is split into three parts, the regenerator, the

cooling section and the heating section. The ice cream mixes first start from the raw regenerator part, where it is heated, via the counter current pasteurised mix till the temperature of the raw mix reached 57-68℃. then the mix is then transferred to the heating section, where the heating is complete, the ice cream would go through a holding tube, where the holding tubes controls the holding time of the ice cream mix, the holding tube length is crucial as the temperature change would differ when the length of the holding tube increases (Aguiar & Gut, 2014), as the holding tube's use is to maintain the temperature of the ice cream batch so that the batch do not turn to solid (Oraon, 2017). The sensor at the end part of the machine would check the temperature of the mixture with the thermometer. The sensors would control the flow diversion device, where they control the flow of the ice cream mix, the ones with the temperatures that are desired are sent to the second generator, and then proceeds to the homogenisation stage, while the ones that do not reach the desired temperature are reflowed back and mixed with the raw mix and the cycle continues.

2.2.3 Homogenisation

Homogenisation is the process of dispersing one type of the liquid so that an emulsion between the two different liquids, mainly dispersion of fat with milk for ice cream that are originally to form the homogenisation (Foucquier et al., 2011). It is also promoted as a way to promote the ice cream without the use of heat. Currently, the ice cream industry promotes the usage of High Pressure Homogenisation, which uses up to 200 Mpa, where the conventional homogenisation only uses in a range of 20-60 Mpa (Sidhu & Singh, 2016). Homogenisation helps in stabilizing liquids, as Sidhu & Singh

(2016) study showed homogenisation stabilized the soymilk during storage. (Innocente, Biasutti, Venir, Spaziani, & Marchesini, 2009) shows that, the ice cream mixes that have gone through homogenisation have improved textures, as in improved viscosity of the ice cream batches, in which is due to homogenisation reduces the fat globule particle size. The importance of the ice cream quality relies on the homogenisation as the improved ice cream mix has better stability. After homogenisation, the mixtures are left for aging before proceeding to the next step.

2.2.4 Aging

Aging of ice cream takes places after homogenisation of ice cream mix ends. Aging is also the step that the mixture, that gone after the melting of fat during pasteurization and the reduction of the globule size inside the ice cream mixture, but the mixture does not have the qualities for freezing, and thus, the mixture is left beside to cool down, with a time range between 4-12 hours (Goff & Hartel, 2013). During this time period, nucleation and crystallisation can be observed as the time is well suited for the formation of the mini crystals. Aging occurs at 4°C as during this temperature, fat crystals starts to form inside the ice cream mix. The difference of aging time will reduce the percentage of liquid fats inside the ice cream, since the heat released would promote nucleation within the ice cream (Dogan & Kayacier, 2007). The short time also guaranteed that there will be no complete crystallisation during the aging process, which helps in destabilizing the fat crystals, as well as partial agglomeration that are inside the ice cream mix (Pei, & Schmidt, 2010; Sato, 2001). Directly after the homogenization process, the proteins are all directly placed on top of the fat globules, and when the crystallisation starts, the different materials start to form different sizes and shapes of

crystals. The emulsifiers now partially take place of the role for stabilizing the fat globules from proteins during crystallization of the mix (Goff & Hartel, 2013; Goff, Liboff, Jordan, & Kinsella, 1987). Crystallization also can be affected by the fibre inside the mix, insoluble fibre, in this case wheat promotes the nucleation as well speeding up the crystallisation (Soukoulis et al., 2009). The soluble and insoluble fibres, might predict that soursop pulp might have increased effect of crystallisation, as apple and orange fibre helps in crystallisation of ice cream mix.

2.2.5 Addition of flavour and air

After the aging of the ice cream mixture, the ice cream mixture is whipped until soft and smooth, the whipping would also increase the volume of the ice cream mixture, where the ice cream cooperates air inside the ice cream, in which the air that are incorporated in are known as overrun (Mohan et al., 2014; Zheng, Marschall, Heymann, & Fermando, 1997). Overrun has huge impact towards the overall texture, flavour and storage of the ice cream, it improves texture, as low air composition of air in ice cream would make the ice cream more dense while high air composition in ice cream makes ice cream creamier and lighter (Ludvigsen, 2012). The high overrun would also improve the storage life of ice cream mixes during storage (Ludvigsen, 2012; Sekarigenge, Erume, & Ongol, 2015). The high overrun is also viable to melting, so emulsifiers is a must for high overrun ice cream to make the ice cream a high quality ice cream as emulsifiers helps ice cream resist melting, achieve partial crystallisation as well as improve fat emulsification (Ludvigsen, 2012).

Most of the flavour that are added after aging are volatile flavouring agents, such as vanilla essence. The essence would run off-flavour as the vanillin would oxidized by

the heat, when it is supplied with oxygen, and there are different types of end products for vanillin after oxidisation as vanillin has 3 different types of reactive functional group (Weerawatanakorn, Wu, Pan, & Ho, 2015). There are many reactions occurred during the mixing of the flavours of the ice cream and the base, but study showed that the base of the ice cream is important to the overall flavour of the ice cream. For fat soluble flavouring agents, the percentage of fat inside ice cream mix affects the flavour releasing potential of the flavouring agent (King, 1994).

2.2.6 **Freezing and hardening**

Freezing after the whipping of the ice cream is an important factor on the texture as this affects the overall quality of the ice cream. Freezing affects ice cream as the crystallisation would affect the ice cream in many ways, freezing process is where after the cooperation of air in the ice cream mix, where the overrun would be left to be set where until the desired overrun ratio is achieved (H. Douglas Goff & Hartel, 2013a). Freezing takes place in the freezer, and the different types of ice cream will have different temperatures for freezing to develop the textures. The optimal ice cream freezing would be around 4-12 hours, with an increased 12 hours for hardening. The ice creams that are done for freezing can be consumed directly, as the ice cream is already done, while hardening is required for firmness as well as increase shelf life during the transportation. The downside of hardening is if partial agglomeration is not reached as well as imbalance mixing, the texture of the ice cream starts to deteriorate. The ice cream quality is also maintained after hardening commences.

The machinery used for the freezing of the ice cream mixes can differ according to industrial requirements and processes. There are different types of machine for freezing. There are batch freezers and continuous freezers. Batch freezers conduct freezing in small batches, examples are Wangcharoen (2012) uses the 5 Kg batch freezer while conducting their experiments, most air blow freezers shown are also batch freezers, as it can only freeze one batch per time (Patel, Lakherab, & Sarda, 2013). The continuous freezers pumped air into the freezer to freezes the ice cream (Mohan et al., 2014) and under pressured like 3.5 to 5 atm (Adapa, Schmidt, Jeon, Herald, & Flores, 2000), and it is use to conducted for factory that processes ice cream more than 500 gallons (Deosarkar, Khedkar, Kalyankar, & Sarode, 2015).

2.2.7 Packaging of ice cream

Packaging in ice cream industry is the application for a barrier for the ice cream to preserve the ice cream from hazards, in the forms of photooxidation, dehydration, odour transmittance, and temperature fluctuation (Patel et al., 2013). The ice cream packages are also important during the hardening stage, in which is an extension of the freezing stage. Patel et al. (2013) showed that the packaging plays a role for the heat transmittance during hardening, where spacing of the packaging affects the uniform air flow.

2.3 Major Components of Ice cream

In ice cream, there are always major components that affects all the aspects of the ice cream, in which the major components are: palm milk, soymilk, proteins, fat, additives, sugar,

water, minerals and air. Palm milk is tested for the feasibility of palm milk as viable alternative to other milks that are not as healthy as palm milk while the alternate milk to test is soymilk. Proteins and fat are the components that give the texture of ice cream. Additives such as emulsifiers stabilizes the ice cream, sugars gives out the flavour of ice cream, water gives the texture in the form of crystals, minerals are nutrients to be absorbed for growth.

2.3.1 Palm milk

Palm milk is an introduced by the Malaysian Palm Oil Board and the Palm Oil Research Institute of Malaysia (PORIM) to be an alternative to the plant milks that are deemed to be less healthy, such as coconut milk Study claims that the palm milk, proved that the palm milk have similar proximate compositions, in which the sensory tests conducted by PORIM proved that the palm milk obtained points similar to the coconut milk, making palm milk a suitable candidate (Ng & Tee, 1998; Zainal, Zaida, Affendi ,Yusoff, 1997), where even palm milk have slightly lower calories than coconut milk. The usage of palm milk in common food in Malaysia showed that some actually prefer the use of palm milk, but some foods , such as coconut milk, are preferred for nasi lemak (Zainal, Sahri, Rosnani, Isa, & Aziz, 2016). The comparison of the palm milk and coconut milk in fatty acid composition. Almost half of the acid composition of the palm oil is lauric acid (Aziz, Zainal, Rosnani, Aini, & Ismail, 2008), where although it's one of the strongest saturated fat with anti-microbial activities, the saturated fat structure would help promote LDL cholesterol (Dayrit, 2015), although not as potent as palmitic acid (Denke & Grundy, 1992). Lauric acid also is the best saturated fat for intake as it contributes the least to fat accumulation (Dayrit, 2015), and thus, lesser fat. Palm milk contains the greatest number of oleic acid and palmitic acid. Palmitic acid is a type of saturated fat which are detrimental as it is an important component for plasma membrane, and it is important for lipid transportation and secretory (Agostoni, Moreno, & Shamir, 2016). As compared to lauric acid, palmitic acid promotes more to release LDL-cholesterol, but the cholesterol factor is nullified with the comparison of the

another fatty acid inside the palm milk, oleic acid (Denke & Grundy, 1992) the palmitic acid inside palm milk originates from palm oil. Oleic acid is a type of monounsaturated fatty acid that has some benefits, including reducing blood pressure, and they are able to prevent certain types of disorders (Campos, Souza, Peghini, Silva, and Cardoso, 2013).

2.3.2 Coconut milk

Coconut milk are the extract of the flesh obtained by coconut flesh. Coconut milks is often used in culinary dishes, such as curries Bridges (2018). The nutrients and the texture are almost similar to dairy milk but the slight differences in physiological and nutritional properties make coconut milk a popular choice as an alternative to dairy milk for desserts Corradini et al. (2014).

The nutritional values of coconut milk are more superior compared to dairy milk. Wijayratna & Nadeeshani, (2015), Guetouache, Guessas, Bettache, Medjekal, & Samir, (2014) and Gantner, Mijić, Baban, Škrtić, & Turalija, (2015) pointed out that coconut milk had better overall nutritional value, where the coconut milk have better fat content, better fat composition. The protein value is almost similar while the coconut milk has better antioxidant content. the cow's milk has better mineral content as well. The cow's milk has higher total sugar content as well. Densel, Burtch, & Tang (2014) pointed out that one of the main benefits of coconut ice cream is that it can cater lactose intolerant customers due to not containing any lactose. Other benefits that coconut milk has that dairy milk does not is that coconut milk contains fibre as well as higher concentration of iron (Bridges, 2018)

The coconut milk has more protein variety than cow's milk, Kwon, Park, & Rhee, (1996) showed that there are at least 5 types of proteins contained inside coconut milk, where Hajirostamloo, (2009) showed that the protein mainly in cow's milk is mainly casein, the main functions of the protein are to act as coagulants so the ice cream can freeze and bind together faster, according to Arbuckle, (1986) and Goff & Hartel, (2013).

The fat content of the coconut milk is also different compared to cow's milk. Fuangpaiboon and Kijroongrojana (2017) pointed that the main fat constituents of coconut fat are lauric acid and myristic acid while Huth and Park (2012) show that the main fat components are palmitic acid and lauric acid. Compared to coconut milk, most of the dairy milk are saturated fat while most of the coconut milk is unsaturated fat. The difference in fat will alter the physiological aspects of the ice cream.

2.3.4 Protein

The key ingredient for all ice creams are proteins, where proteins are given by milk and plants, where casein are the main type of protein from animal milk while soy protein originate from soy milk, which are produced from soy beans. The texture of the cow's milk and soy milk do not differentiate too much and the chemical composition of the soy milk and cow's milk are somewhat similar (Hajirostamloo, 2009). This brings out that soy milk can be a good alternative to cow's milk if the consumers prefers the reduced cholesterol of the ice cream. Palm milk also contains a good amount of proteins, containing 1g of protein per 100g of palm milk (My Fitness Pal, 2018), it shows that palm milk can substitute some types of milk, such as coconut milk and animal milk in the future as key ingredients in some products such as ice cream.

2.3.5 Fats

One of the prime ingredients that affect the texture of the ice cream directly is the fat content of the ice cream, which they can be classified into different types. Fat serves to give out the creamy flavour which it was a crucial parameter to show the quality of the ice cream. The fat globules are also responsible for reducing the melting rate of the ice cream, cutting down the ice crystals and ice crystal perception of the ice cream (Guinard et al., 1997). Fats are classified into saturated fat and unsaturated fat due to saturated fat does not have any double bonds inside their carbon chain bond. where we can see that they have a significant chemical difference when compared between two. According to (Hajirostamloo, 2009), there were differences between the fat contain inside the same amount on soymilk and cow's milk. The usage of palm milk that labels as they have less unsaturated fat and more saturated fat, in which saturated fat is neutral towards healthy while unsaturated fats have positive effects on improving health by lowering the low density lipoprotein cholesterol while promote high density lipoprotein cholesterol in arteries. (Kris-Etherton, 2009). This was promoted by the Malaysian Palm Oil Board to encourage the use of the palm milk as an alternative to high saturated proteins sources such as coconut milk and cow's milk (Zainal, 2017).

2.3.6 Additives

One of the more important ingredients used for ice cream manufacturing are the uses of additives. There are many types of additives, from preservatives to colourings that improve shelf life, texture, flavour, colour, or more than one of the following above, it is shown that there are actually a few types of additives been added into the ice cream that help shape the texture and colour. One of the additive types are commonly used are the

stabilizers, which they help to form textures that are smooth and silky, there are many commonly used stabilizers that are used for experiment, while many have been replaced by polysaccharide hydrocolloids in the industry (Bahramparvar and Tehrani, 2011). Guar gum is one of the renounced ice cream stabilizers, which used as thickening agents, is added sparingly in food products (Mortensen et al., 2017) due to it being recognized as a strong stabilizers (Bahramparvar and Tehrani, 2011). Another type of additives that is important to the texture of the ice cream is the emulsifier. Emulsifiers main purpose is to keep the emulsion together so that the fats and the water inside the ice cream do not separate to different sides (Deosarkar et al., 2015). As emulsion help in coalescence in fat globules as well as destabilizing them (Bahramparvar and Tehrani, 2011),it gives out the smooth texture of the ice cream, and the fat globules that are dispersed will promote the creamy texture of the ice cream, but there are downsides of using emulsifiers, where according to Bahramparvar and Tehrani (2011), the emulsifiers can oxidise easily, where it will cause the flavour to run off. Excessive use of emulsifiers can also contribute to an easily melting ice cream and viscosity mix. One natural emulsifier that can be found naturally are the soy milk, which contains lecithin, as well as egg yolks.

2.3.7 Sugar

Sugar, is a type of sweetener that plays a pivotal role in the formation of the ice cream as well as textural and flavour roles. The sugars found in ice creams are used: sucrose in soymilk and lactose in cow's milk. The sugar's main role is to alter the viscosity of the ice cream which was affected during crystallisation process (Adapa et al., 2000), where the sugar crystals formed would affect the overall smoothness of the ice cream. When lactose crystallise, there are a tendency of forming coarse milk crystals, thus

reducing the quality of the ice cream by giving a sandy texture when eaten (Fox and Mcsweeney, 1998). Sucrose on the other hand does not crystalize easily (Husband, 2014), have normally came from plants, such as sugar cane and now, soy milk, it has the properties of lowering down the freezing point of the ice cream mixture, where an increase in 1% of sucrose content will lower the freezing point of the mixture by 0.1°C (Pintor, A., Buendia, H.B., Totosaus, 2017).

2.3.8 Water

Water is where the original form of ice when placed above melting point, in which it is important for the formation of the ice cream. Most of the water found inside the ice cream are provided by the milks that were added, which is cow's milk and soymilk. The main function of the water inside the ice cream is to provide moisture for the ice cream and allow the formation of ice crystals to give the ice cream the firm and texture, in which ice formed almost 50% of the total weightage (The McGraw-Hill Companies, 2018). While the freezing of the water forms different sizes of ice crystals, the reduction of freezing time would however increase the total number of the small sized ice crystals which they form. The types of freezers, the surface area of the container, and the speed of the dasher of the freezer allows faster freezing of the ice cream and lower number of the large crystals, since nucleation always starts either at the wall of the ice cream container, or else formed around the solids inside the ice cream (Fox & Mcsweeney, 1998;)

2.3.9 Minerals

Minerals are one of the required nutrients for the metabolisms of the human growth as well as maintaining health, the main minerals that can found in both soy milk and cow's milk are calcium, iron and phosphorous. Hajirostamloo, (2009) showed that soy milk, although show much more superior in terms on protein and fat content, cow's milk is still preferable in terms of mineral content, where although soy milks have higher amount of iron, but the cow's milk has much higher content in phosphorous and calcium. Ice cream can be a good way to plenish the lacking nutrients as some nutrients can be lacking for some diets such as vegan diet.

2.3.10 Air

The final ice cream ingredient that is really important is the air, where the air will contribute to the hardness, as well as fluffiness of the ice cream, one of the main physical parameters is the overrun, which by definition is the process where the ice cream mixture is processed to incorporate air into the ice cream mixture with the intention of improving the texture (Cruz, Antunes, Sousa, Faria, & Saad, 2009). The high level of air inside the ice cream will soften the ice cream, as well as making the ice cream more soft and creamier to eat (Ludvigsen, 2012). Some types of ice cream, such as soft serve and gelato does not require much air (Alfaifi & Stathopoulos, 2010; Goff & Hartel, 2013)

2.4 Growth of ice cream in Malaysia

The market of ice cream is big in Malaysia, according to Canadean, (2015). The ice cream market accounts for 1.3% of the 14, 954.1 million USD of the total food market value, where it was shown there are a moderate food growth between 2009-2014, at 3.5%, with bulk ice cream having the largest category within the ice cream market, with 50.7% as a whole. The estimated growth of the ice cream market, provided by Canadean, (2015) shown there are an estimated 5.4% increase in off trade value and 4.6% increase in off trade volume as well as an 5% increase in in trade value and 4.2% of in trade volume in 2019. This can be seen as a good opportunity as the increase in value and volume in both in trade and off trade means there are demand upon the ice cream market. The main ice cream categories found in Malaysia are 3 types: artisan ice cream, bulk ice cream and impulsive ice cream. Canadean, (2015) shows that in 2014, single serve ice cream has a market volume of 17.1 million Kg while artisan has 0.6 million Kg, while bulk ice cream contributed a 22.2 million Kg. with all showing a growth of compound annual growth rate of 3.5-4.9%. this showed that the ice cream has great growth potential in Malaysia.

2.5 Soursop

Soursop, are the fruits of *Annona muricate* that are planted in the more rural parts of Malaysia. The plant originates from the South America, particularly the West Indies.

Figure 2.2: Sample of soursop

The soursop tree can grow until 20 feet, and the soursop is available whole year around (Morton, 2004). Soursop currently is known for the savoury flavour when consumed raw and also it is also a choice for alternative medicine to cancer (Moghadamtousi et al., 2015). The leaves, seeds, fruits, barks and roots of the different species of the soursop have different uses for traditional medicine. the fruits, in particular are under research, along with their leaves, bark and roots to extract and investigate the medicinal properties of the tree (Dongre, 2014; Sawant & Dongre, 2014), although the tree bears less fruit compare to other types of fruit, as it bears 12 to 24 fruits per tree. Dongre (2014) showed that a group of 5 years old soursop tree in Hawaii can bear 42.5 kg of soursop fruits, with an increase to 78 kg on the third year after a decrease in second year, this shows the soursop provide decent amount of fruits in the long run that can provide raw materials to the industry, thus giving out big potential for development in soursop.

Soursops are normally consumed in 3 ways: it is eaten raw directly after either pluck from the tree, or bought back from supermarkets and markets, the juices from the

soursops are extracted or dried to make tea, extracted to make concentrated cordials, or directly make soursop juices. The development of the soursop ice cream opens up a new possibility for product development, given the fruit is described as a hybrid of acid to sub-acid taste with the scent of a pineapple is unique to soursop (Degnon, Adjou, Noudogbessi, Metome, & Boko, F., Ahoussi, E., Soumanou, M., Sohounhloue, 2013). The fruit are green in colour, but as they ripened, the fruit turns to yellowish green, as due to decrease in chlorophyll content in the fruit skin (Dongre, 2014), the fruit also changes texture, they turn soft as they mature. The flesh of the soursop is white in colour with seeds that are brown in the inside. Their pulp are also prepared raw or frozen for consumption or processing uses (Jiménez-Zurita et al., 2017)

Soursop contains high amount of nutrients and volatile substances that are currently studied on, as well as high fibre and water content, with the pulp containing 80-81% of water and 0.79g of indigestible fibre. Badrie and Schauss (2010). Badrie & Schauss, (2010) show that the fruit contains many types of nutrients that soursop is viable to be sufficient enough to provide large amounts of nutrients. Other than that, it contains high amount of phosphorous, iron, calcium and niacin. The high amount of ascorbic acid might contribute to the unique taste of the soursop. the volatile compounds, such as methyl alcohol and ethyl alcohol can be found in ripen fruits. The high number of volatile compounds that are present in the fruit inhibits development of the soursop (Badrie & Schauss, 2010).

2.5.1 Antioxidant of soursop

Soursop are also renowned for their abundance of anti-oxidants contain inside the fruits. Isabelle et al., (2010) report shows that soursop have 2.96 mg of total phenolic value in Gallic Acid/ gram in fresh water. It shown that soursop have respective amounts of antioxidants inside soursop. the fact that the high amounts of antioxidants maybe one factor to one of the uses on traditional medicine. Amarowicz, Pegg, Rahimi-Moghaddam, Barl, & Weil, (2004) report pointed out that the different types of extracts that are extracted using different mediums have different effects on different studies, such as the ethyl acetate extract of soursop leaves onto cancer cells. Gavamukulya, Elella, Wamunyokoli, & Shemy, (2014) paper shows the differences of types of phenols and other types of anti-oxidants in soursop fruits and leaves, such as a high terpenoids content in soursop leaves ethanolic extract and high tannin content in water extracts of soursop leaves. This gives good amount of information for antioxidants in soursop fruits.

CHAPTER 3

METHODOLOGY

3.1 Chemicals and Apparatus

3.1.1 Non-electrical Apparatus

Pot, portable stove, sugar, fine salt, Dutch Milk Fresh Milk, Palm Milk, spoon, fork, bowl, measuring cylinder, stop watch, 2.53mm metal sieve, LG refrigerator, retort stand, separating funnel 1L, hexane, beaker, distilled water, cloth sieve, plastic Tupperware.

3.1.2 Electronic Apparatus

Hanna electronic model HI 318 pH meter, Pensonic model PM116 (G) Hand mixer, Brooke Field CT3 texture analyser

3.2 Preparation of the ice cream

3.2.1 Preparation of the vanilla ice cream samples

The ice cream recipe is obtained by Mark Bittman (2016) where the mixing part of the recipe is referred from Patel and Amin (2015) with some augmentations. The preparation starts by preparing 500 ml of dairy milk, 0.87ml of salt and 125 ml of sugar and mixing the ingredients in a wok and a spoon for 1 minute. After that the mixture is cooked under low heat until the mixture starts to steam. The ice cream mix is left aside to

cool down, while the ice cream is left to cool down, a cup of 125 ml dairy milk is then whisked with 45 ml of corn starch. The mix is whisked until the corn starch leaves no residue. And then the 2 batches of ice cream were then mixed together and heated under medium- low heat. The mix is cooked until it starts to thickened. After that, the batter is then mixed with a mixer for 30 minutes while adding 5 ml of vanilla extract. After that, the ice cream is left for -4°C for 4 hours, after that the ice cream was blended for another 30 minutes before being left over for 2 nights.

3.2.2 Substitution of the dairy milk with coconut and palm milk

As for the next step, out of 725 ml of the total volume of the milk, 10%, of the dairy milk was replaced with coconut milk where the milks were added into the 500 ml batch, where the ice cream mix is heated. the milk batter is the then added with the 125 ml milk-corn starch mix, where the ice cream mix is then heated and mixed. After that, the ice cream mix is blended, and then freezes in a Tupperware, and then blended and freeze again. The process is repeated with substitution with 20% and 30% of coconut milk, as well as 10%, 20% and 30% of palm milk. the selection of the ice cream is conducted after comparing the results of the 7 samples according to the fat content, and physiological aspects.

3.2.3 Substitution of soursop juice

After the selection of the ice cream recipe, the ice cream recipe was augmented to substitute in 30% of the soursop juice from the original corn starch. The soursop juice was obtained by first skinning the soursop, then the soursop was then squeezed with a

cheese cloth, possibly eliminated the deseeding process as well. The soursop juice was added in the mixing part, where 13.5 ml of the fresh soursop juice are poured into the ice cream batter during the mixing.

3.3 Analysis of Physical Properties of the ice cream with palm and coconut milk substitution

The analysis conducted on the ice cream were: dripping test, pH test, hardness test, colour analysis, and fat determination, where table 3.1 has showed in the table below.

Table 3.1: Table of the constituents of different batches of ice cream.

Test	Control	10% coconut	20% coconut	30% coconut	10% palm	20% palm	30% palm
Full cream milk (ml)	725	652.5	580	507.5	652.5	580	507.5
Sugar (ml)	250	250	250	250	250	250	250
Salt(ml)	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Corn starch (ml)	45	45	45	45	45	45	45
Coconut milk (ml)	-	72.5	145	217.5	-	-	-
Palm milk (ml)	-	-	-	-	72.5	145	217.5
Vanilla extract (ml)	5	5	5	5	5	5	5
Total (ml)	1025.87	1025.87	1025.87	1025.87	1025.87	1025.87	1025.87

3.3.1 Dripping Test

The dripping test is conducted with references from Dervisoglu & Yazici, (2006), where 80 g of the ice cream are put on a 2.36 mm pore size metal sieve under room temperature. The ice cream is placed on the mesh to let it melt. A stopwatch is used to take for the first drip for the ice cream melts onto the plate placed beneath the mesh. Triplicate results, of the time taken for the first drip to drop onto the plate are taken and recorded (Aboulfazli, Baba, and Misran 2014).

3.3.2 pH

pH is taken by the usage of the electronic pH meter, where 10ml of the melted samples are directly measured with the pH meter. The readings are taken thrice (Chansathirapanich & Ngamchuachit 2016).

3.3.3 Colour Evaluation

The samples are run through the Konica Minolta CR-400 Chromameter. The samples are placed in a transparent Tupperware and then the samples are place on the chromameter and they are tested for their colour. Lightness, redness and yellowness of the ice cream are taken and then recorded. Triplicate results are taken (Roland, Phillips, and Boor, 1999).

3.3.4 Texture Analysis

With the use of the Brooke Field CT3 texture analyser, the ice cream is taken frozen from the refrigerator, one slice of the frozen ice cream is put in a plastic Tupperware, where the ice cream is pressed with a 6 mm cylinder probe with the penetration length of 10 mm, while the speed of the probe was at 1 mm per second. The ice cream is place to be pressed for 2 times and a triplicate result was taken, where the Texture Analysis curve and report is recorded and compared (Choo, Leong, and Henna Lu, 2010).

3.3.5 Determination of fat content

The fat analysation test is conducted via the hexane-water separatory method using 60ml of hexane and 5ml of the liquid ice cream sample. The sample of the ice cream and hexane are added into the separatory funnel where the ice cream and the hexane are add ed into the funnel. The funnel is shacked vigorously by held the cap on the bottom and the tip facing the top for 1 minute. During the period, the tip of the funnel is open to release the gases After 1 minute, it is placed on a retort stand and then it is left for 60 second. After that, the conical flask is place below the separatory flask and the fluids are separated. The weight of the flask before and after draining one of the 2 layers are measured and recorded Nielsen, (2014).

3.4 Physical properties analysis of ice cream incorporated with soursop using coconut milk

The tests conducted on the soursop ice cream were the dripping test, the pH test, colour analysis and texture analysis, where the methods of conducting the test can be referred back at 3.3.

Table 3.2: The table of different ice cream batches which have different concentration of soursop.

Volume (ml)	Coconut milk vanilla	Coconut milk soursop	Dairy milk	Dairy milk soursop
Full cream milk	507.5	507.5	725	725
sugar	250	250	250	250
salt	0.87	0.87	0.87	0.87
Coconut milk	217.5	217.5	-	-
Corn Starch	45	35	45	35
Vanilla Extract	5	-	5	-
Soursop	-	15	-	15
Total	1025.87	1025.87	1025.87	1025.87

3.5 Statistical Analysis

ANOVA and T-test is conducted on SPSS 21 software for colour of the ice cream samples to determine whether the ice cream samples have a significant or insignificant outcome (Chetti et al., 2012).

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Physical properties of the ice cream

4.1.1 Dripping time

Substitution of vegetable milk overall increases the dripping time of the ice cream.

Table 4.1: The table showing differences of Dripping time, hardness and pH of Ice Cream with different ratios of coconut and palm milk substituted.

Test	0%	10% coconut	20% coconut	30% coconut	0% palm	10% palm	20% palm	30% palm
Dripping time (s)	266.33	498.33	922.33	1029	266.33	262	302	570
Hardness (g)	3478	2292	913	783	3478	721	895.33	2886
pH	6.68	6.62	6.54	6.34	6.68	7.2	7.09	6.59

The overall trend for the ice creams for coconut and palm milk substitution increases the dripping time of the ice cream, according to Table 4.1. As comparison of coconut milk, palm milk has a slight decrease from 266 to 262 seconds while compared an almost doubled in dripping time, from 266 seconds to 498 seconds. As increase in concentration. The palm milk has a slight increase while the increasing from 10% to 20% concentration gives an 85% increase in dripping time. As for 30% concentration, the

coconut milk has double the melting time taken for it to melt. The highest spike of the dripping time is when the increase of 10% to 20% substituted ice cream.

The increase in dripping time makes the ice cream less resistant towards melting although the overall decrease in hardness of the ice cream. Yeon et al. (2017) agreed with Fuangpaiboon and Kijroongrojana (2017), in which they pointed out the hardness, viscosity and other factor do affect the ice cream. The increase in water and the overall moisture content causes the enlarged ice crystals to be more resistant towards melting. The increase in the melting time also pointed out that the overall increase samples that substituted dairy milk with vegetable milk. the substitution also showed that the coconut milk samples have higher melting time compared to palm milk ice cream. Patil and Benjakul (2018) pointed out that the coconut milk often melts fast, but with the presence of salt, it will melt more slowly. As for palm milk, Zainal, Sahri, Rosnani, Isa, & Aziz, (2016) shows that reduction in total fat and protein content allows for faster melting time. The chart that shows the coconut milk also compares that the sugar inside coconut is lower than palm milk, but that did not have significant changes on the freezing.

Gabbi, Bajwa, and Goraya (2018) showed that the melting rate is affected by the fat globule network also, and the increase of the fat network strengthened the ice cream, and thus, the larger fat globules are found within the ice cream, the faster the ice cream starts to melt, while Douglas Goff and Hartel (2013) written that 15-20 minutes are the desired time for ice cream to melt.

4.1.2 pH of ice cream

Overall, pH of coconut milk ice cream is more acidic when compared to palm milk ice cream, according to the trends shown in Table 4.2.

Table 4.2: The table showing the pH of the ice cream with different concentrations of palm and coconut milk.

Tests	**0% coconut**	**10% coconut**	**20% coconut**	**30% coconut**	**0% palm**	**10% palm**	**20% palm**	**30% palm**
pH	6.68	6.62	6.52	6.34	6.68	7.20	7.09	6.59

According to the table above, the addition of the different concentrations of coconut and palm milk drastically changes the pH of the ice cream. The 10% substitution of the ice cream gives a difference of 0.58 from 6.68 to 7.20, the increase to 20% vegetable milk concentration reduces both pH of the ice cream by 0.1. the ice cream of 20% is the closest to neutral pH. Increases the concentration to 30% ice cream reduces the pH of coconut ice cream to 6.34 where the palm milk ice cream also reduces to 6.59.

The overall trend of the coconut milk showed a reducing trend where the palm milk showed a curve where the low concentration of palm milk increases the pH but as the concentration increases, the pH of the ice cream decreases.

The pH of the ice cream also is influenced by the source of milk used for the ice cream. The pH of the ice cream are mostly influenced by the milk where normal milk is consider mildly acidic. Aboulfazli et al. (2014); Branch and Branch (2014) pointed out that dairy milk is about between 6.6 to 6.8, and thus the pH of the normal ice cream lands around that range, as the percentage of the coconut milk increases, the trend shows an overall decrease in pH when compared to the coconut milk and palm milk. The palm milk has a pH range of 6.7 where according to Rosnani, Aini, Ibrahim, & Ismail (2008) while coconut milk has a pH approximate 6.1 to 7, that is how that the increase in coconut milk

proportion reduces the pH value. The increase in proportion of palm milk reduces the pH due to the overall acidity of the ice cream increases. The increases in the acidity increases the pH to slight towards the pH of palm milk. The palm milks that have slightly acidic pH has been slightly lean towards due to the acidic nature. Thus, the overall trend shows the increase in vegetable milk reduces the pH of ice cream.

4.1.3 Hardness

Based on the Table 4.1, the hardness shows an overall reduction on the hardness when substitution of milk with other vegetable milk occurs.

When compared to other 6 ice cream samples. 10% coconut milk has almost triple the hardness of the ice cream, measuring 2292 g comparing to the 783g of the palm milk. When the concentration of the vegetable fat increases, the hardness of the ice cream changes, making the ice cream roughly the same hardness. When compared to the 30% concentration, the palm milk way harder than their coconut counterpart.

The overall trend shows that, the increase of palm milk increases the hardness while the increase of coconut milk drastically decreases the ice cream's hardness.

The hardness of the ice cream is by mostly affected by the ice cream's fat content as well as the crystallisation of ice cream. The fat content of the ice cream directly affects the ice cream as Goff and Hartel (2013) pointed out that the ice content, crystal size and fat globule size affects the ice cream hardness. The increase in water increase in fat content, making the increase in ice content.

According to Amarasiri, (2009), The main components of fat inside coconut milk is oleic acid, and lauric acid. The high amounts of the acids lowered the melting point of the ice cream as well as the hardness of the ice cream. Aziz et al. (2008) showed that the palm milks showed even reduced hardness. The palm milks composition shows even more fat content as well as reduced moisture content helps in reducing the hardness of the ice cream. Compared to Rosnani, Aini, Yazid, and Dzulkifly, (2007);Rosnani, Isa, and Ibrahim, (2014), the hardness of the ice cream is far lower than the ice cream that is prepared for the experiment is due to the differences of methods used. The ice cream prepared for the above experiments are using ice cream machines to conduct the mixing and cooling phase while the ice cream made for my ice cream due to following the steps of Patel and Amin (2015), it will be harder from the previous journals. The increase of water content also tend to increase the hardness of the ice cream as water often crystalizes and gives the hardness to the ice cream. Sato, (2001) shows that the ice crystals often determine the hardness of the ice cream where large ice crystals will harden the ice cream while small ice crystals will be softer.

After the aging process, The smoothed surface and the hardened surface shows that the large ice crystals formed at the surface of the ice cream causes the ice cream to hardened. Cook and Hartel (2010) pointed out that the most important parts of the ice cream making is the nucleation and the first phase of crystallization, where the ice crystals started to form. The blades of the ice cream machine will be constantly moving whilst the methods used by Patel and Amin,(2015) will cause the ice cream .to chunk and the blenders will not able to move constantly as larger blender cannot fit into the freezer whilst the smaller ones cannot run in prolonged duration. The aging process adds more hardness to the ice cream as the freezing solidifies the already large ice crystals and thus, successfully increase the hardness of ice cream

T-tests are conducted for seeing that the ice cream is that the hardness of the ice cream is significant towards the ice cream. The tests show that when using the ice cream with 30% substituted coconut milk, 10% substituted palm milk and 30% substituted palm milk showed there are difference on hardness on the ice cream.

4.1.4 Colour Evaluation of Ice cream

The parameters tested on both Coconut and Palm milk of various concentrations are lightness (L*), redness (A*) and yellowness(B*), where the chromameter is used for detecting the colours of the samples, where Figure 4.3 and 4.4 shows the parameters of the colour evaluation and their values.

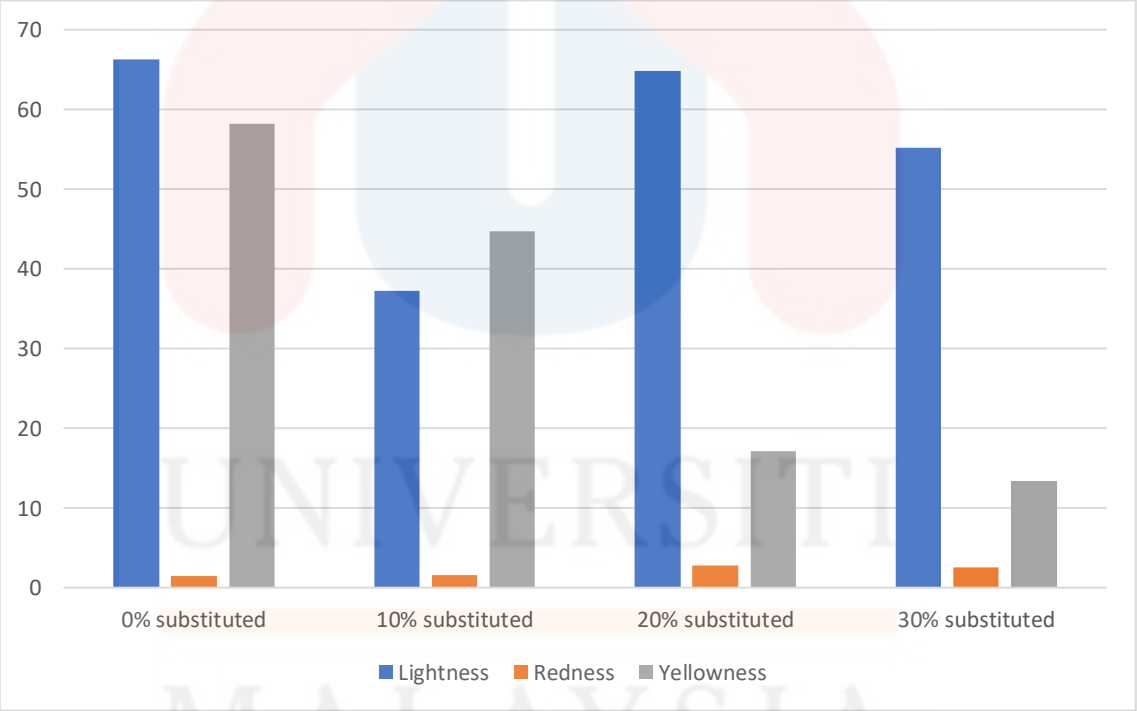

Figure 4.3: The bar chart showing the colour difference of the ice cream prepared with coconut milk at different percentage

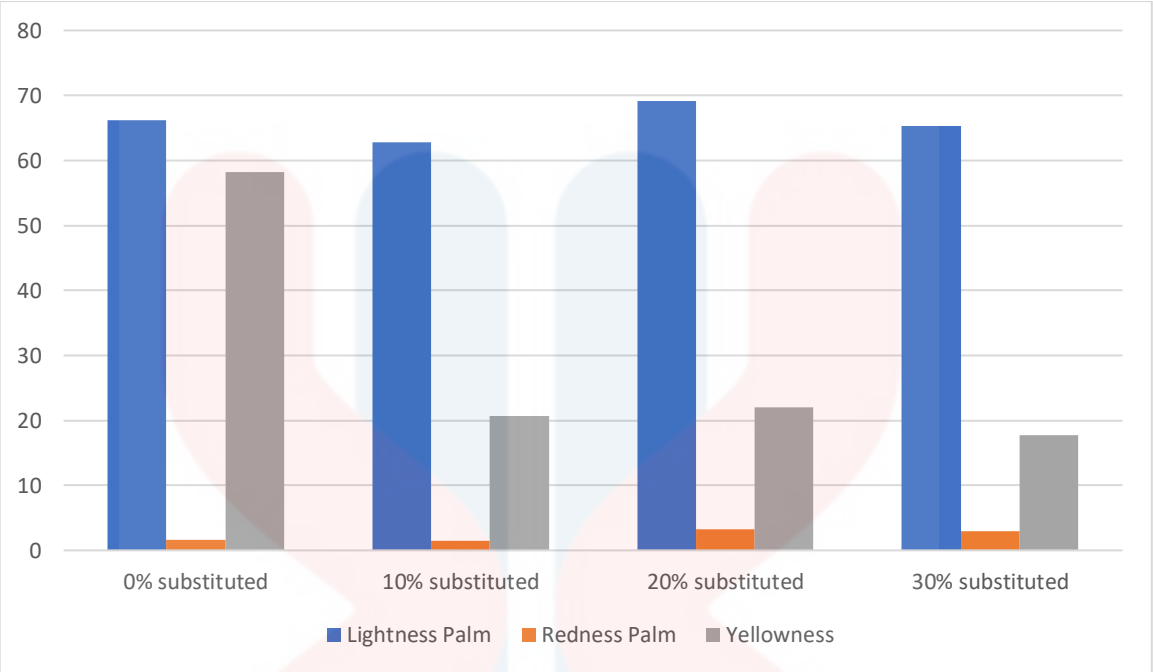

Figure 4.4 The bar chart showing the colour difference of the ice cream prepared with palm milk at different percentage

According to the figures above, the trend shows that an overall decrease in greenness of the ice cream, while the lightness showed similar trend, the redness of the ice cream had low significance of the ice cream.

The 10% substituted of the ice cream the lightness of the ice cream had drastic differences. The palm milk has almost double the rating of the coconut milk. the redness of the coconut milk is slightly higher than palm milk, where the ratings of 1.59 compared to 1.49 of the palm milks. the yellowness of the coconut milk has at least double of the ice cream. When the concentration increases, the lightness changes to 69 to the palm milk and 64 for the coconut milk. the redness increases to 3.21 for the palm milk where the coconut milks changes to 2.74. the increases to 30% concentration of the ice cream reduces to 55 while the palm milk's lightness reduces to 65. The greenness of palm milk reduces to 17.76 while the yellowness of the ice cream reduces to 13.

The colours of the ice cream generally showed a high lightness and greenness, abide low redness value. the table above points out that of all 7 samples, all the samples shows the high L*, medium B* and low A* trend. This is because of the vanilla extract and the milk gives the colour. The increase in coconut milk shows a net lost on lightness, or L* and yellowness, or B*, while the redness of the ice cream increases. While the ice cream colour is mainly cosmetic, where Choi and Shin (2014); Yeon et al. (2017) pointed out that the colours of the ice cream are mainly to attract customers to eat the ice cream.

After conducting the ANOVA test, for $\alpha = 0.05$, the lightness and redness has no significant differences on the ice cream, where the α is less than 0.05, but there are significant changes in yellowness of the ice cream. The ice creams colours also show that the changes of the milk, affects the colours of the ice cream, even with a slight margin. The changes of the milk do affect as the control's 58.18, changes to 17.16 for 20% coconut milk, as it also changes to 17.756 for 30% palm milk ice cream.

4.1.5 Fat content of ice cream

The trend of the fat volume of the ice cream where increases in coconut milk concentration eventually increases the fat content while the eventually increase of coconut milk reduces the ice cream fat content.

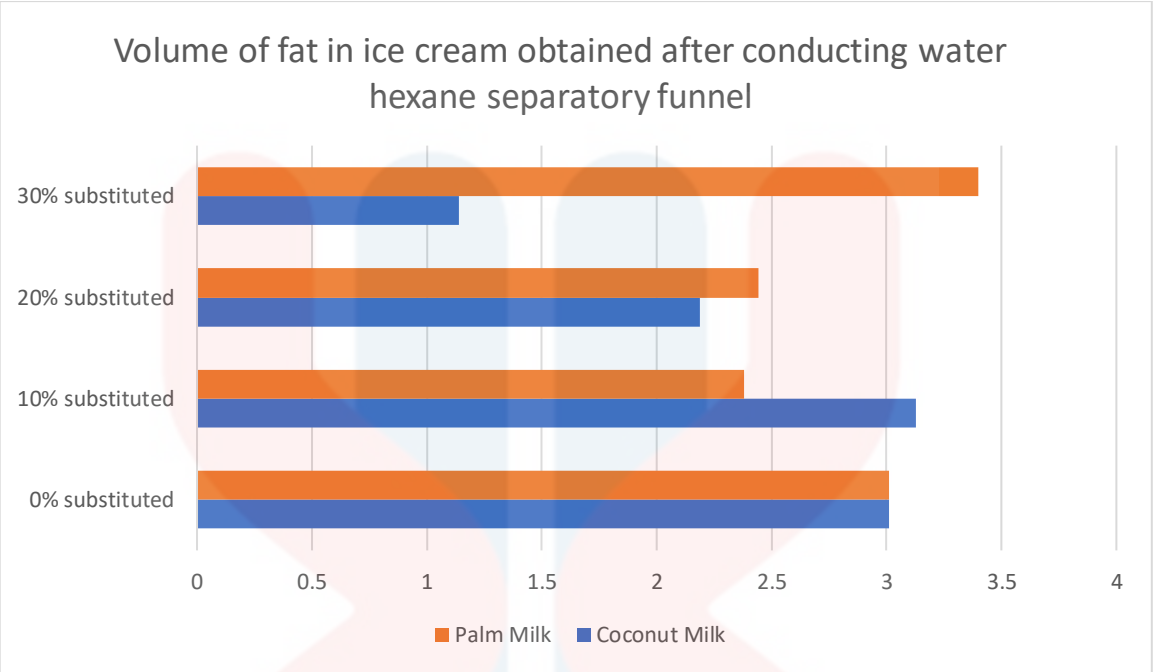

Figure 4.5: The bar chart showing the fat content of the ice cream.

Based on the figure 4.5, when 10% of the ice cream was substituted with coconut and palm milk, the palm milk has slightly lower fat content. but when the palm milk concentration increases to 20% the palm milk increases to 2.44 while the coconut milk showed decrease in fat content to 1.14.

One of the most important aspects of the ice cream is the fat content of the ice cream. Fat content out rules whether the ice cream is consider as ice cream or not. Board. (2017) states that the minimal ice cream fat content in Malaysia is 10%, and thus, any ice cream that has a fat content below 10% cannot be considered as ice cream. Ng and Tee, (1998) pointed out that the ice cream highly affects the quality and Chansathirapanich and Ngamchuachit, (2016) shows that the reduction in fat increases the hardness of the ice cream, even as time passes, the ice cream hardens even more. this explains that the lesser fat content of the coconut milk ice creams have higher hardness than control and their palm milk counterpart ice creams. Prindiville, Marshall, and Heymann, (1999) stated

that the ice cream where the increase in milk fat increases the hardness of the ice cream, as well as minor increase in smoothness and creaminess of the ice cream.

After conducting the tests of the ice cream, the ice cream chosen for the second phase of the ice cream is the 30% substituted palm milk and the 30% coconut milk. the melting time of the 30% substituted coconut milk ice cream is the highest while the ice cream has decent hardness. The fat content is totally different as 30% coconut milk has the lowest fat content while 30% palm milk has the highest fat content. Although the melting time has high difference, they both have decent dripping time although the 10% and 20% of both variants have higher dripping time.

4.2 Substitution of soursop juice into ice cream

4.2.1 Dripping time of ice cream

For an overall trend referred to Tables 4.6 and 4.7, the ice creams whom had substituted with soursop ice cream have overall improved physical aspects of the ice cream. The ice cream which coconut milk has been tested that there is an increase of 30 seconds, from 956 seconds to 1029 seconds. The increase of the vanilla dairy ice cream increase at least quadruple comparing to the soursop dairy ice cream, from 266 seconds to 1083 seconds.

The dripping time of the ice cream was improved by the addition of the soursop juice. The overall dripping time is improved at least 20% when compared to its vanilla flavour variant. The ice cream's dripping time improved due to the ability of the fibre allowed the ice cream to hasten the ice cream's hardening time, and Soukoulis et al. (2009) pointed out that fibre helps in hardening and also slowing the melting time of the ice

cream, making it more resistant towards melting. The replacement of the corn starch with the soursop juice proved to be a good substitute as Patel & Amin, (2015) showed that the addition of fibre, regardless of fruit, improves the hardness of the ice cream.

4.2.2 pH testing of ice cream

According to the Tables 4.6 and 4.7 below, the overall trend of the experiment shows that the pH augments the ice cream of the soursop towards 6.52. the pH of the coconut ice increases while adding to the ice cream, the dairy milks ice cream showed a decrease in pH.

The pH of the ice cream can be seen as an overall decrease of the pH due to the addition of the soursop juice to the ice cream. The pH of the soursop juice is acidic where Badrie & Schauss (2010) pointed out that the soursop juice has a pH value of 3.7 while the reduction of the pH is minimal due to the low amount of the juice added. The mixing of the coconut milk and the palm milk will alter the pH of the ice cream batter, and thus, the difference of pH compared between the coconut milk batch without and with the soursop juice.

4.2.3 Colour of the ice cream.

Based on the Tables 4.6 and 4.7, the overall trend of the experiment shows changes on lightness(L*), redness (A*) and yellowness (B*), according to tables 4.3 and 4.4. The addition of the soursop increases the lightness of the ice cream from 47.39 to 55.22, but the redness and greenness of the ice cream decreased from 2.71 and 17.93 to 2.5 and 13.43 respectively.

As for the dairy ice cream, the addition of the soursop juices the redness of the ice cream from 1.59 to 2.5 while the lightness and greenness of the ice cream is decreased from 66.22 and 58.18 to 52.66 and 12.98 respectively

The colour of the ice cream is mostly for cosmetic purposes according to Choi and Shin (2014), while for the comparison between the ice cream, the ANOVA conducted on the 4 sets of ice cream samples shown that there are significant differences on the greenness but no significant differences on redness and lightness. Similar results from Dias (2017) supported my observation and calculation as the addition of the soursop affects the ice cream's colour

4.2.4 Hardness of the ice cream

The overall insight of the ice cream, referred to Tables 4.6 and 4.7 is that the addition of the ice cream increases the hardness of the ice cream. For coconut ice cream, the hardness of ice cream quadrupled, from 783.00 g to 3984.25 g. Compared to the dairy milk's data, the addition of soursop at least doubled the hardness of the ice cream, from 3478.00 g to 7013.25 g.

The introduction of soursop has significant changes to the physiological changes. The addition of soursop sop significantly increases the hardness of the ice creams when compared to the vanilla variant ice cream. Soukoulis, Lebesi, & Tzia, (2009) show that the dietary fibre can improve multiple the physiological properties of the ice cream, while Dervisoglu & Yazici, (2006) stated that the inclusion of fibre into ice cream helps on the dripping time and also shows significant changes on the colour of the ice cream.

Comparison between the 2 ice creams, the coconut milk sample had higher hardness than control ice cream, as the fibre inside the ice cream strengthened the hardness of the ice cream. where the fibre strands of the soursop juice helped in further freezing the ice cream. The control ice cream which has higher fat content in comparison had lesser hardness. Soukoulis & Fisk, (2014) pointed that not just the fibre, the inulin contained inside the soursop enhances the freezing speed of the ice cream where shear lining behaviour is increased in ice creams. When compared to their vanilla flavoured counter parts, the increase in hardness is tremendous due to the assist from the fibres and the soursop proteins. The soursop helped on the hardness and it can improve the fast melting properties of the ice cream.

Table 4.6: The physical aspects of the 30% substituted coconut ice cream of vanilla flavour ice cream and soursop flavour ice cream

Parameters	**Vanilla coconut ice cream**	**Soursop coconut ice cream**
Dripping time (s)	956	1029
pH	6.34	6.52
L*	47.39	55.22
A*	2.71	2.50
B*	17.93	13.43
Hardness	783	3984.25

.

Table 4.7: The physical aspects of the dairy ice cream of vanilla flavour ice cream and soursop coconut ice cream

Parameters	Vanilla dairy ice cream	Soursop dairy ice cream
Dripping time (s)	266.33	1083
pH	6.68	6.52
L*	66.22	54.66
A*	1.59	2.50
B*	58.18	12.98
Hardness	3478	7013.25

CHAPTER 6

CONCLUSION & RECOMMENDATION

In conclusion, out of the different ice cream mix ratios, coconut milk with the ratio of 30% substitution provides the highest physical aspects of the ice cream, where it improves the dripping time of the ice cream, reduces the hardness of ice cream, provides a difference in colour, improves slightly the pH of the ice cream as well as reduces the fat content of the ice cream, where it solves the first problem statement.

The introduction of soursops of the ice cream overall improves the pH, dripping time and hardness of the ice cream, as well as giving a significant change in colour of the ice cream. This result makes soursop worthwhile to be added into ice cream as the overall physical aspects, promoting consumption of fibre in Malaysian diet.

Recommendations and limitation that have encountered during the project is that some of the experiments should have be conducted such as the ice crystal behavioural test, and sensory evaluation during the course of the project where Fuangpaiboon and Kijroongrojana (2017) pointed that the use of sensory evaluation can point out where more people can give their opinion on the ice cream, and thus, more data to analyse.

Further studies can be conducted on chemical and phytochemical aspects of the coconut soursop ice cream. Alyaqoubi et al. (2015) pointed out that coconut milk is rich in antioxidants while Souza, Pereira, Queiroz, Borges, & Carneiro, (2012) pointed out

that soursop have high levels of anti-oxidants contained. The study of antioxidants in ice creams can be tested as highly nutritious ice cream as there are little to no researches about anti-oxidant ice cream had been conducted in the field.

Ice cream quality can be improved with the adjustments of materials and methods. Cook and Hartel,(2010) that the size of the ice cream crystals affects the hardness of the ice cream. The ice cream that allowed large ice cream formation results in harder ice cream. This can be improves by using an ice cream machine, where the blades of the machine allows the formation of small crystals, smoothen and decreases the ice cream's hardness. Çam, Erdoğan, Aslan, & Dinç (2013) showed that addition of by-products affects the ice cream more due to proper mixing. The use of the machine can ensure the ice cream is properly mixed, and thus, a more proper texture ice cream.

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Appendix

Section A: Raw Data Tables

Table 1.1: Table showing the dripping time of ice creams of different concentrations and the average and standard deviations

Time (s)	1	2	3	total	average	Standard deviation
control	335	203	261	799	266.3333	66.16142
10% coco	565	457	473	1495	498.3333	58.28665
20% coco	940	1000	827	2767	922.3333	87.84266
30% coco	1147	1010	930	3087	1029	109.7406
10% palm	301	330	156	787	262.3333	93.22196
20% palm	211	130	565	906	302	231.3374
30% palm	735	350	625	1710	570	198.3053

Table 1.2: Table showing the differences of colour according to lightness, redness and greenness of the ice cream of different compositions, and also the average and standard deviation.

	L*	A*	B*	AL*	AA*	AB*
Control 1	67.88	1.18	18.77	66.21667	1.48	58.18
2	68.55	1.33	19.94			
3	62.22	1.93	19.47			
10% coco 1	55.71	1.05	22.68	37.18333	1.586667	44.71
2	37.42	1.97	15.71			
3	18.42	1.74	6.32			
20% coco 1	63.62	2.68	16.9	64.87667	2.736667	17.16
2	62.05	2.6	16.46			
3	68.96	2.93	18.12			
30% coco 1	52.48	2.52	13.04	55.22333	2.503333	13.42667
2	58.35	2.58	14.25			
3	54.84	2.41	12.99			
10% palm 1	63.4	1.52	20.54	62.78667	1.493333	20.67
2	62.04	1.44	20.22			
3	62.92	1.52	21.25			
20% palm 1	68.37	3.22	22.95	69.06667	3.21	22.06333
2	68.99	3.31	21.46			
3	69.84	3.1	21.78			
30% palm 1	61.77	2.66	16.77	65.25667	2.916667	17.75667
2	67.5	3.22	18.48			
3	66.5	2.87	18.02			

Table 1.3: The table showing the pH of ice cream obtained during the experiment.

pH	1	2	3	total	average	Standard dev
Control	6.69	6.66	6.69	20.04	6.68	0.017321
10% coco	6.6	6.6	6.67	19.87	6.62	0.040415
20% coco	6.54	6.55	6.54	19.63	6.54	0.005774
30% coco	6.39	6.33	6.3	19.02	6.34	0.045826
10% palm	7.5	7.2	6.9	21.6	7.2	0.034641
20% palm	7.07	7.13	7.07	21.27	7.09	0.427122
30% palm	7.07	6.43	6.26	19.76	6.59	0.017321

Section B: Pictures from the Final Year Project

Figure 2.1: Experiment of conducting dripping time test on control ice cream.

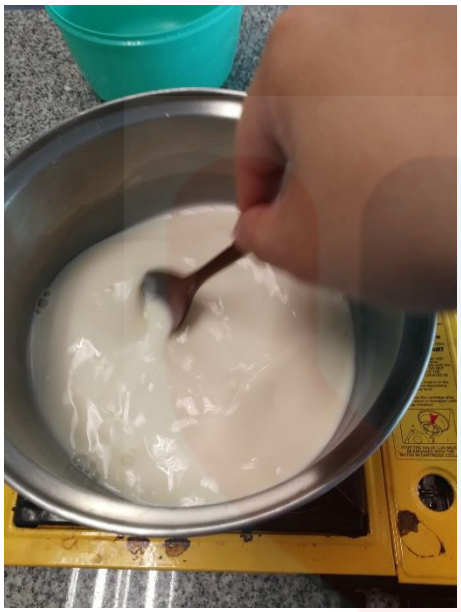

Figure 2.2: the pot of batter of 10% coconut milk vanilla ice cream batter.

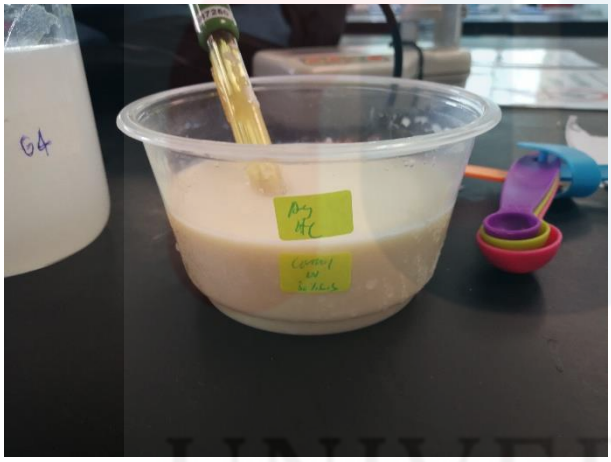

Figure 2.3: the testing of pH of melted control ice cream with 30% substituted soursop juice

Figure 2.4: The dairy ice cream sample

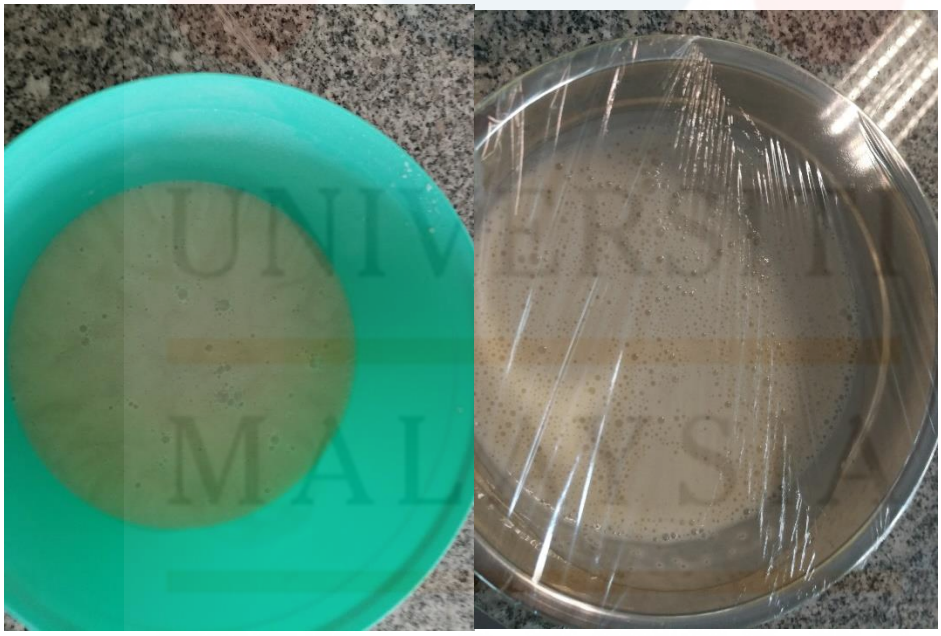

Figure 2.5: The 10% coconut milk sample

Figure 2.6: The 20% coconut milk sample

Figure 2.7: The 10% palm milk sample

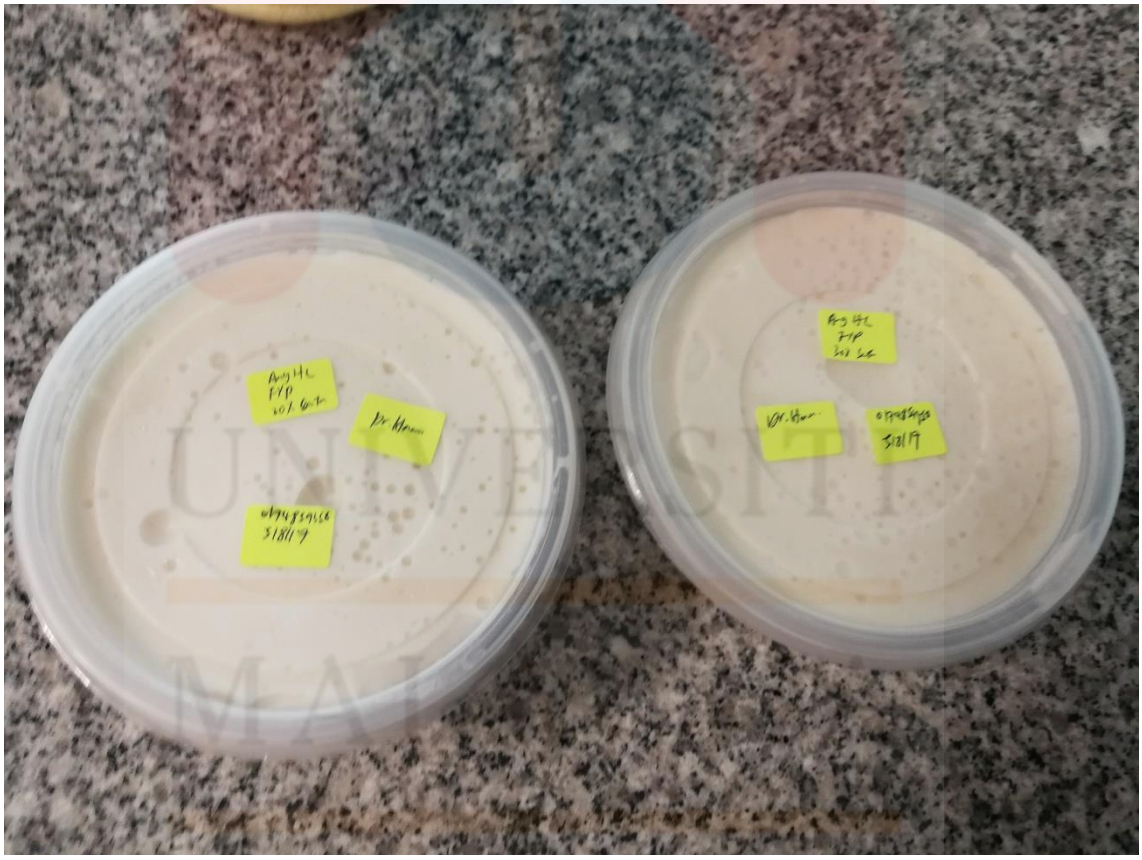

Figure 2.8: 2 samples of 30% substituted coconut milk ice creams