EFFECT OF MIXED STABILIZERS ON
STABILIZATION OF STERILIZED COCONUT MILK

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By:
MELISA ADRIANI
09.70.0068

DEPARTMENT OF FOOD TECHNOLOGY
FACULTY OF AGRICULTURAL TECHNOLOGY
SOEGIAPRANATA CATHOLIC UNIVERSITY
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By:
MELISA ADRIANI
Student ID: 09.70.0068
Department of Food Technology
Faculty of Agricultural Technology

This Report Has Been Approved and Supported by Examiner in Practical Training Exam on Tuesday, June 19th, 2012

Semarang, July 6th 2012

Advisor

Tatawan Tipvarakarnkoon

Ra Sulistyawati, S.TP, MSc
PREFACE

Praise and Glory to Almighty God, because of His Blessings so author can completely finish this report entitled “EFFECT OF MIXED STABILIZERS ON STABILIZATION OF STERILIZED COCONUT MILK”. This report has written as a requirement to acquire Bachelor Degree of Food Technology. In this report, will be discussed more detail about coconut milk and its stabilizers.

Surely, author were not alone both during training and making of report. Author got a lot of support and guidance from every people. So, in this occasion author wants to say a bunch thankyou for:

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9. Every people that can not mentioned one by one

The author realized that the writing of this report is still far from perfect and there are still many shortcomings due to the limitations of the Author. Therefore, the authors expect suggestion from all parties. Furthermore, the authors still hope that this report can be useful and provide knowledge to all those in need.
Semarang, July 6th 2012

Author
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COMPANY PROFILE

Assumption University is a private Catholic university with three campuses in the Hua Mak, Central World Plaza and Suvarnabhumi areas of Bangkok, Thailand. The university is led by the Brothers of St. Gabriel, a Catholic order devoted to education and philanthropy, who have been active in education in Thailand since 1901. Assumption University is noted for attracting large numbers of foreign students from countries including Russia, China, Burma, India, Bangladesh, Pakistan, and other Asian countries. Assumption University is also the first international university in Thailand. From its three campuses in Bangkok, Assumption University offers undergraduate and graduate programs in academic areas including business, law, engineering, and architecture. Other programs include languages, risk management, nursing, and the arts.

The Faculty of Biotechnology was founded in 1993 as the ninth faculty in Assumption University to produce graduates working in biotechnology field and its related fields. The Faculty has been offering two 4-year bachelor’s programs in Agro Biotechnology and Food Biotechnology. Both programs were approved of their academic standard by the Ministry of University Affairs in 1997. Since then the Faculty has produced 4 classes of graduate with the degree of BS in Agro-Industry and in Food technology, to the country. The majorities of the Thai people are involved in agriculture and related industries. Knowledge in biotechnology can be directly implied to the utilization of agricultural products to increase the value. Therefore it has a big impact on the living of most Thais. Biotechnology can provide agriculture with a variety of useful agents, from soil innoculents to veterinary products and possibly aqua-cultural and marine cultural products. Biotechnology implementation begins with the supplement of traditional genetic methods for the development of new or improved plant and animal strains for conventional agriculture. It also provides the food industry with bio-process and food ingredients like starter cultures and enzyme, which directly involved in food processing.
Abstract

Most of Thailand’s food is based on coconut milk. Coconut milk has a short shelf life that inhibits the exportation. Coconut milk needs an emulsifier or stabilizer to prevent the creaming process. In this study, stabilizer that used is Xanthan-guar gum and the emulsifier one is Acacia gum. Most of people didn’t like coconut milk-based food because of high saturated fat content, so as food technology student, we try to substitute half of coconut milk with vegetable oils that classified into unsaturated fats. To know the best percentage of CM : Oil, we should check and rheological properties and creaming index of emulsion. Especially in Europe that have a low temperature, coconut milk can easily crystallize there. Because of Thailand is one of the biggest exporter coconut milk around the world, so we should know the best percentage to make a good emulsion and this can play important role to export product (low-cholesterol coconut milk). To know the physical properties of coconut milk, the equipment to be used is rheometer MCR301 with double gap rotational cylinder. To check creaming index, measurement used by vernier caliper during 1 week in 3 different temperatures. From the experiment we know that soybean oil is the most-suitable with acacia gum solution and the higher percentage of coconut milk give the more stability. Moreover, we also know that Xanthan-guar gum mixture give a high stability in coconut milk emulsion.

Keyword: Acacia gum; coconut milk; rheology; coconut oil; soybean oil; sunflower oil; ricebran oil
1. INTRODUCTION

1.1 Background
Coconut milk is a milky white oil-in-water emulsion. It is obtained from extraction of coconut flesh with or without added water. It contains fat, water, carbohydrate, protein, and ash with the major components being water and fat. Coconut milk is one of the popular cooking ingredients in Thailand. Among the popular Thai food dishes using coconut milk are curries and dessert. The importance of coconut milk to Thai industries has prompted food scientists and food engineers in this country to develop new products from coconut milk for use as ingredients in household recipes both for the Thai market and for export (Tansakul & Chaisawang, -).

The information on thermal properties, especially thermal conductivity, of coconut milk has not been reported probably because of the oil-in-water emulsion nature of coconut milk that easily separates into two different phases, i.e., a heavy aqueous phase and a lighter cream phase. This causes the difficulty in applying the line heat source probe method due to the unstable and low viscous characteristics of coconut milk. Therefore, in this study, the addition of emulsifier into coconut milk coupled with homogenization are necessary to prevent the separation of emulsion and make it more viscous (Tansakul & Chaisawang, -).

Coconut milk that has been extracted is more stable. Coconut milk was naturally stabilized by coconut proteins which were globuline, albumine and a phospholipide emulsifier. But that’s not enough to keep the longer shelflife time of coconut milk, so artificial stabilizer or emulsifier is needed. Coconut milk often gives some problems to food scientists because coconut milk can not be sterilized with the same temperatures as other products. This is caused by coagulation process of coconut milk if heated above 100°C and heating can reduce almost all of flavour in coconut milk itself. Therefore, long time preservation is need to stabilize with emulsifier or stabilizer followed by homogenization to reduce the particle size of fat globule (Enig, 2009).

The processing of sterilized coconut milk starts with the extraction of coconut milk, which is then heated to a temperature of about 92 °C to 95 °C for 5 to 20 min (a process often referred to in the coconut industry as pasteurization) and often mixed with emulsifiers and/or stabilizers before a homogenization process (Tangsuphoom & Coupland, -). The physical properties of coconut
emulsions have not been well studied. It is common practical knowledge that heating and homogenization affect the stability of coconut milk emulsions. However, the mechanisms of such stability alterations and the underlying emulsion science are still unclear. In this work we determine the effects and mechanisms of stabilizer added, homogenization and heat treatment on the colloidal stability of freshly-manufactured coconut milk.

The food law states that coconut milk products must have 18-20% fat content. But, coconut milk itself is easily crystallize if exported to European country because coconut milk has very low crystallization point. So we need to substitute half of coconut milk with vegetable oil. Furthermore, vegetable oil has high content of unsaturated fatty acid that better to health compared with coconut milk that contains high value of saturated fatty acid. Before this, there is a study done by Christiana Sigit that learn about the substitution but still don’t know the best percentage. Therefore, in this study the main topic is the effect of stabilizer to sterilized coconut milk and also learn the best percentage of coconut milk and vegetable oil to make the coconut milk can not easily crystallize.

1.2 Objectives

The objectives of this study are to determine the effect of stabilizers on coconut milk, to substitute the vegetable oil into coconut milk, to know the properties of coconut milk emulsion.
2. LITERATURE REVIEW

2.1 Coconut Milk Emulsions
Coconut milk (CM) is an oil in water emulsion extracted from whole coconut or can be extracted both from coconut solid endosperm and coconut meat. The older coconut, the better coconut milk that can extracted. The emulsion of coconut milk relatively unstable because of the large droplet size (Tangsuphoon & Coupland, 2009) and the poor emulsifying properties of coconut proteins adsorbed at the oil-water interface (Monera & del Rosario, 1982; Onsaard, Vittayanont, Sringam & McClements, 2006). To make more stable product, other emulsifier or stabilizers are usually added during manufacturing and frequently the stabilized coconut milks are subsequently preserved by chilling, freezing, pasteurization or sterilization (Seow & Gwee, 1997) which can provide additional stresses on emulsion structure. Preserved processed that done in this study was heat treatment especially sterilization. Whole coconut is divided into some parts. They are exocarp and mesocarp with ±5 cm thickness, endocarp, testa with content about ±2,11% of coconut meat, meat, and coconut water.

![Cross Section of Coconut](image)

Figure 1. Cross Section of Coconut

Coconut milk is easily spoiled at room temperature and low temperatures. Therefore, thermal processing is required to prevent the spoilage. Coconut milk has very rich of nutrients to support microorganism growth that is the common spoilage microorganisms (Seow and Gwee, 1997). However, the thermal processing is caused of unpleasant physical changes such as phase separation, fat coagulation, and off-flavor or lipid oxidation. The crack of the oil-in-water emulsion also occurs in both raw coconut milk (by gravitational left-stand) and processed coconut milk (by heat treatment) which is normally considered as an unacceptable
physical defect. Due to the lack of protein content, coconut milk is poor emulsion stability over a relatively wide pH range from 3.5 – 6.0 (Seow and Gwee, 1997).

Coconut milk was naturally stabilized by coconut proteins are globuline and albumine and also phospholipide emulsifier. But that’s not enough to keep the longer shelflife time of coconut milk, so artificial stabilizer or emulsifier is needed (Enig, 2009). The term “emulsion instability” is broadly used to describe the ability of an emulsion to resist changes in its properties with time.

![Image](image.jpg)

**Figure 2** Instability of food emulsions

### 2.2 Rheology

The first use of the word “Rheology” is credited to Eugene C. Bingham (circa, 1928). Rheology is the science of the deformation and flow of matter. It studies of the deformation and flow of matter (Rao, 1999; Steffe, 1996) under of mechanical force (Tsheuschner, 2004). Results of rheology is showing superposition of viscous and elastic effects aid in the study of material by observing structural changes under of applied forces (Malkin and Isayev, 2006). Rheology can be expressed in terms of viscous, elastic, and viscoelastic functions. In terms of fluid and solid phases, viscous functions are used to relate stress or strain. Viscoelastic properties cover materials that exhibit both viscous and elastic properties (Rao, 1999).

### 2.3 Acacia Gum

Acacia gum, also known as gum arabic, is a natural gum exudate obtained from acacia trees in the “African sub-Sahelian Zone”. The gum has a highly branched compact arabinogalactan structure which gives a low-viscosity solution together with a central protein fraction that provides good emulsification properties. The powder hydrates readily in water and
concentrations up to 40-50% can be handled easily. Acacia gum contains protein which are very important for the emulsifying properties but sensitive to heat denaturation. The selection of temperature and selection time are key parameters for determining the quality of the gum (Imeson, 2010)

Acacia gum is a highly branched arabinogalactan polysaccharide with a high molecular weight developing a low viscosity in water. All molecules of acacia gum contain the same sugars: galactose, arabinose, rhamnose, and glucuronic acids partially neutralized with calcium, potassium, sodium, and magnesium salts. Arabinogalactans are attached to a protein skeleton forming the arabinogalactan protein (ACP) fraction. The polysaccharide fraction is composed of a linear chain of β[1,3] linked galactose. In position [1,6], this chain is branched with side chains of galactose and arabinose (Jurasek et al., 1993).

Compared to other water-soluble polysaccharides with a similar molecular weight, acacia gum exhibits very low viscosity in water. At 1% concentration, guar, xanthan, and lambda carrageenan develop viscosity around 3000-5000 mPas. To reach such viscosities, acacia gum has to be dissolved at concentrations of 40-50%. The low viscosity in solution is due to the globular, highly branched structure of acacia gum which hinders the formation of crosslinks or hydrogen bonding with water. Rheological behaviour of acacia gum solutions is Newtonian up to 25% concentration and then becomes pseudoplastic. This highly branched structure for both acacia gums makes the product highly resistant to hydrolysis in acidic media and to degradation in extreme thermal conditions and by enzymes (Sanchez et al., 2002). Acacia gum is not considered as a thickening hydrocolloid when dissolved in water at low concentrations up to 30%. However, when used in sucrose or sugar-free systems at high levels of dry solids, acaca gum provides a unique texture to confectionary products (Edwards, 1995).

Acacia gum is used as an emulsifier and stabilizers in preparing oil-in-water emulsions. Acacia gum is not considered an actual emulsifier which contains a lipophilic and hydrophilic part in its molecule. Acacia gum is a water-soluble polysaccharide. However, it is possible to give it a hydrophilic-lipophilic balance value (Chun et al., 1958). The protein contained in the AGP fraction of the molecule gives a surface-active behaviour to the molecule and allows formation of a colloidal film around the oil droplets.
To guarantee a long shelf life of a concentrated or diluted emulsion, it is necessary to ensure ability to avoid creaming, flocculation, and coalescence (Dickinson and Galazka, 1991). Stabilisation of the emulsion is obtained by steric hindrance due to the high-molecular-weight fraction of the gum molecule and electric repulsion due to the uronic acids on each dispersed oil droplet. The level of acacia gum used to stabilise emulsions depends upon the type, dosage, and specific gravity of oil (Buffo and Reineccius, 2000).

2.4 Xanthan – Guar Gum

Xanthan gum is a high molecular-weight polysaccharide secreted by the microorganism *Xanthomonas campestris* and produced commercially in a batch fermentation process. It hydrates in cold water to give a viscous solution with pseudoplastic flow behaviour. Xanthan gum shows synergistic thickening with guar gum and forms very elastic cohesive gels with locust bean gum and konjac mannan. Xanthan gum is produced at the cell wall surface by the bacterium *Xanthomonas campestris* during its normal life cycle (Harding et al., 1995).

The primary structure of xanthan gum consists of a cellulosic backbone of β-(1,4) linked D-glucose units substituted on alternate glucose residues with a trisaccharide side chain. The trisaccharide side chain is composed of two mannose units separated by a glucuronic acid (Jansson et al., 1975; Melton et al., 1976). Dispersion and hydration are the first steps in all applications of hydrocolloid thickeners. To achieve the optimum functionality of any hydrocolloid, it is important to ensure that the product is properly hydrated before use. The main factors that affect the hydration of xanthan gum are dispersion, mixing speed, particle size and the composition of the solvent. Xanthan gum is a fast hydrating water soluble hydrocolloid which can be dissolved at room temperature. Achieving full viscosity development requires a minimum quantity of water and a uniform dispersion of the gum in the water. A very fine powder is difficult to disperse but once dispersed it is quick to hydrate whereas a coarse mesh powder is easily dispersed but hydrates more slowly. Hydration time depends on the effectiveness of the dispersion, the mesh size of the xanthan particles, the type of solvent, and other ingredient in the recipe.

Xanthan is a very effective thickener and stabiliser compared to other hydrocolloids. It has a higher low-shear viscosity at lower concentrations and is more pseudoplastic at the shear rates typical of food processes compared to other hydrocolloid thickeners. The temperature stability of xanthan gum compares favourably with other thickeners. Xanthan solutions
exhibit exceptional stability during heating. As temperature increases, the viscosity of the xanthan solution decreases but this viscosity is recovered upon cooling. When severe heat treatments are applied, such as pasteurization or sterilization for a few minutes, the solution viscosity remains practically unchanged after cooling. Many other commonly used thickeners lose their viscosity at high temperature and do not recover this on cooling (Urlacher and Dalbe, 1997).

Guar gum is the ground endosperm from the seeds of the guar plant Cyamopsis tetragonoloba. Synergy between xanthan and guar gum can be characterized by the gain in viscosity and elastic modulus. The synergy is affected by the quality of the guar gum. The structure of the xanthan gum can also influence the synergy with guar gum (Shatwell et al., 1991a,b; Morrison et al., 2004).

2.5 Vegetables Oils

Vegetable oil is a kind of oil that can be used for cooking and for fuel. It has a high smoke point and can take high heat so it can use for frying. Vegetable oil, also a blend of oils from seeds and plants. Any oil that comes from plants is known as vegetable oil. It is extracted from plant sources such as: corn, peanuts and soybeans. The various seeds it comes from are: cottonseed, safflower seed, rapeseed and sunflower seeds. There is some types of vegetable oil such as: hazelnut, sunflower, corn, soybean, sesame, walnut, rapeseed, almond, palm, groundnut, safflower, coconut, and virgin olive oils, etc (Horn, 2007).

2.5.1 Coconut Oil

Coconut oil (Cocos nucifera L.) are traditionally found in coastal region in Asia. Coconut oil is a commercially important oil in the lauric acid group. Lauric acid oils differ significantly from other fats and oils in that they pass abruptly from a brittle solid to liquid within a narrow temperature range. Coconut oil is a hard brittle solid at ambient temperature. Sharp melting fats leave a clean, cool, nongreasy sensation on the palate, which is difficult to match with non lauric oils (Richard & Brien, 2004).

Coconut oil are two of the most important oil crops in tropical regions. Therefore, an understanding of the thermal behaviour of these edible oil products is important for many practical applications in the oils and fats industry. Over the past two decades, differential scanning calorimetry (DSC) has been increasingly utilised for thermodynamic
characterisation of edible oils and fats. The rapid growth in popularity can be attributed in part to the availability of instruments of higher sensitivity and greater ease-of-use, as well as to software which provides rigorous analysis of experimental data, even for the non-expert (Tan & Man, 2002).

Generally, coconut fats belong to the unique group of vegetable oils called lauric oil about 44 – 51 %. Lauric acid (CH₃(CH₂)₁₀COOH) is known as small molecule fatty acid (< 14:0) which contains short or medium chain of saturated fatty acid. Other chemical compositions of coconut oil belong to myristic acid (16 – 19 %), caprylic acid (9.0 – 9.5 %), palmitic acid (8.0 – 9.5 %), oleic acid (5 – 6 %), capric acid (5 – 10 %), steric acid (3.0 – 3.5 %) and linoleic acid (1.0 – 1.5 %), respectively. More than 90 % of fatty acids of coconut oil are saturated (Tipvarakarnkoon et al, 2008).

2.5.2 Soybean Oil

Soybean oil is obtained from soybeans (Glycina maxima). Soybean oil high in polyunsaturates, linoleic acid, and linolenic fatty acid is classified as a semidrying oil. Soybean oil is a very versatile oil as far as processing and product formulation are concerned in that it is a natural winter or salad oil, has heat-sensitive color pigments that deodorize to a red color much less than 1.0 Lovibond, develops large and easily filtered crystal when partially hydrogenated and fractionated, has a high essential fatty acid content, etc. The triglyceride structure of soybean oil is characterized by an almost total absence of saturated fatty acids in the sn-2 position. Random distribution of oleic and linolenic fatty acids on all glycerol p-positions, and a high proportion of linoleic acid in the sn-2 position. (Richard & Brien, 2004)

Crude soybean oil consist of 90-95% triglyceride, while the rest is phosphatide, free fatty acid, sterol and tocopherol. Soybean oil has about 15% content of saturated fatty acid so, soybean oil is good to be substitution agents for lipid / oil that has high content of saturated fatty acid like coconut milk. So, we can say that soybean oil is one of the low cholesterol oil like we can see the picture below (Anonym, 2007)
Figure 3. Fatty Acid of Oils.

Soybean oil has a high content of linoleic acid and a lower level of linolenic acid. These are both essential fatty acids for humans and therefore of dietary importance, but they are also the cause of oxidative instability of this oil. Processing techniques, such as hydrogenation and lipid modification through traditional plant breeding or genetic transformation, have been used to modify the fatty acid composition to improve its oxidative or functional properties. Triacylglycerols (TAG) are the primary neutral lipids in soybean oil (Gunstone, 2002).

2.5.3 Sunflower Oil

Sunflower oil is obtained from the seed of the plant *Helianthus annuus*. Sunflower oil has a distinctive, not altogether unpleasant flavor and odor, which is easily removed by deodorization. Traditionally, sunflower oil has been chemically refined, but it has been reported that physical refining has been successfully practiced. Sunflower oil has been valued as a component for spreads in Europe because of its high linoleic fatty acid and absence of linolenic fatty acids (Richard & Brien, 2004).

Sunflower oil could be classified as a natural winter oil if it did not contain waxes. These compounds are responsible for the turbidity that develops when oils are held at temperatures below 70°F (21.1°C). The waxes are present in the sunflower seed hulls and are extracted with the oil, generally at levels of 0.02 to 0.35% but sometimes higher. Sunflower waxes are
based on C-20 to C-22 fatty acids and C-24 to C-28 alcohols and melt at 70 to 80°C (158-176°F) (Richard & Brien, 2004).

2.5.4 Rice bran Oil

Typically, rice bran oil comprises about 20% saturated fatty acids and an even balance of monounsaturated and polyunsaturated fatty acids (40:40). Rice bran oil contains relatively large amounts of unsaponifiable component. Rice bran oil contains 2-4% free fatty acids at the time of milling. If not immediately extracted, the lipids in freshly milled rice bran undergo hydrolysis due to the presence of a potent lipase. Rice bran oil is usually difficult to refine due to high free fatty acid levels, waxes, bran fines, and pigments. The stability of rice bran oil is probably due to the combined protective effects of oryzanol, phytosterols, squalene, tocopherols, and tocotrienols (Gunstone, 2002).

1.5.5 Characteristic of Oils

Table 1. Fatty Acids Composition of Oils

<table>
<thead>
<tr>
<th>Fatty Acid</th>
<th>Coconut Oil (%)</th>
<th>Soybean Oil (%)</th>
<th>Sunflower Oil (%)</th>
<th>Rice Bran oil (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caproic (6:0)</td>
<td>0.5</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Caprylic (8:0)</td>
<td>7.8</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Capric (10:0)</td>
<td>6.7</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Lauric (12:0)</td>
<td>47.5</td>
<td>-</td>
<td>0.5</td>
<td>-</td>
</tr>
<tr>
<td>Myristic (14:0)</td>
<td>18.1</td>
<td>0.1</td>
<td>0.2</td>
<td>0.4</td>
</tr>
<tr>
<td>Palmitic (16:0)</td>
<td>8.8</td>
<td>11</td>
<td>6.8</td>
<td>19.8</td>
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<tr>
<td>Palmitoleic (16:1)</td>
<td>-</td>
<td>0.1</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Stearic (18:0)</td>
<td>2.6</td>
<td>4</td>
<td>4.7</td>
<td>1.9</td>
</tr>
<tr>
<td>Oleic (18:1)</td>
<td>6.2</td>
<td>23.4</td>
<td>18.6</td>
<td>42.3</td>
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<tr>
<td>Linoleic (18:2)</td>
<td>1.6</td>
<td>53.2</td>
<td>68.2</td>
<td>31.9</td>
</tr>
<tr>
<td>Linolenic (18:3)</td>
<td>-</td>
<td>7.8</td>
<td>0.5</td>
<td>1.2</td>
</tr>
<tr>
<td>Arachidic (20:0)</td>
<td>0.1</td>
<td>0.3</td>
<td>0.4</td>
<td>0.9</td>
</tr>
<tr>
<td>Behenic (22:0)</td>
<td>-</td>
<td>0.1</td>
<td>-</td>
<td>0.3</td>
</tr>
</tbody>
</table>


Table 2. Density of Oils

<table>
<thead>
<tr>
<th>Liquid</th>
<th>Temperature (°C)</th>
<th>Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coconut oil</td>
<td>15</td>
<td>0.924</td>
</tr>
<tr>
<td>Coconut oil</td>
<td>30</td>
<td>0.915 – 0.920</td>
</tr>
<tr>
<td>Soybean oil</td>
<td>15</td>
<td>0.924 – 0.928</td>
</tr>
<tr>
<td>Soybean oil</td>
<td>25</td>
<td>0.916 – 0.922</td>
</tr>
<tr>
<td>Sunflower oil</td>
<td>20</td>
<td>0.92</td>
</tr>
<tr>
<td>Sunflower oil</td>
<td>25</td>
<td>0.915 – 0.919</td>
</tr>
<tr>
<td>Rice bran oil</td>
<td>20</td>
<td>0.916–0.922</td>
</tr>
</tbody>
</table>

Table 3. Melting Point of Oils

<table>
<thead>
<tr>
<th>Oil</th>
<th>Melting point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybean oil</td>
<td>-16 to -22</td>
</tr>
<tr>
<td>Sunflower oil</td>
<td>-18 to -20</td>
</tr>
<tr>
<td>Sesame oil</td>
<td>-</td>
</tr>
</tbody>
</table>

Source: Gunstone (2002)
3. MATERIALS AND METHODS

3.1 Materials
This research has been done at laboratory of faculty of Biotechnology, Assumption University, Thailand and Metrohm Siam Ltd, Thailand. Materials needed for this study are glasswares, homogenizer, microscope, babcock bottle, stirrer, balance machine, centrifuge, vernier caliper, coconut milk, soybean oil, sunflower oil, ricebran oil, acacia gum 100%, n-butyl alcohol, ammonia solution, sulfuric acid 98%, sodium metabisulfide, sodium azide, hygrometer, xanthan gum, guar gum.

3.2 Methods
3.2.1 Effect of Acacia Gum Concentration on Rheological Properties (Viscosity) of Fresh Prepared Coconut Milk Emulsions
3.2.1.1 Preparation of Acacia Gum Solution 30%
Acacia gum (Jumbo Trading co., ltd. and Thai Pure Science co., ltd) was diluted to obtain 30% wt/wt by distilled water. Wait until properly mix. It usually take about 1 hour. It was kept in refrigerator for overnight.

3.2.1.2 Pre-heat and Fat Content Determination
Heat coconut milk in waterbath. It was possible to determine the fat content if it has reached ± 37°C. Firstly, add 8.8ml of CM into the centrifuge tube. Then add 4 ml of n-butyl alcohol, 3ml of ammonia solution and 8.7 sulfuric acid 98%. The addition of chemical must be done on acid room. Adding of sulfuric acid must be done slowly because it was flammable chemical. After added them, centrifuge for 500 rpm in 5 minutes or more. After centrifugation has done, see the solution and find out the phase of oil in the solution. The oil was the yellow one. Put it in the babcock bottle and see how many percent of oil inside coconut milk. This method was adapted from AOAC official method 989.04 “Fat in Raw Milk : Babcock Method”

3.2.1.3 Sample Preparation
Pure coconut milk has bought from a traditional market in Bangkok, Thailand. After measuring the fat content by methods that adapted from AOAC, pure coconut milk have to be preheate 1 at high temperature for 5 minutes. After that, coconut milk must be added by some compounds. They are water, acacia gum solution, sodium azide and sodium metabisulphite.
The aim of water added is to obtain the fat concentrations of 20%. Sodium azide were added for antimicrobials and antibrowning. Then, coconut milk emulsion were homogenized using the homogenizer (IKA ULTRA-TURRAX® T18 basic, Germany) at 15,5000 rpm for 3 minutes. At this test, we make 6 different treatment. They are, pure coconut milk, emulsion with 2% of Acacia Gum solutions, emulsion with 4% of Acacia Gum solutions, emulsion with 6% of Acacia Gum solutions, emulsion with 8% of Acacia Gum solutions, and emulsion with 10% of Acacia Gum solutions.

3.2.1.4 Measurements by Rheometer at Metrohm Siam Company, Bangkok, Thailand.
Measurements has done by MCR301 Rheometer (Physica®, Anton Paar GmbH, Graz, Austria-Europe) equipped with a double gap rotational cylinder DG26.7. The parameter measured by this experiment was viscosity.

3.2.1.5 Creaming Index of ACG 2% Emulsion
Emulsion 2% ACG must be poured into tube 10 ml for each. The tubes must be treated in 3 temperature condition: 5°C, 20°C and 30°C. samples must be checked everyday during a week using vernier caliper and take a photo on first and last day only. The total height of the emulsions in the tubes (Ho) and the height of the serum layer (H1) were measured in every day. The extent of creaming was characterized by a creaming index from formula percentage of creaming index $= 100\times (H1/Ho)$.

3.2.2 Density of Edible Oils
First we have to prepare three types of oil. They are soybean oil, sunflower oil, and rice bran oil. After that, the three types of oil were taken approximately 80 ml in a glass measuring cylindrical and the density will be measured by hygrometers. The density was measured 5 times with 2 temperature treatment at 25°C and 30°C.
3.2.3 Effect of Added Oils into Acacia Gum Stabilized and Coconut Milk Emulsions and to Substitute Unsaturated Oils Into Coconut Milk Emulsions which Stabilized by Acacia Gum 8%

3.2.3.1 Preparation of Acacia Gum Solution 30%
Acacia gum (Jumbo Trading co., ltd. and Thai Pure Science co., ltd) was diluted to obtain 30% wt/wt by distill water. Wait until properly mix. It usually take about 1 hour. It was kept in refrigerator for overnight.

3.2.3.2 Pre-heat and Fat Content Determination
Heat coconut milk in waterbath. It was possible to determine the fat content if it has reached ± 37°C. Firstly, add 8.8ml of CM into the centrifuge tube. Then add 4 ml of n-butyl alcohol, 3ml of ammonia solution and 8.7 sulfuric acid 98%. The addition of chemical must be done on acid room. Adding of sulfuric acid must be done slowly because it was flammable chemical. After added them, centrifuge for 500 rpm in 5 minutes or more. After centrifugation has done, see the solution and find out the phase of oil in the solution. The oil was the yellow one. Put it in the babcock bottle and see how many percent of oil inside coconut milk. This method was adapted from AOAC official method 989.04 “Fat in Raw Milk : Babcock Method”

3.2.3.3 Sample Preparation
Pure coconut milk has bought from a traditional market in Bangkok, Thailand. After measuring the fat content by methods that adapted from AOAC, pure coconut milk have to be preheated at high temperature for 5 minutes. After that, coconut milk must be added by some compounds. They are water, acacia gum solution, oil (except control), sodium azide and sodium metabisulphite. The aim of water added is to obtain the fat concentrations of 10% and 20% (control). Sodium azide were added for antimicrobials and antibrowning. Then, coconut milk emulsion were homogenized using the homogenizer (IKA ULTRA-TURRAX® T18 basic, Germany) at 15,5000 rpm for 3 minutes. Half of homogenized coconut milk were poured into Duran bottles and sterilized at 121°C for 15 minutes. Both non-sterilized and sterilized coconut milks were then measured creaming index, optical microscopy determination and flow test.
3.2.3.4 Creaming index
Each sample must be poured into tube 10 ml for each. The tubes must be treated in 3 temperature condition: 5°C, 20°C and 30°C. samples must be checked everyday during a week using vernier caliper and take a photo on first and last day only. The total height of the emulsions in the tubes (Ho) and the height of the serum layer (H1) were measured in every day. The extent of creaming was characterized by a creaming index from formula percentage of creaming index = 100* (H1/Ho).

3.2.3.5 Micrograph (DinoCapture 2.0)
Prepare 9.5 ml distilled water in tubes and then take the sample 500μl using micropipette. Vortex first before see the micrograph. The images of the emulsion were then analyzed by a Dino Capture 2.0 Software (DinoCapture 2.0, Version 1.2.7). At least 10 photos were taken from each coconut milk emulsion samples. For each photo, 10 individual droplets were then measured coarse oil droplet size by randomly selection.

3.2.3.6 Flow Test
This test has done by transferred 3 ml of each sample into small tubes and place in refrigerator to make it freeze. The sample must be taken everyday and checked by vernier caliper everyday. The total height of the emulsions in the tubes (Ho) and the height of the serum layer (H1) were measured. The flow test can be known by using formula = H0-H1. If ΔH = 0 means the sample already freezeed.

3.2.4 Effect of Added Oils into Xanthan-Guar Gum Stabilized and Coconut Milk Emulsions and to Substitute Unsaturated Oils Into Coconut Milk Emulsions which Stabilized by Xanthan-Guar Gum 0.15%

3.2.4.1 Preparation of mixed Xanthan-Guar Gum 0.15%
Xanthan gum and Guar Gum was diluted by water and mixed together to obtain 0.15%. Wait until properly mix. It usually take longer time than acacia gum mixing. It was kept in refrigerator for overnight.

3.2.4.2 Pre-heat and Fat Content Determination
Heat coconut milk in waterbath. It was possible to determine the fat content if it has reached ± 37°C. Firstly, add 8.8ml of CM into the centrifuge tube. Then add 4 ml of n-butyl alcohol,
3ml of ammonia solution and 8.7 sulfuric acid 98%. The addition of chemical must be done on acid room. Adding of sulfuric acid must be done slowly because it was flammable chemical. After added them, centrifuge for 500 rpm in 5 minutes or more. After centrifugation has done, see the solution and find out the phase of oil in the solution. The oil was the yellow one. Put it in the Babcock bottle and see how many percent of oil inside coconut milk. This method was adapted from AOAC official method 989.04 “Fat in Raw Milk : Babcock Method”

3.2.4.3 Sample Preparation
Pure coconut milk has bought from a traditional market in Bangkok, Thailand. After measuring the fat content by methods that adapted from AOAC, pure coconut milk have to be preheated at high temperature for 5 minutes. After that, coconut milk must be added by some compounds. They are water, xanthan-guar gum solution, oil (except control), sodium azide and sodium metabisulphite. The aim of water added is to obtain the fat concentrations of 10% and 20% (control). Sodium azide were added for antimicrobials and antibrowning. First, coconut milk emulsion except xanthan-guar gum solution were homogenized using the homogenzer (IKA ULTRA-TURRAX® T18 basic, Germany) at 15,500 rpm for 2 minutes and then put the xanthan-guar gum solution into emulsions and stirred well by magnetic stirrer for 15 minutes. Half of homogenized coconut milk were poured into Duran bottles and sterilized at 121°C for 15 minutes. Both non-sterilized and sterilized coconut milks were then measured creaming index and optical microscopy determination. The flowtest has not done in this experiment.

3.2.4.4 Creaming index
Each sample must be poured into tube 10 ml for each. The tubes must be treated in 3 temperature condition : 5°C, 20°C and 30°C. samples must be checked everyday during a week using vernier caliper and take a photo on first and last day only. The total height of the emulsions in the tubes (\(H_o\)) and the height of the serum layer (\(H_l\)) were measured in every day. The extent of creaming was characterized by a creaming index from formula percentage of creaming index = 100* \((H_l/H_o)\).

3.2.4.5 Micrograph (DinoCapture 2.0)
Prepare 9.5 ml distilled water in tubes and then take the sample 500μl using micropipette. Vortex first before see the micrograph. The images of the emulsion were then analyzed by a
Dino Capture 2.0 Software (DinoCapture 2.0, Version 1.2.7). At least 10 photos were taken from each coconut milk emulsion samples. For each photo, 10 individual droplets were then measured coarse oil droplet size by randomly selection.
4 RESULT AND DISCUSSION

4.1 Effect of Acacia Gum Concentration on Rheological Properties of Fresh Prepared Coconut Milk Emulsions

4.1.1 Viscosity of Coconut Milk Emulsion

Table 4. Effect of Acacia Gum Concentration on Rheological Properties of Fresh Prepared Coconut Milk Emulsions

<table>
<thead>
<tr>
<th>Sample</th>
<th>$\eta_{H}$</th>
<th>$\eta_{O}$</th>
<th>$\eta_{DYN-K}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HB</td>
<td>OS</td>
<td>$N$</td>
</tr>
<tr>
<td>Pure CM</td>
<td>76.59 ± 39.01</td>
<td>73.26 ± 36.71</td>
<td>99.09 ± 52.74</td>
</tr>
<tr>
<td>ACG 2% fresh</td>
<td>8.20 ± 0.21</td>
<td>7.31 ± 0.03</td>
<td>8.65 ± 0.02</td>
</tr>
<tr>
<td>ACG 4% fresh</td>
<td>13.66 ± 0.97</td>
<td>11.02 ± 0.43</td>
<td>14.09 ± 1.04</td>
</tr>
<tr>
<td>ACG 6% fresh</td>
<td>20.32 ± 1.35</td>
<td>17.92 ± 3.16</td>
<td>21.20 ± 1.39</td>
</tr>
<tr>
<td>ACG 8% fresh</td>
<td>48.66 ± 4.24</td>
<td>52.13 ± 1.81</td>
<td>47.39 ± 15.04</td>
</tr>
<tr>
<td>ACG 10% fresh</td>
<td>95.06 ± 9.82</td>
<td>88.41 ± 10.11</td>
<td>108.34 ± 8.80</td>
</tr>
</tbody>
</table>

From table 4, we can see the higher amount of acacia gum solution added into emulsion, higher degree of $\eta_{H}$ and $\eta_{DYN-K}$ obtained from emulsion. But, from pure CM sample, the result obtained is high enough but not higher than ACG 10% fresh. In pure CM also, standard deviation obtained also resulting in high amount. This phenomenon maybe due to coconut milk characteristic that easily separate into cream and skim. For another sample is tend to be more stable because already added by emulsifier that plays role in emulsion stabillization.

4.1.2 Creaming Index of ACG 2% Emulsion

Table 5. Creaming Index of ACG 2% Emulsion

<table>
<thead>
<tr>
<th>Sample</th>
<th>Temp</th>
<th>day 0</th>
<th>day 1</th>
<th>day 2</th>
<th>day 3</th>
<th>day 4</th>
<th>day 5</th>
<th>day 6</th>
<th>day 7</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>26.94 ± 8.00</td>
<td>31.22 ± 6.57</td>
<td>34.16 ± 5.59</td>
<td>38.56 ± 3.62</td>
<td>41.18 ± 2.93</td>
<td>41.10 ± 2.72</td>
<td>42.60 ± 4.17</td>
<td></td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>39.90 ± 3.16</td>
<td>47.64 ± 1.02</td>
<td>51.68 ± 1.18</td>
<td>53.11 ± 2.40</td>
<td>56.22 ± 1.46</td>
<td>57.37 ± 1.46</td>
<td>58.19 ± 0.89</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>43.50 ± 2.19</td>
<td>50.31 ± 0.87</td>
<td>53.74 ± 0.67</td>
<td>56.20 ± 0.85</td>
<td>57.12 ± 0.57</td>
<td>58.04 ± 1.39</td>
<td>57.10 ± 3.81</td>
<td></td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>13.90 ± 1.83</td>
<td>14.90 ± 1.42</td>
<td>16.67 ± 1.37</td>
<td>17.51 ± 1.69</td>
<td>25.09 ± 7.93</td>
<td>19.06 ± 1.02</td>
<td>18.57 ± 0.97</td>
<td></td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>25.02 ± 3.37</td>
<td>32.76 ± 4.52</td>
<td>35.67 ± 3.81</td>
<td>35.55 ± 4.56</td>
<td>37.03 ± 4.32</td>
<td>37.84 ± 3.69</td>
<td>37.26 ± 2.81</td>
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</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>26.68 ± 3.92</td>
<td>33.86 ± 4.70</td>
<td>35.63 ± 5.20</td>
<td>36.67 ± 4.17</td>
<td>36.02 ± 3.99</td>
<td>36.90 ± 3.91</td>
<td>36.49 ± 3.66</td>
<td></td>
</tr>
</tbody>
</table>

From table 5 we can see that normally creaming index will be increasing day by day. If there is a decreasing, maybe caused by the emulsion quality itself that already changed due to external factors that resulting into undesirable one. The lower temperature, the lower creaming index that indicate better emulsion stability. The same thing also demonstrated by Tangsuphoom & Coupland (2009) that the emulsion of coconut milk relatively unstable
because of the large droplet size and the poor emulsifying properties of coconut proteins adsorbed at the oil-water interface (Monera & del Rosario, 1982; Onsaard, Vittayanont, Sringam & McClements, 2006).

![Chart](chart.png)

Figure 4. Creaming Index ACG 2% Emulsions.

### 4.2 Density of Edible Oils

Table 6. Density of Edible Oils

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Oil Type</th>
<th>Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>25°C</td>
<td>Coconut oil</td>
<td>0.911 ± 0.002</td>
</tr>
<tr>
<td></td>
<td>Virgin Coconut Oil</td>
<td>0.913 ± 0.003</td>
</tr>
<tr>
<td></td>
<td>Soybean Oil</td>
<td>0.914 ± 0.002</td>
</tr>
<tr>
<td></td>
<td>Sunflower Oil</td>
<td>0.917 ± 0.003</td>
</tr>
<tr>
<td></td>
<td>Ricebran Oil</td>
<td>0.907 ± 0.006</td>
</tr>
<tr>
<td>30°C</td>
<td>Coconut oil</td>
<td>0.906 ± 0.002</td>
</tr>
<tr>
<td></td>
<td>Virgin Coconut Oil</td>
<td>0.902 ± 0.003</td>
</tr>
<tr>
<td></td>
<td>Soybean Oil</td>
<td>0.902 ± 0.003</td>
</tr>
<tr>
<td></td>
<td>Sunflower Oil</td>
<td>0.904 ± 0.004</td>
</tr>
<tr>
<td></td>
<td>Ricebran Oil</td>
<td>0.905 ± 0</td>
</tr>
</tbody>
</table>

From table 6 we can see that density of any kinds of oil are quite similar. The higher temperature, density will be lower. Richard & Brien (2004) demonstrated the same thing that the higher temperature, density will be lower.
4.3 Effect of Added Oils into Acacia Gum Stabilized and Coconut Milk Emulsions and to Substitute Unsaturated Oils Into Coconut Milk Emulsions which Stabilized by Acacia Gum 8%

### 4.3.1 Creaming Index

Table 7. Creaming Index of 8% ACG Emulsions

<table>
<thead>
<tr>
<th>Sample</th>
<th>NON STERILIZATION</th>
<th></th>
<th>STERILIZATION</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5°C</td>
<td>20°C</td>
<td>30°C</td>
<td>5°C</td>
</tr>
<tr>
<td>CM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>DAY 1</td>
<td>DAY 7</td>
<td>DAY 1</td>
<td>DAY 7</td>
</tr>
<tr>
<td>CM : SBO</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 - 80</td>
<td>95.27 ± 0.8</td>
<td>93.27 ± 1.05</td>
<td>44.71 ± 4.83</td>
<td>83.41 ± 4.83</td>
</tr>
<tr>
<td>50 - 50</td>
<td>28.94 ± 3.42</td>
<td>29.33 ± 3.87</td>
<td>32.86 ± 3.94</td>
<td>70.74 ± 6.16</td>
</tr>
<tr>
<td>80 - 20</td>
<td>18.63 ± 11.27</td>
<td>30.83 ± 20.25</td>
<td>28.79 ± 8.42</td>
<td>52.91 ± 2.75</td>
</tr>
<tr>
<td>CM : SFO</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 - 80</td>
<td>96.02 ± 0.55</td>
<td>96.05 ± 0.74</td>
<td>94.63 ± 0.65</td>
<td>93.52 ± 0.39</td>
</tr>
<tr>
<td>50 - 50</td>
<td>83.91 ± 12.18</td>
<td>84.23 ± 6.59</td>
<td>79.66 ± 3.39</td>
<td>82.51 ± 2.32</td>
</tr>
<tr>
<td>80 - 20</td>
<td>9.47 ± 4.57</td>
<td>13.16 ± 4.64</td>
<td>28.56 ± 4.6</td>
<td>52.46 ± 2.84</td>
</tr>
<tr>
<td>CM : RBO</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 - 80</td>
<td>45.29 ± 52.3</td>
<td>92.53 ± 1.32</td>
<td>90.03 ± 2.38</td>
<td>88.22 ± 3.41</td>
</tr>
<tr>
<td>50 - 50</td>
<td>23.89 ± 30.85</td>
<td>69.67 ± 23.18</td>
<td>65.95 ± 9.55</td>
<td>68.32 ± 6.54</td>
</tr>
<tr>
<td>80 - 20</td>
<td>25.78 ± 16.42</td>
<td>40.03 ± 15.69</td>
<td>30.7 ± 3.92</td>
<td>51.67 ± 3.27</td>
</tr>
</tbody>
</table>
From table we can see that almost similar with data on table 5, creaming index value will tend to be increased day by day. If there is a decline, maybe caused by emulsion quality and oil quality itself that changed because of external factors resulting in undesirable product. From table, we can see also see in per centage of CM : Oil 20-80 is very unstable emulsion. This thing indicate that the most stable emulsion obtained from the highest content of coconut milk inside emulsion. Moreover, oil that provide the best stability to emulsion is soybean oil. That didn’t mean that other oil is bad, but soybean oil is the most suitable with acacia gum solution. The same thing also demonstrated by Tangsuphoon & Coupland (2009) that the emulsion of coconut milk relatively unstable because of the large droplet size and the poor emulsifying properties of coconut proteins adsorbed at the oil-water interface (Monera & del Rosario, 1982; Onsaard, Vittayanont, Sringam & McClements, 2006) as explained before. Richard & Brien (2004) demonstrated that soybean oil high in polyunsaturates, linoleic acid, and linolenic fatty acid is classified as a semidrying oil. Soybean oil is a very versatile oil as far as processing and product formulation are concerned in that it is a natural winter or salad oil, has heat-sensitive color pigments that deodorize to a red color much less than 1.0 Lovibond, develops large and easily filtered crystal when partially hydrogenated and fractionated, has a high essential fatty acid content, etc.

**CM : SBO 5°C**

![Diagram](image)

**Figure 5.** Creaming Index of CM:SBO at 5°C
Figure 6. Creaming Index of CM:SBO at 20°C

Figure 7. Creaming Index of CM:SBO at 30°C

Figure 8. Creaming Index of CM:SFO at 5°C
Figure 9. Creaming Index of CM:SFO at 20°C

Figure 10. Creaming Index of CM:SFO at 30°C

Figure 11. Creaming Index of CM:RBO at 5°C
4.3.2 Micrograph

Table 8. Oil Droplets of ACG 8% Emulsions

<table>
<thead>
<tr>
<th>sample</th>
<th>Oil droplets</th>
<th>non sterilization</th>
<th>sterilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>CM</td>
<td>8.06 ± 3.01</td>
<td>9.73 ± 4.06</td>
<td></td>
</tr>
<tr>
<td>CM : SBO</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 - 80</td>
<td>8.25 ± 2.44</td>
<td>11.63 ± 7.95</td>
<td></td>
</tr>
<tr>
<td>50 - 50</td>
<td>7.37 ± 2.78</td>
<td>7.61 ± 4.01</td>
<td></td>
</tr>
<tr>
<td>80 - 20</td>
<td>8.41 ± 2.81</td>
<td>10.27 ± 4.01</td>
<td></td>
</tr>
<tr>
<td>CM : SFO</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 - 80</td>
<td>11.42 ± 11.80</td>
<td>10.11 ± 14.90</td>
<td></td>
</tr>
<tr>
<td>50 - 50</td>
<td>6.92 ± 2.71</td>
<td>7.36 ± 4.27</td>
<td></td>
</tr>
<tr>
<td>80 - 20</td>
<td>9.42 ± 3.85</td>
<td>11.45 ± 5.03</td>
<td></td>
</tr>
</tbody>
</table>
From table we can see that oil droplet from sterilization emulsion tend to be higher than non-sterilization one. Bigger oil droplets indicate that the emulsion already resulted in shape changed because of denaturation. As known that almost component of coconut milk non-resistant from heat treatment. Standard deviation of sterilized one also higher than non-sterilization, indicate that many diverse size of oil droplets. The smaller oil droplet indicate the better stabilization of each emulsion. Seow & Gwee (1997) demonstrated that the thermal processing is caused of unpleasant physical changes such as phase separation, fat coagulation, and off-flavor or lipid oxidation.

### 1.3.3 Flowtest

Table 9. Flowtest of ACG 8% Emulsions

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>20 - 80</th>
<th>50 - 50</th>
<th>80 - 20</th>
</tr>
</thead>
<tbody>
<tr>
<td>CM</td>
<td>6.05 ± 2.98</td>
<td>7.16 ± 3.82</td>
<td></td>
</tr>
<tr>
<td>CM ster</td>
<td>8.01 ± 2.55</td>
<td>11.23 ± 9.98</td>
<td></td>
</tr>
<tr>
<td>80 - 20</td>
<td>8.18 ± 3.35</td>
<td>8.94 ± 3.33</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>day 1</th>
<th>day 2</th>
<th>day 3</th>
<th>day 4</th>
<th>day 5</th>
<th>day 6</th>
<th>day 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>CM</td>
<td>2.74 ± 0.41</td>
<td>1.58 ± 0.94</td>
<td>1.00 ± 0.92</td>
<td>0.17 ± 0.29</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
</tr>
<tr>
<td>CM ster</td>
<td>0.87 ± 0.82</td>
<td>0.12 ± 0.20</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
</tr>
<tr>
<td>CM : SBO</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 - 80</td>
<td>3.35 ± 0</td>
<td>1.7 ± 0</td>
<td>2.12 ± 0</td>
<td>2.12 ± 0</td>
<td>2.37 ± 0</td>
<td>3.7 ± 0</td>
<td>3.85 ± 0</td>
</tr>
<tr>
<td>20 - 80 ster</td>
<td>1.16 ± 0</td>
<td>0.73 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
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<tr>
<td>50 - 50</td>
<td>0.75 ± 0</td>
<td>2.675 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
</tr>
<tr>
<td>50 - 50 ster</td>
<td>0 ± 0</td>
<td>1 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
</tr>
<tr>
<td>80 - 20</td>
<td>1.44 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
</tr>
<tr>
<td>80 - 20 ster</td>
<td>0.4 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
</tr>
<tr>
<td>CM : SFC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 - 80</td>
<td>3.16 ± 0</td>
<td>2.75 ± 0</td>
<td>2.15 ± 0</td>
<td>2.15 ± 0</td>
<td>3.7 ± 0</td>
<td>4 ± 0</td>
<td>4 ± 0</td>
</tr>
<tr>
<td>20 - 80 ster</td>
<td>0.9 ± 0</td>
<td>0.65 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0.9 ± 0</td>
<td>2.1 ± 0</td>
</tr>
<tr>
<td>50 - 50</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
</tr>
<tr>
<td>50 - 50 ster</td>
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<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
</tr>
<tr>
<td>80 - 20</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
</tr>
<tr>
<td>80 - 20 ster</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
</tr>
<tr>
<td>CM : RBO</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 - 80</td>
<td>2.9 ± 0</td>
<td>2.35 ± 0</td>
<td>2.5 ± 0</td>
<td>2.5 ± 0</td>
<td>3.15 ± 0</td>
<td>3.8 ± 0</td>
<td>3.55 ± 0</td>
</tr>
<tr>
<td>20 - 80 ster</td>
<td>2.01 ± 0</td>
<td>1.5 ± 0</td>
<td>0.5 ± 0</td>
<td>0.5 ± 0</td>
<td>1.2 ± 0</td>
<td>1.2 ± 0</td>
<td>2.4 ± 0</td>
</tr>
<tr>
<td>50 - 50</td>
<td>1.4 ± 0</td>
<td>2.385 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
</tr>
<tr>
<td>50 - 50 ster</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
</tr>
<tr>
<td>80 - 20</td>
<td>1.225 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
</tr>
<tr>
<td>80 - 20 ster</td>
<td>0.49 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
</tr>
</tbody>
</table>
That table indicates that higher amount of coconut milk resulting that the emulsion will be easier to freeze. Based on literature review, good emulsion that emulsion that rapidly melt after transferred into room temperature. But in this case, the result obtained were diverse and fluctuative, maybe due to the quality of oil and coconut milk itself that already changed because of external factors or maybe the method used for this experiment has not yet perfect that cause many mistakes in measurement.

4.3.4 Photo

Picture 1. Creaming Index 20-80 5°C day 1 and day 7

Picture 2. Creaming Index 20-80 20°C day 1 and day 7

Picture 3. Creaming Index 20-80 30°C day 1 and day 7
Picture 4. Creaming Index 50-50 5°C day 1 and day 7

Picture 5. Creaming Index 50-50 20°C day 1 and day 7

Picture 6. Creaming Index 50-50 30°C day 1 and day 7

Picture 7. Creaming Index 80-20 5°C day 1 and day 7
Picture 12. Flowtest 80-20 day 1 and day 7
4.4 Effect of Added Oils into Xanthan-Guar Gum Stabilized and Coconut Milk Emulsions and to Substitute Unsaturated Oils Into Coconut Milk Emulsions which Stabilized by Xanthan-Guar Gum 0.15%

4.4.1 Creaming Index

Table 10. Creaming Index of Xanthan-Guar Gum 0.15% Emulsion.

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>5°C</th>
<th>20°C</th>
<th>30°C</th>
<th>5°C</th>
<th>20°C</th>
<th>30°C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DAY 1</td>
<td>DAY 7</td>
<td>DAY 1</td>
<td>DAY 7</td>
<td>DAY 1</td>
<td>DAY 7</td>
</tr>
<tr>
<td>CM</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
</tr>
<tr>
<td>CM : SBO</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
</tr>
<tr>
<td>CM : SFO</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
</tr>
<tr>
<td>CM : RBO</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
</tr>
</tbody>
</table>

Based on the table above, we can see that the stabilizer used in this experiment caused a very stable emulsion. Almost all emulsion is not subjected to separate during storage in many temperature control. There is only 1 emulsion subjected to separate, but this is not a big thing because the creaming index value only in small amount. Urlacher & Dalbe (1997) demonstrated that Xanthan is a very effective thickener and stabilizer compared to other hydrocolloids. It has a higher low-shear viscosity at lower concentrations and is more pseudoplastic at the shear rates typical of food processes compared to other hydrocolloid thickeners. Xanthan solutions exhibit exceptional stability during heating. When severe heat treatments are applied, such as pasteurization or sterilization for a few minutes, the solution viscosity remains practically unchanged after cooling.
4.4.2 Micrograph

Table 11. Oil Droplets of 0.15% Xanthan-Guar Gum Emulsions

<table>
<thead>
<tr>
<th>sample</th>
<th>Oil droplets</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>non sterilization</td>
</tr>
<tr>
<td>CM</td>
<td>10.91 ± 7.95</td>
</tr>
<tr>
<td>CM : SFO</td>
<td>13.23 ± 4.30</td>
</tr>
<tr>
<td>CM : RBO</td>
<td>10.08 ± 7.89</td>
</tr>
</tbody>
</table>

Same with table 8, from this table we can see also that oil droplet from sterilization one tend to be more stable than non-sterilization one. Bigger oil droplet indicated that emulsion already changed shape due to denaturation. Smaller oil droplet indicate the more stable emulsion. Seow & Gwee (1997) demonstrated that the thermal processing is caused of unpleasant physical changes such as phase separation, fat coagulation, and off-flavor or lipid oxidation.

4.4.3 Photo

Picture 13. Creaming Index of XG 0.15% 5 °C day 1 and day 7

Picture 13. Creaming Index of XG 0.15% 20 °C day 1 and day 7
Picture 13. Creaming Index of XG 0.15% 30 °C day 1 and day 7
CONCLUSION

- The higher amount of acacia gum solution, the higher viscosity obtained
- Density of oil tend to be decline in higher temperature
- Creaming index value tend to increase day by day
- Quality factor of coconut milk and oil affect the value of creaming index
- Higher percentage of coconut milk in emulsion give more stability to emulsion
- Soybean oil well-suited with acacia gum, resulting in good effect to emulsion stability
- Oil droplet in sterilization emulsion tend to be bigger than non-sterilization one
- Higher amount of coconut milk, the easier emulsion to be
- XG 0.15% give the good stability in emulsion
REFERENCES


Buffo, R. And Reineccius, G. (2000). Beverage Emulsion and The Utilization of Gum Acacia as Emulsifier/Stabilizer. Perfumer and Flavorist, 25 (July/August), 24-44


Tscheuschner, H.-D. 2004. Grundzüge der Lebensmitteltechnik. Behr’s Verlag GmbH & Co. KG, Germany


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<th>2</th>
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<td>Discipline, responsibility for the assigned tasks and punctuality</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Willingness to learn and continue to develop skill and knowledge</td>
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<td></td>
<td>✓</td>
<td></td>
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<tr>
<td>Listen and follow the assigned work from a supervisor</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
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<tr>
<td>Proper conduct and respect workplace’s rules and regulations</td>
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<td>✓</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Personal appearance with proper dress as set by work place</td>
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<td></td>
<td>✓</td>
<td></td>
<td></td>
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<tr>
<td>Cooperation with coworkers and organization</td>
<td></td>
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<td></td>
<td>✓</td>
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<tr>
<td>Self confidence</td>
<td></td>
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<td>✓</td>
<td></td>
</tr>
<tr>
<td>Good attitude toward work</td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Ability to make decisions and solve problem</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
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<tr>
<td>Accept other comments and suggestions</td>
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<tr>
<td>Ability to adapt to work place and coworkers</td>
<td></td>
<td></td>
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<td>✓</td>
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</tr>
</tbody>
</table>

**Overall Total**

**Grand Total**

**Strengths**

Great discipline, and responsibility, diligent and enthusiasm to learn new things.

**Weaknesses**

What were the major strengths of this student? and what would you recommend?

**Practical training result**

☑ Satisfied

☑ Unsatisfied

**Assessor**

Tatchawan Tippaphai

**Position**

Lecturer
# FIELD WORK ASSESSMENT

**HOST INSTITUTION**

**STUDENT'S NAME**

**STUDENT'S ID**

**DEPARTMENT/FACULTY**

Food Technology/Food Agricultural Technology

Soegijapranata Catholic University

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<td>Neatness</td>
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Scoring:
- > 75 Very Good
- 66 – 75 Good
- 55 – 66 Sufficient
- < 55 Poor

Bangkok, March 2012

Advisor,

(signature)

**Name**: Dr. Tatsawon Tipvamksarnkum

**Position/Occupation**: Full-time Lecturer

Faculty of Biotechnology

Assumption University
### FIELD WORK ASSESSMENT FORM

**Student's Name**: Melisa Adriani  
**Student's ID**: 09.70.0068  
**Topic**:  

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**Date**: 75.07.2013  
**Supervisor**:  
**Signature**:  

**Scoring**

- **>= 80**: A
- **75 - < 80**: AB
- **70 - < 75**: B
- **65 - < 70**: BC
- **60 - < 65**: C
- **50 - < 60**: CD
- **45 - < 50**: D