PRODUCTION OF VIRGIN COCONUT OIL VIA CENTRIFUGATION AND OVEN METHODS

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PRODUCTION OF VIRGIN COCONUT OIL VIA CENTRIFUGATION AND OVEN METHODS

MOHAMAD FARIZ BIN AHMAD

A thesis submitted in fulfillment
of the requirements for the award of the degree of
Bachelor of Chemical Engineering

Faculty of Chemical & Natural Resources Engineering
Universiti Malaysia Pahang

May 2009

I declare that this thesis entitled “Production of virgin coconut oil via centrifuge and oven methods” is the result of my own research except as cited in references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.”

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Special Dedication to my family members,
my friends, my fellow colleague
and all faculty members

For all your care, support and believe in me.

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ABSTRACT

The conventional ways of breaking emulsions using heat is disadvantageous from the both economic and environmental perspectives. In this study, the production of virgin coconut oil from coconut oil milk was investigated. Centrifugation and hot method were used for separation of oil. Analysis was carried out by gas chromatography. Results show that, production of virgin coconut oil increases with increasing centrifugal speed. The optimum temperature required to maintain the nutrition oil oil was found to be 60oC. Experimental data also presented to show the influence of Triton -X-100, Tween 20 and SDDS on stability of virgin coconut oil emulsion.

ABSTRAK

Penggunaan cara lama untuk membaurkan emulsi dengan menggunakan haba adalah sesuatu kerugian dari segi ekonomi dan persekitaran khususnya. Dalam kajian ini, penghasilan minyak kelapa dara melalui santan kelapa dikaji. Kaedah emparan dan penggunaan haba digunakan untuk penghasilan minyak, Analisis minyak di lakukan dengan pengunaaan alat kromatografi gas. Hasil ujikaji ini menunjukan bahawa; penghasilan minyak kelapa dara adalah tinggi apabila halaju emparan tinggi. Suhu yang optimum diperlukan untuk mengekalkan nutrisi minyak yang terhasil. Data ujikaji juga memperlihatkan kesan agen pembauran seperti Triton-X-100, Tween 20 dan SDDS terhadap kestabilan emulsi minyak kelapa dara.

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g	-	acceleration due to gravity (9.81 m/s2)
h	-	travel distance of droplet (m)
Min	-	minutes
mL	-	mililiter
mm	-	milimeter
r		water density (kg/m^3)
r^0		oil density (kg/m^3)
v	-	terminal velocity of droplet (m/s),
VCO	-	virgin coconut oil
w/v	-	weight per volume
w/w	-	weight per weight
y		viscosity of the continuous phase (pa·s)
%	-	percentage
°C	-	degree Celsius
°F	-	degree Fahrenheit

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CHAPTER 1

INTRODUCTION

1.1 Background of the research.

Virgin coconut oil or VCO is directly extracted from fresh coconut flesh and it different between coconut oil in term of nutrient composition and method of production. Virgin coconut oil belongs to a group of vegetable oils abundant in lauric acid (Hui, 1996). German and Dillard (2004) cited the virtues of Lauric acid of having antiviral, antibacterial, anticaries, antiplaque and antiprotozoal functions. The Philippine National Standards or PNS (Bureau of Product Standards (BPS), 2004) defines VCO as the oil obtained from the fresh, mature kernel of the coconut by mechanical or natural means, with or without the use of heat, without undergoing chemical refining, bleaching or deodorizing, and which does not lead to the alteration of the nature of the oil. Aside from Lauric acid, VCO contains a considerable amount of short-chain fatty acids such as capric, caproic and caprylic which were also investigated to have antimicrobial and antiviral effects (Bergsson, Arnfinnsson, Karlsson, Steingri0Msson, & Thormar, 1998; German & Dillard, 2004; Van Immerseelet al., 2004). VCO has been claimed to have numerous beneficial health effects (Delmo, 2004; Villariba, 2003, 2004). Nevin and Rajamohan (2004) reported that VCO lowered total cholesterol, triglycerides, phospholipids, LDL, and VLDL cholesterol levels and increased HDL cholesterol in serum and tissue. Lauric acid makes up nearly 50% of the medium chain fatty acid (MCFA). Published studies showed that virgin coconut medium chain fatty acids

(MCFA) that mimic those of mother's breast milk can boosts the infant immune system, and also cause adult metabolic rate increase as VCO is converted directly to energy in the liver, passing through intestinal portal veins. Other benefit of virgin coconut oil is increasing in the rate of recuperation and therapeutic application; such as antioxidants, antimicrobials, anodynes and vulneraries. The new cells produced help increase of metabolism and faster the rate of damaged cell replacement.

The prize of virgin coconut oil in international market is in range of USD 10 – 15 per liter. Virgin coconut oil is more valuable in term of profit than coconut oil because the health effect and besides that the raw material (coconut) easy to get and cheap and also make this fields more interesting.

1.1.1 Benefit of virgin coconut oil**:**

- Kills viruses that cause influenza, herpes, measles, hepatitis C, SARS, AIDS, and other illnesses.
- Kills bacteria that cause ulcers, throat infections, urinary tract infections, gum disease and cavities, pneumonia, and gonorrhea, and other diseases.
- Kills fungi and yeasts that cause candidiasis, ringworm, athlete's foot, thrush, diaper rash, and other infections.
- Expels or kills tapeworms, lice, giardia, and other parasites.
- Provides a nutritional source of quick energy.
- Boosts energy and endurance, enhancing physical and athletic performance.
- Improves digestion and absorption of other nutrients including vitamins, minerals, and amino acids.
- Improves insulin secretion and utilization of blood glucose.
- Relieves stress on pancreas and enzyme systems of the body.
- Reduces symptoms associated with pancreatitis.
- Helps relieve symptoms and reduce health risks associated with diabetes.
- Reduces problems associated with malabsorption[1] syndrome and cystic fibrosis.
- Improves calcium and magnesium absorption and supports the development of strong bones and teeth.
- Helps protect against osteoporosis.
- Helps relieve symptoms associated with gallbladder disease.
- Relieves symptoms associated with Crohn's disease[2], ulcerative colitis, and stomach ulcers.

[1] Malabsorption is a state arising from abnormality in digestion or absorption of food nutrients across the gastrointestinal (GI) tract.

[2] Crohn's disease (also known as regional enteritis) is an autoimmune disease, which can

- Improves digestion and bowel function.
- Relieves pain and irritation caused by hemorrhoids.
- Reduces inflammation.
- Supports tissue healing and repair.
- Supports and aids immune system function.
- Helps protect the body from breast, colon, and other cancers.
- Is heart healthy; improves cholesterol ratio reducing risk of heart disease.
- Protects arteries from injury that causes atherosclerosis and thus protects against heart disease.
- Helps prevent periodontal disease and tooth decay.
- Functions as a protective antioxidant.
- Helps to protect the body from harmful free radicals that promote premature aging and degenerative disease.
- Does not deplete the body's antioxidant reserves like other oils do.
- Improves utilization of essential fatty acids and protects them from oxidation.
- Helps relieve symptoms associated with chronic fatigue syndrome.
- Relieves symptoms associated with benign prostatic hyperplasia (prostate enlargement).
- Reduces epileptic seizures[3].
- Helps protect against kidney disease and bladder infections.
- Dissolves kidney stones.
- Helps prevent liver disease.
- Is lower in calories than all other fats.
- Supports thyroid function.
- Promotes loss of excess weight by increasing metabolic rate.
- Is utilized by the body to produce energy in preference to being stored as body fat like other dietary fats.
- Helps prevent obesity and overweight problems.

affect any part of the gastrointestinal tract from mouth to anus; as a result, the symptoms of Crohn's disease vary among afflicted individuals

[3] An epileptic seizure is caused by twitching excessive and/or hypersynchronous electrical neuronal activity, and is usually self-limiting

1. 1.2 Virgin Coconut Oil can be produced by two common methods**:**

1.3.1 Heated (Hot Methods) processes.

Hot methods apply extreme pressure or high heat to extract the oil from the nut.

1.3.2 Non-Heated (Cold Methods) processes.

Cold methods obtain oil without applying heat or pressing the coconut meat mechanically, hence the more common term "cold pressed".

1.1.3 Production of virgin coconut oil by centrifugation method (Separation process-cold method)

Centrifuged Coconut Oil is made from fresh coconuts opened less than 48 hours after they are picked from the trees. They first shell the coconuts and then chop the flesh, placing it in an expeller press. The temperatures of the coconut flesh and the resulting coconut milk emulsion do not exceed 25° C or 78.8° F (room temperature). Once the coconut is shelled, it takes less than 45 minutes to produce the milk. The resulting coconut milk emulsion is then chilled slightly to 10° C (50° F) so that the oil will "pull out of solution." In other words, the chilling helps to break the protein emulsion that holds the oils in solution. Next, the cooled milk, by use of a large centrifuge, is separated into the pure oil that we sell here and a "skim" coconut milk. This method of extraction requires no heat at all. It works like a cream separator that is used for separating cream from cow's milk. It requires quite a few passes through this chilled centrifuge to obtain pure oil, but the resulting oil is absolutely fabulous. Cold processed virgin coconut oil allows the retention of monoglycerides and other natural anti-oxidants such as tocopherol (vitamin E), vitamin A and C which serves as natural preservatives. Heating will destroy these substances leaving only the lauric acid to work alone rather than in conjunction with these micro-nutrients.

1.1.4 Production of virgin coconut oil by oven method (Emulsion-hot method)

Production of virgin coconut oil by oven must be in control especially the temperature because we need to maintain the nutrient inside the virgin coconut oil and the nutrient will be destroyed by high temperature. An emulsion is a mixture of two immiscible (unblendable) substances. One substance (the dispersed phase) is dispersed in the other (the continuous phase). Emulsion is also a term used in the oil field as untreated well production that consists primarily of crude oil and water. Eighty percent of the oilfield emulsion produced is the type of water-in-oil *(w/o)* emulsion (Lixin at al., 2003). Water/oil/solid emulsions are mixture of ordinarily incompatible materials. The concept of microwave demulsification was first introduced by Klaila (1983) and Wolf (1986) in their patent applications. Authors Chih and Yeong (2002), *Fang et al*. (1989) and Fang and Lai (1995) reported demulsification of water-in-oil (w/o) emulsions by microwave radiation. By using microwave method more efficient separation process can be achieved

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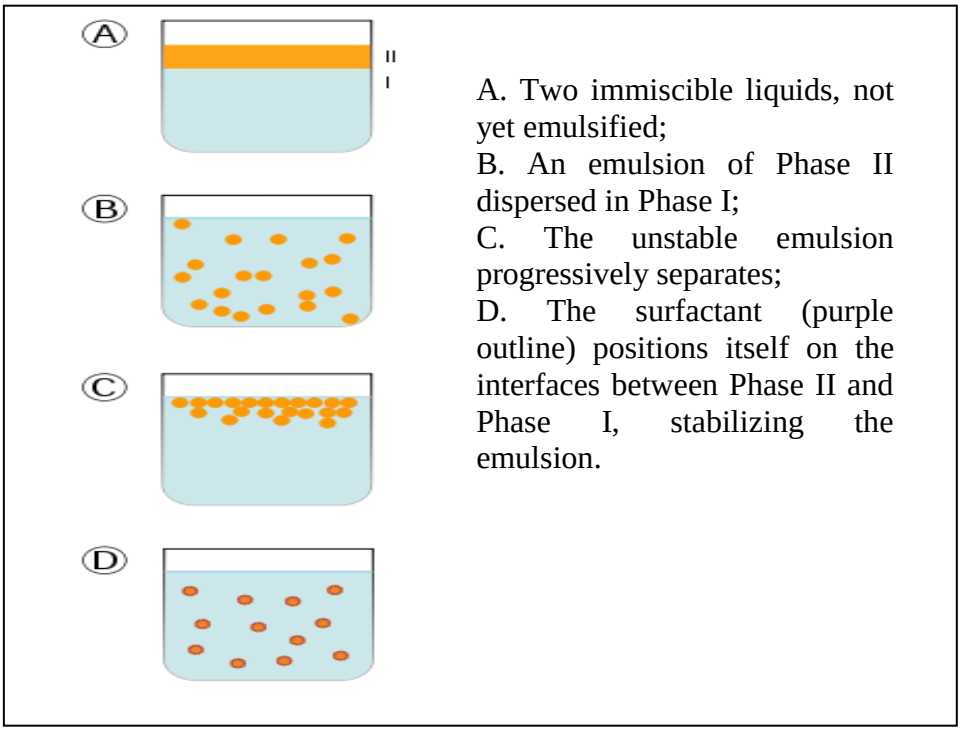


Figure 1.0: Emulsification process

1.2 Identification of problem.

Once mistakenly believed to be bad for the heart because of its saturated fat content, virgin coconut oil is now known to contain a unique form of saturated fat that actually helps prevent heart disease, stroke, and hardening of the arteries as well as provide many other health benefits. Asian and Polynesian people who rely on coconut and virgin coconut oil as a part of their daily diet have the lowest heart disease rates in the world. Some of these people get as much as 50 percent of their total daily calories as saturated fat, primarily from virgin coconut oil. If virgin coconut oil caused heart disease, as some people used to believe, these people would have all died off centuries ago. Those populations who consume large quantities of coconut oil have remarkably good cardiovascular health. Absent are the heart attacks and strokes characteristic in Western countries where coconut oil is rarely used.

Furthermore with all the miracle cures and special diets around us, we should be getting more slender and healthy by the minute. But notice people in your local supermarkets and restaurants today and decide for yourself whether that appears to be true. After a three-decade run as the national obsession, dieting to become slim by eating less fat or skipping meals simply has not worked. The only things really getting thinner are our wallets. We have been taught that fat and oil are bad for our health because they clog our arteries, make us fat, and have us falling apart in no time. For the past few decades, the official story has been that the dreaded killers have been the saturated fats. These are often found in the bodies of large animals and are usually not contributed to our dinner plates willingly. Virgin coconut oil does not inhibit the effects of the thyroid hormone, while many seed and grain oils have been proven to do so. Because a faster metabolism burns more weight off your body, a stronger thyroid function along with some physical exercise will help you lose excess body fat, or avoid you're putting it on in the first place.

In high technology era a Philippines research study shows that the coconut oil can delay as well as reduce HIV (human immunodeficiency virus) which spreads AIDS.

The breakthrough may come as a light at the end of the long dark tunnel in the worldwide fight against AIDS. The study, carried out by the government's San Lazaro Hospital and pharmaceutical giant United Laboratories since 1989, discovered that coconut chemical lauric acid inhibits delays and reduces the spread of HIV virus. Lauric acid is the basis of monolaurin and sodium lauryl sulfate which were found as the active chemicals promising in controlling HIV.

On July 19, 1995, Dr. Mary Enig, noted biochemist and nutritionist, was quoted in an article published in The HINDU, India's National Newspaper as stating that virgin coconut oil is converted by the body into "Monolaurin" a fatty acid with anti-viral properties that might be useful in the treatment of AIDS. The staff reporter for The HINDU wrote about Enig's presentation at a press conference in Kochi and and reported on Dr. Enig's observation the Monolaurin helped in inactivating other viruses such as measles, herpes, vesicular stomatitis and Cytomegalovirus (CMV) and that research undertaken so far on virgin coconut oil also indicated that it offered a certain measure of protection against cancer-inducing substances. All the analysis of virgin coconut oil show that virgin coconut oil have big potential to develop and can generate the economy especially to add commercial value of coconut product.

1.3 OBJECTIVES

The aim of this study/research is to produce virgin coconut oil. Hence, the objectives of this research are:

- The study of production virgin coconut oil via centrifuge and oven methods.
- The study of mechanism of demulsification.

1.4 SCOPE OF STUDY

- Characterization (properties) of virgin coconut oil in term of physical and chemical properties.
- To study the effect of the temperature on virgin coconut oil production by heat the sample (*VCO*) below 60^{o}C by using Oven)
- The range of rotation/speed is 6000, 8000, 10000 and 12000 rpm by using high speed centrifuge separator-Sorvall.

1.5 Significant of study

Virgin coconut oil has many potential benefits that are yet to be discovered. By doing this research, it is hoped that virgin coconut oil would bring more and more values to the coconut trees. Thus, more land will be opened for the plantation of coconut trees. The country's economy will benefit from this as coconut sugar can be exported to other countries as demands increase. The people, as well, will have more job opportunities in the field.

CHAPTER 2

LITERATURE REVIEW

2.1 Virgin Coconut Oil

There is no industry standard definition for "Virgin Coconut Oil" as there is in the olive oil industry for "Virgin" and "Extra Virgin" olive oil. Today, there are many coconut oils on the market that are labeled as "Virgin Coconut Oil." Virgin coconut oil belongs to a group of vegetable oils abundant in lauric acid (Hui, 1996). German and Dillard (2004) cited the virtues of lauric acid of having antiviral, antibacterial, anticaries, antiplaque and antiprotozoal functions. Nolasco, Balboa, Serrame, and Lim-Sylianco (1994) found that coconut oil, trilaurin and tripalmitin inhibited the promotion stage of carcinogenesis. A study by de Roos, Schouten, and Katan (2001) showed that consumption of solid fat rich in lauric acids resulted in a more favorable serum lipid profile in healthy men and women than with solid fat containing trans fatty acids. Dayrit (1997) enumerated the medicinal values of coconut oil itself while Lim-Sylianco et al. (1991) reported that the antigenotoxic activity of dietary coconut oil surpassed that of dietary soybean oil.

Virgin Coconut Oil can only be achieved by using fresh coconut meat or what is called non-copra. Chemicals and high heating are not used in further refining, since the natural, pure coconut oil is very stable with a shelf life of several years. There are currently two main processes of manufacturing Virgin Coconut Oil:

1. Quick drying of fresh coconut meat which is then used to press out the oil. Using this method, the coconut meat is quick dried, and the oil is then pressed out via mechanical means.

2. Wet-milling. With this method the oil is extracted from fresh coconut meat without drying first. "Coconut milk" is expressed first by pressing. The oil is then further separated from the water. Methods which can be used to separate the oil from the water include boiling, fermentation, refrigeration, enzymes and mechanical centrifuge.- "Fermentation" here is defined as the natural separation of the coconut oil from water using gravity. No machine or other substances are used in the extraction. First, coconut milk is expressed from the freshly harvested coconuts by using the pure water that is present inside the coconuts. The coconut milk is then allowed to sit for approximately half a day. During this time, the heavier water separates from the oil by sinking to the bottom, while the lighter coconut solids float to the top (curds). In between the coconut solids and the water is a crystal clear coconut oil that is completely unrefined. The oil is then slightly heated (less than boiling temperatures) for a short time (5 -15 minutes depending on air temperatures) to remove any remaining moisture, and then filtered. The result is a clear coconut oil that retains the distinct scent and taste of coconuts. This is a traditional method of coconut oil extraction that has been used in the Philippines for hundreds, if not thousands of years.

2.2 The Chemistry of Coconut Oil

Coconuts have always played a specific and unique role in the diets of mankind. The secrets that give this unique role are found in the fat part of whole coconut, in the fat part of desiccated coconut, and in extracted coconut oil. The Philippine National Standards or PNS (Bureau of Product Standards (BPS), 2004) defines VCO as the oil obtained from the fresh, mature kernel of the coconut by mechanical or natural means, with or without the use of heat, without undergoing chemical refining, bleaching or deodorizing, and which does not lead to the alteration of the nature of the oil. Aside from lauric acid, VCO contains a considerable amount of short-chain fatty acids such as capric, caproic and caprylic which were also investigated to have antimicrobial and antiviral effects (Bergsson, Arnfinnsson, Karlsson, Steingri0Msson, & Thormar, 1998; German & Dillard, 2004; Van Immerseel et al., 2004). VCO has been claimed to have numerous beneficial health effects (Delmo, 2004; Villariba, 2003, 2004). Nevin and Rajamohan (2004) reported that VCO.

- Lauric acid makes up nearly 50% of the fatty acids from the fat of the coconut. Only coconut and palm kernel oil have any significant amounts of lauric acid. Lauric acid has greater antiviral activity than any other saturated fatty acid; more than either of its fellow coconut ingredients, caprylic acid, or capric acid. It has only been in recent years that Lauric acid has been recognized for its unique properties in food use, related to its antiviral, antibacterial, and antiprotozoal functions. It is also found in mother’s milk.

- Caprylic acid makes up about 7-8% of coconut oils fatty acids and is an effective anti-fungal.

- Capric acid makes up 6-7% of coconut's oils fatty acids. This is another medium chain fatty acid that has a similar benefit to lauric acid. It has been added to the

list of coconut's antimicrobial components. These fatty acids are found in the largest amounts in coconut.

- Myristic acid is yet another medium chain fatty acid makes up about 17% of coconut oil.

Kidneys Prefer

- The kidneys have been found to preferentially use saturated fats for protective cushioning and as a quick energy source. Commonly occurring saturated fats in the kidney storage depots include: myristic, palmitic and stearic acids.

- Kidney function can be enhanced by the high content of myristic acid found in coconut oil. Myristic acid helps signaling across the kidney cell membrane, hence the importance of saturated fats in cellular communication.

Anti-Fungal, Anti-Viral, Anti-bacterial, Antiprotozoan

- Medium-chain saturated fatty acids in coconut oil are potent antimicrobial agents, effective against fungi, viruses and many bacteria. The most effective fatty acids are lauric acid, caprylic acid and capric acid. They appear to work by causing microbial cell walls to actually disintegrate.

Anti-Inflammatory

- Recently published research says that natural coconut fat in the diet leads to a normalization of body lipids (fats) improves the immune system's anti-inflammatory response and protects against alcohol damage to the liver.

Fast Energy Access

- Shorter-chained saturated fats like coconut oil have been used by physicians as conjunctive treatment in liver disease. Short and medium chain fatty acids are directly absorbed into the bloodstream and utilized by the liver. Their short chain length allows these fats to be directly converted into energy.This reduced metabolic load allow the liver to get on with its primary function of detoxifying, producing bile, and maintaining blood sugar levels.

Protection against Carcinogens

- Studies have also shown that the short and medium chain saturated fatty acids found in coconut oil provide protection against carcinogenic compounds.

Enzymes:

- There are no enzymes in coconut oil. If there were, the oil would quickly deteriorate and have a very short shelf life. Enzymes' role in plants is to break things down and initiate the process of decomposition. High quality coconut oils, particularly Virgin Coconut Oil, have a very long shelf life (2 years or more) and therefore have no appreciable amounts of enzymes in the oil. "There are no enzymes in coconut oil, nor any other edible oil for that matter." - Mary Enig, Ph.D. author "Know Your Fats"

Lipase

- Like raw butter and cream, fresh raw coconut has the fat splitting enzyme Lipase. Walter Last, nutritionalist and author of The Natural Way to Heal and Self Help Cancer Cure says: "Lipase has vast importance for our health, not just in regard to the commonly recognized diseases of the fat metabolism such as overweight and underweight, cardiovascular disease, diabetes, strokes and degenerative muscle diseases, but also for skin problems, autoimmune diseases, cancer,

degenerative diseases of the brain and nervous system, and also for rejuvenation and regeneration in general."

Lauric Acid and Monolaurin

- Lauric acid is formed into monolaurin in the human or animal body. A number of patents have been granted in the United States for medical uses of lauric oils, lauric acid, and monolaurin. Although one earlier patent was granted more than three decades ago, the rest of these patents have been granted within the past decade.

Monolaurin

- Monolaurin is the antiviral, antibacterial, and antiprotozoal monoglyceride used by humans and animals to destroy fat-coated viruses including:

1. Herpes: Recent research shows that Herpes virus has is a causative role in the initial formation of atherosclerotic plaques and the reclogging of arteries after angioplasty.

2. Measles: There is published scientific research identifying low level measles virus as a major cause of chronic Crohn's disease.

3. Cytomegalovirus, or CMV, is a common virus that infects most people worldwide. CMV infection is usually harmless and rarely causes illness. A healthy immune system can hold the virus in check. However, if a person's immune system is seriously weakened in any way, the virus can become active and cause CMV disease.

4. Influenza: Pathogenic bacteria including listeria monocytogenes: The manifestations of these bacteria include septicemia, meningitis, encephalitis, and intrauterine or cervical infections in pregnant women, which may result in spontaneous abortion or stillbirth.

5. Helicobacter Pylori: is a major causative factor of 90% of gastric and 75% of duodenal ulcers. In Western countries the prevalence of Helicobacter Pylori infections roughly matches age (i.e., 20% at age 20, 30% at age 30, 80% at age 80 etc). Transmission is by food and human contact, sharing food utensils etc. A minority of cases of Helicobacter infection will eventually lead to an ulcer and a larger proportion of people will get non-specific discomfort, abdominal pain or gastritis. Protozoa such as Cryptosporidium; one of the most resistant parasites of water chemical treatments ever encountered. This makes treating water for Cryptosporidium very difficult. The parasite responds somewhat to chlorine but only in high doses and it is resistant to many commonly used hospital and laboratory disinfectants. In recent years Cryptosporidium has been regarded as the most dangerous waterborne human pathogen in developed countries.

6. Giardia Lambdia: In Australia, Giardia rears its head in the less common instance of infection through water supplies and swimming pools. During the past 2 decades, Giardia infection has become recognized as one of the most common causes of waterborne disease. The most publicized incident of drinking water contamination in Australia occurred in July – September 1998 in Sydney. High numbers of Cryptosporidium and Giardia were reported for treated water, and boil-water notices were issued for 3 million residents.

Caprylic Acid and Candida

- Caprylic Acid is one of the fatty acids found in coconut oil that has been used for quite some time in fighting Candida. William Crook, M.D., the author of The Yeast Connection, reports that many physicians have used caprylic acid successfully to support overcoming yeast and that it works especially well for those patients who have adverse reactions to antifungal drugs.

Capric Acid and HIV

- Capric acid is formed into monocaprin in the human or animal body. Monocaprin has also been shown to have antiviral effects against HIV and is currently being tested for antiviral effects against Herpes Simplex and antibacterial effects against Chlamydia and other sexually transmitted bacteria. Besides Capric acid, two other medium chain fatty acids found in coconut oil have been found to support suppression of Candida Albicans. A study done at the University of Iceland found capric acid causes the fastest and most effective, killing of all three strains of Candida Albicans tested, leaving the cytoplasm disorganized and shrunken because of a disrupted or disintegrated plasma membrane. Lauric acid was the most active at lower concentrations. This study shows great promise that all the medium chain fatty acids in coconut oil work together to overcome Candida albicans. Chlamydia trachomatis is inactivated by Lauricacid, Capric acid, and monocaprin.

2.3 Chemical- Physical Properties for virgin coconut oil (VCO).

Table 2.1: Chemical- Physical Properties.

Properties	Value
Color	Colorless to brownish yellow
Specific gravity at 25^{o}C (room temperature)	0.917-0.919
Free Fatty Acid Value	0.01-1.00
Saponification value	250-264
Iodine value	7.50-10.50
Refractive index at 40^{o}C	1.448-1.449
Moisture	0.10-0.25
Viscosity at 50^{o}C (cP)	24

Table 2.2: Fatty Acid Compositions in Virgin Coconut Oil

Fatty Acid	Compositions
Lauric acid	46.0%
Myristic acid	19.9%
Palmitic acid	9.8%
Caprylic acid	6.8%
Oleic acid	6.4%
Capric acid	6.0%
Stearic acid	3.4%
Linoleic acid	1.3%
Caproic acid	0.45

2.4 The Myth of Enzymes and Coconut Oil *by Brian Shilhavy, CEO Tropical Traditions.*

As the truth about the health benefits of coconut oil continues to spread, many people are jumping into the coconut oil reselling business and making fantastic claims for their particular brand of coconut oil. Unfortunately, most of these distributors have never lived in the tropics where coconuts are grown, and know very little about the actual processing of coconut oil.

One current claim being propagated through the Internet is that certain coconut oils are more "raw" than others because they supposedly see less heat, and actually contain enzymes that are beneficial. However, this is simply not true. If any coconut oil actually contained any appreciable amounts of enzymes, that oil would quickly deteriorate and have a very short shelf life. That is, after all, the job of enzymes in plants: to break things down and start the process of decomposition. High quality coconut oils, particularly Virgin Coconut Oil, have a very long shelf life (2 years or more) and would not have any appreciable amounts of enzymes in the oil.

When we first started making Virgin Coconut Oil the traditional way, and the demand for such a high-quality product grew very rapidly, we proceeded to investigate every possible way coconut oil was produced in order to provide larger quantities. One of the ways we learned about was from a professor at the University of the Philippines, who had extracted the oil through enzyme action, and then further separated the oil via a centrifuge process. He made it very clear that the enzymes needed to be completely removed.

Others who are very knowledgeable about coconut oil have stated the same thing when I asked them: enzymes are NOT present in coconut oil. Here is what they told me:

"There are no enzymes in coconut oil, nor any other edible oil for that matter." - Mary Enig, Ph.D, a nutritionist/biochemist and the author of *Know Your Fats*.

"If you don't heat the oil high enough to destroy the enzymes and then filter them off, plus filter the oil, that oil becomes unstable and tastes terrible." Ray Peat, Ph.D, author of several articles on fats and oils, and coconut oil in particular.

"The good thing about coconut oil is that it isn't damaged by heat. That's why it's so good for cooking. It's the saturation that makes it stable. If coconut oil contains enzymes it would become very perishable - just like all raw foods containing enzymes." Lita Lee, Ph.D. - Lita is a chemist, enzyme nutritionist, nutritional counselor, and has written on coconut oil.

"Coconut oil does not contain enzymes. Many in the raw food movement are misinformed about this." Dr. Adiel Tel-Oren, M.D., medical doctor, doctor of chiropractic, licensed nutritionist, certified clinical nutritionist, frequent lecturer on the health benefits of coconut oil, and owner of the Ecopolitan, the largest organic raw food restaurant in Minneapolis.

So it is a myth that there are coconut oils on the market that are "live" with enzymes and "see no heat." Coconuts are native to the tropics, where temperatures are very hot. Any coconut oil distributed anywhere in North America has "seen heat." Shipping containers used to ship the coconut oil to the US by sea from the tropics reach temperatures of over 130 degrees. If you have a truck deliver coconut oil to your home in the summer time by any of the major carriers, temperatures inside that truck will reach up to 125 degrees. In the winter time coconut oil turns solid and MUST be heated in order to be repackaged into retail size containers from drums. Tropical Traditions uses large insulated containers that hold many drums and keep a steady temperature of between 90 to 100 degrees F. in the winter time to keep our stored oil liquid so it can be repackaged. It does take longer to liquefy 55 gallon drums this way (a few days) in the winter, but it more closely resembles ambiance air temperatures in the tropics. Many other repackages use electric drum bands to melt the coconut oil more quickly, and temperatures inside the drum become much hotter, closer to boiling temperatures. So any coconut oil you buy will have "seen heat." But the good news is that coconuts are designed by our Maker to grow and thrive in hot climates, and the oil is not harmed in any way by these low-level heats.

In the end, we determined that the traditional method of making coconut oil from fresh coconuts via family producers produced the highest quality Virgin Coconut Oil on the market. We work directly with family farmers, helping them become certified organic according to strict USDA standards. Our family producers hand pick each coconut they use to make our Gold Label Virgin Coconut Oil, using only coconuts harvested within 24 hours. Our Gold Label Virgin Coconut Oil is made from fresh coconut milk, allowed to separate from the water naturally, and then lightly heated for a few minutes to remove any remaining water or enzymes that may cause deterioration. Our moisture levels, free fatty acid content, and peroxide value are usually lower than industry standards. In addition, in 2006 laboratory tests were done on several Virgin Coconut Oils in the Philippine market that supposedly did not use any heat in the processing, and the Virgin Coconut Oil produced by Mt. Banahaw Health Products Corp. in the Philippines exclusively for Tropical Traditions tested the highest for antioxidant levels (more info.) In 2007 we implemented our Gold Label standards which uses the water from inside the coconut to wet-mill the coconut milk used to make the coconut oil, and since then our antioxidant levels have tested even higher than they did in 2006. Even though we now produce larger quantities of Gold Label Virgin Coconut Oil via our network of family farmers, it is still hand-made the traditional way. No other coconut oil on the market sees more individual attention to details in the processing, as all other coconut oils are mass-produced. We believe this is the highest quality coconut oil one can find anywhere, and many others agree with us!

"I have tried all other brands of coconut oil, and *Tropical Traditions* is the best!" Marilyn Diamond, best selling author of *Fit for Life*.

"Tropical Traditions Virgin Coconut Oil is the only coconut oil I use and recommend because it's the freshest, best tasting coconut oil I've found. I've compared it to others and it won my vote." Cherie Calbom, *The Juice Lady*, nutritionist and best-selling author of Juicing for Life.

Table 2.3: Nutritional and dietary information for virgin coconut oil

Nutritional and Dietary Information for Virgin Coconut Oil		
	Per 100g	**Per 15g**
Energy in kJ/kcal	3760/900	564/135
Carbohydrates	0g	0g
Sugars	0g	0g
Fat	100g	15g
Saturated	92.1g	13.7g
(Of which:)		
Medium Chain Fatty Acids	8g	1.2g
Caprylic C8	10g	1.5g
Capric C10	48g	7.2g
Lauric C12	17g	2.6g
Myristic C14		
Long Chain Fatty Acids		
Palmitic C16	9g	1.4g
Stearic C18	2.0g	0.3g
Unsaturated	6.2g	1g
Polyunsaturated	2.1g	0.3g
Sodium	0g	0g

2.5 Method of production - Virgin coconut oil

Many fats and oil are produced with refining or rendering processes that usually involve heat. Some are obtained through a simple pressing. Oils that are obtained through cold extraction, such as virgin olive and coconut oil, are usually more expensive than highly refined oils and fats obtained through high heat extraction methods.

Cold Methods:

1. Cold Pressed

Cold pressing refers to oils obtained through pressing and grinding fruit or seeds with the use of heavy granite millstones or modern stainless steel presses. Pressing and grinding produces heat through friction but temperature must not rise above 48ºC for an oil to be considered cold pressed. The maximum temperature for cold pressed olive oil is even lower. Olive, coconut, sesame, peanut, and sunflower are among the oils that may be obtained from cold pressing. Cold pressed oils retain all of their flavor, aroma, and nutritional value.

3. Vacuum Extraction

Vacuum extraction is another method of cold extraction that produces oils with an expeller process. The process occurs in an atmosphere with no oxygen or light to prevent oxidization. The temperature during the expeller process may be as low as 70ºF.

Hot Methods

1. Expeller Pressed

Expeller pressing is similar to cold pressing, except extreme pressure is added. Pressure up to 15 tons per square inch squeezes oil from fruit or seeds. The high pressure produces high heat *(as high as 150ºC)* Oils produced by expeller process cannot, therefore, be considered cold pressed as the heat causes partial oxidation. The oils obtained with this method retain much of their flavor, aroma, and nutritional value, but not to the extent of cold pressed oils.

2. Solvent Extraction

Chemical solvents are often used to extract oil, which is then boiled to vaporize most of the solvents. Further refining such as bleaching, deodorizing, and heating to high temperatures cleanses the oil, resulting in a product that has very little of the original flavor, aroma, or nutrients contained in the seeds or fruit before processing. Most of the oils produced with this method have a high ‘smoke point’ and a long shelf life. Most commercially produced vegetable oils are produced with this method.

Production virgin coconut oil in lab:

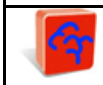
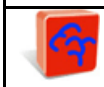
Virgin Coconut Oil in laboratory using three different methods. The three batches produced in laboratory were all produced with little or no heat, some using refrigeration and never going above 47 degrees Celsius (less than 117 degrees F.) The values that were tested in all these Virgin Coconuts oils were: melting point, gravity, saponification, iodine, free fatty acid (FFA), peroxide value, moisture content, fatty acid

composition, tocopherols, and total phenolic content. Their results found that: "while the VCOs produced by the three methods and using different varieties had some differences in chemical and quality properties, these differences may not be large enough to significantly affect the overall quality of the VCO. Further, their levels are still within the CODEX standards for coconut oil." In the 6 commercial brands they tested (where it is routinely assumed today that "no heat" is better), they found some had values that exceeded the limits of standards in areas like moisture content and FFA. The study was concluded by stating: "The effect of higher temperature (>50^{o}C) during processing on the quality of VCO is likewise important to determine and is being investigated."

GC analysis of fatty acids:

The fatty acid compositions of total lipids from VCO were analyzed by gas chromatography. Fats were methylated with trimethylsulfonium hydroxide (Butte, 1983). Fatty acid methyl esters were separated by gas chromatography using a system (HP 5890, Hewlett–Packard GmbH, Waldbronn, Germany) equipped with an automatic on-column injector, a polar capillary column (30 m FFAP,0.53 mm ID, Macherey and Nagel, Du¨ren, Germany) and a flame ionisation detector (Eder & Brandsch, 2002). Helium was used as carrier gas at a flow rate of 5.4 mL/ min. Fatty acid methyl esters were identified by comparing their retention times with those of individually purified standards.

Table 2.4: Different method utilized in oil manufacturing.

CHEMICAL TRADITIONAL SYSTEM	
Seed Cleaning and Polishing	
	HEATING
	GRINDING
	HEATING UP AT 150° AND 2300 BAR PRESSURE FOR FLAKING
	EXTRACTION SOLVENT (HEXANE) slight traces of hexane remain in the oil, considered non toxic by "the law" (if below 0,012 parts per million)
	FILTERING AND SOLVENT ELIMINATION THROUGH VAPOR.
	UNREFINED OIL (NON EDIBLE)
	DEGUMMING WITH ACID OR CIDULOUS WATER (loss of fosfolipids and folar lipids)
	NEUTRALIZATION WITH CAUSTIC SODA/ NEUTRAL HEXANE/ISOPROPILIC ALCOHOL BLEACHING WITH ACIFIED ASHES. Loss of carotenoids, chlorophylls, xantophylls, tocopherols: appearance of trans isomers
	DEODORIZATION WITH VAPOR AT 180°-220° THE 99% OF -OIL CONTENTS IS EXTRACTED
BUT:	• TOCOPHEROLS, LECITHIN, ETC. CONTENTS LOWER CONSIDERABLY. THEY REMAIN IN VERY LOW PERCENTAGE AND IN ANY CASE WITH SCARCE BIOLOGICAL ACTIVITY • TOTAL LOSS OF THE SO ALLED MINOR COM OUNDS • CONTENTS OF HARMFUL RANS FATTY ACIDS AISE

ORGANIC OILS SYSTEM BY MECHANICAL MEANS	
Seed Cleaning	
	GRINDING AT ROOM TEMPERATURE
	COLD PRESSING
	NATURAL FILTERING
	STOCKING AND BOTTLING UNDER PROTECTIVE ATMOSPHERE: All our oils are vacuum sealed (nitrogen flushed) to guarantee the maximum freshness of the product
➔	ONLY THE 50% OF OIL CONTENTS IS EXTRACTED
AND:	• ALL THE MINERAL-VITAMINIC VALUES AND ANTIOXIDANTS REMAIN UNALTERED • NATURAL PRESERVATION OF THE MINOR COMPOUNDS

2.6 Centrifuged virgin coconut oil

Centrifuged virgin coconut oil is made from fresh coconuts opened less than 48 hours after they are picked from the trees. They first shell the coconuts and then chop the flesh, placing it in an expeller press. The temperatures of the coconut flesh and the resulting coconut milk emulsion do not exceed 25° C or 78.8° F (room temperature). Once the coconut is shelled, it takes less than 45 minutes to produce the milk. The resulting coconut milk emulsion is then chilled slightly to 10° C (50° F) so that the oil will "pull out of solution." In other words, the chilling helps to break the protein emulsion that holds the oils in solution. Next, the cooled milk, by use of a large centrifuge, is separated into the pure oil that we sell here and a "skim" coconut milk. This method of extraction requires no heat at all. It works like a cream separator that is used for separating cream from cow's milk. It requires quite a few passes through this chilled centrifuge to obtain pure oil, but the resulting oil is absolutely fabulous.

Table 2.5: The different between Traditional & Centrifuge Method

Traditional Philippine Fermentation Process	Centrifuge Extraction Process
Neither virgin coconut oil is heated during any of the processes. They are both made from non-hybridized, organic coconuts harvested and processed in the Philippines.	
• If vitality or "life force" is important to you, Philippine virgin coconut oil rates the highest of all virgin coconut oils (not just our coconut oils) It has been tested against coconut oils from all over the world. This testing has been done using radionics and dousing, independently. It has been tested by different individuals who do not know each other and are honestly just seeking information	• If taste is the most important to you, and especially if you use the coconut oil raw, you will probably want the Centrifuge Extracted Virgin Coconut Oil. Our "most discrete customers who have very sensitive and discerning taste buds seem to prefer the Centrifuge Extracted Virgin Coconut Oil to all other virgin coconut oils. The taste is very smooth, a true delicacy.
• If trace minerals are important, the amount of trace minerals appears to be the highest in the Philippine virgin coconut oil.	• If medium chain fatty acids are the most important thing to you, especially lauric acid, then the centrifuged virgin coconut oil we carry will give you a higher percentage of lauric acid than any other coconut oil.
• If price is the most important, the Traditional Philippine Virgin Coconut Oil costs us less, and we pass that savings on to you	• Most of vegetarian who do not like fermented foods choose the centrifuge extracted oil. This process is quick and high tech, yielding a very high quality product
• This process has been used for centuries in the Philippines to make virgin coconut oil. Many people like using the "old traditional ways" because they are often times the healthiest.	• If you are looking for a coconut oil with the highest heat stability of all coconut oils, this is the one. Standard coconut oil still contains about 6% mono-unsaturated fat and 2% polyunsaturated fat. The polyunsaturated fats are not heat stable, and the monounsaturated fats, though fairly stable can still oxidize. This Centrifuged coconut oil contains virtually no polyunsaturated fat, and

	half the mono-unsaturated fats when compared to other coconut oils

2.7 Emulsion:

Processes for the separation of oil and water are very well known to the oil industry. There are no principal differences in the technology required when separating oil and water mixtures which have been recovered during an oil spill clean up operation. The main difference between separation of oil and water connected to production and handling of oil, as compared to an oil spill recovery operation is that the influent may, and generally does, vary significantly. The ratio of oil to water collected during a recovery action can vary from as much as 90% oily phase during boom containment and collection in calm water, to as much as 98% oil free water using the same equipment, but with three meter waves. Another problem which exists is that you can never be prepared for all possible scenarios. Spillages of all types of oils occur under all types of sea conditions. The equipment, utility systems and chemicals must be of a general and flexible type that can adapt to all situations. There are about 50 commercial oil water separators that are marketed for oil spill recovery purposes and can be found listed in the World Catalogue of Oil Spill Response Products [*World Catalog of Oil Spill Response Products* (1997/98).].

The fluids to be separated

Before we begin to discuss separation technology and equipment, it is useful to elaborate on what we are going to separate. Primarily it is water and oil or rather an oily phase. There are two types of water, free water and emulsified water. Most crude oils and intermediate to heavy products will emulsify when spilled at sea, the vast majority forming water-in-oil-emulsions (w/o), often nicknamed ‘chocolate mousse’. The w/o emulsions can be stabilized by natural emulsifiers within the oil, by colloidal particles in

the sea or from by-products of biodegradation of the oil. This weathering process is very complicated and not too well understood.

Droplet formation

The initial intrusion of spilled surface oil into the water column on the open sea is caused by agitation from turbulent surface conditions. Primarily, breaking waves provide the largest contribution of energy necessary for the process. However there are other smaller contributing factors such as ship traffic and small craft movement through surface oil. In inland waters where there may be a fast moving flow, the movement of oil past piers and rocks or the flow over dams can provide all the necessary energy for the process to occur. This intrusion and diffusion of oil into the water column is called *dispersion* [G. Delvigne. *1993 Oil Spill Conference Report* (1993).]. Evaporation, emulsification and weathering of surface oil can lead to the long-term development of more dense water-in-oil droplets (w/o) which make separation of the collected product more difficult and time consuming. Studies on water droplet sizes in w/o emulsions have shown that the maximum content of one liquid in another with uniform particle size is about 70% and this is simply a function of geometric packing constraints. By having emulsion particles of different sizes clustered together this ratio can even be larger [L. T. Munson. Chemical resolutions of petroleum emulsions. In *Surface Operations in Petroleum Production.* American Elsevier Publishing Company Inc., New York (1969).]. It should seem reasonable for the reader to assume that a reverse physical mixing process is possible which produces oil-in-water emulsion (o/w), wherein water is the dispersed substance and oil is the continuous phase. This is indeed the case and sometimes a single emulsion system may include both types of emulsions [M. Fingas, B. Fieldhouse, M. Bobra, E. Tennyson. *The Physics and Chemistry of Emulsions*. Environment Canada and Consultchem, Ottawa, Canada and US Minerals Management Service, Herndon, Virginia.]

Separation theory

We have therefore the situation of separation of either oily droplets from the water (deoiling), or draining of emulsified water from a chocolate mousse type of water-in-oil emulsion. In both cases we are talking about separation, or settling and coalescing of droplets. When looking into the secret 'black boxes' of the different engineering companies that calculate and dimension separators for oil, water and gas, it is both astonishing and a bit disappointing to see how much they rely on Stokes' law. In-house corrections and experimental factors might be included in the calculations, but still basically they are using his simple equation. This is however, a very good starting point to begin to understand the separation processes.

Stokes' law in its original form in MKS units can be expressed as follows:

$$v = h/t = (D^2 g(\rho - \rho'))/18\upsilon$$

Equation 1.0

Where: v = terminal velocity of droplet (m/s),

h = travel distance of droplet (m),

t = time (s),

D = droplet diameter (m),

g = acceleration due to gravity (9.81 m/s2),

r = water density (kg/m^3), r0 =oil density (kg/m^3),

y = viscosity of the continuous phase (pa·s)

From an analysis of eqn (1) you can determine most of what needs to be done to enhance the separation of the phases.

The droplet diameter is squared and therefore has considerable influence on the rate of separation. It is important to increase the droplet size. In practical separator engineering this is done by coalescing devices such as oleophilic meshes, porous media,

coalescence plates, etc. Applying oscillating electrostatic fields and heat to enhance collisions between droplets, adding surfactants to lower the oilwater interfacial tension destabilizes the natural emulsifiers and lowers the electrostatic repellent forces between the droplets.

Heater treatment units affect the surface chemistry of the complex oil spill emulsions and of oil droplet coalescence processes and are very important to the separation process. The details of these processes are far beyond the aim of this paper, but the interested reader can find an updated review by NN/Separation Technology, 1993.

The droplet separation velocity is also increased if we are able to increase the acceleration beyond that normally provided by gravity (i.e. 9.81 m/s2). This can be done in a centrifuge or hydrocyclone which has been developed for just this purpose. Sophisticated equations have been derived to show separation efficiency and rate centrifuges and hydrocyclones, but for our general analysis it is convenient to put oneself in the position of one of the droplets to be separated and just 'feel' the force produced by the high speed rotation and respond by faster and more energetic separation from the continuous phase. Such devices greatly exceed the normal '$\boldsymbol{g}$' force used in 'gravity' separators. This gives rise to the possibility of construction of very compact separation devices which are able to separate very small droplets. The problem with this type of separation device is the high shear force in a two phase system at the point of entering and leaving the separator. Very often the phases re-mix and the fluid leaves the separator as a milky dispersion product. The rate of separation is also increased if we can increase the density difference of the phases. This might be done by adding buoyant gas bubbles to the oil droplets or heavy particles to water droplets in w/o emulsions (chocolate mousse). The application of gas bubble flotation is widely used in the industry and one method for creating gas bubbles is to apply a vacuum above a saturated liquid. This process named *vacuum flotation* forms gas bubbles in the dispersed oil droplets and can be very effective in clearing out oily water. It is believed that part of the reported efficiency of the MSRC oil-water separator is due to this process because of the

separators placement at the suction side of the oil cargo pump [M. A. Murdock, K. R. Bitting, A. B. Nordvik. *Oil/Water Separator Test and Evaluation*, US Coast Guard Report CG-D-06-96. November 1995, Washington, DC (1995).].

The opposite process that of adding heavy particles to an emulsion to adhere to the water droplet and enhance the water droplet separation rate is rarer. This process also has the ability to perforate the rigid interfacial films that are formed when emulsions are weathered, and form channels to drain the water phase from the rigid oily film matrix. The principal author has separated heavy emulsion by adding deemulsifiers and sand in the size of 2–4mm with good efficiency. When using this process care must be taken to find the right chemical to prevent the formation of a new waste in the form of oily sand. Finally the rate of separation of droplets can be increased by lowering the viscosity of the continuous phase. When the continious phase is water, little can be done. However in the case of a w/o-emulsion, heating the oil phase will generally lower the viscosity drastically. In the standard heater treatment units used by the petroleum industry to break and separate heavy w/o-emulsions, applying heat both enhances the chemical activity and increases the settling rate by lowering the continious phase viscosity. Continious heating of a large volume of recovered oil spill can be both difficult and expensive.

2.7 Usage of Virgin coconut oil.

(all the stories here come from Tropical Traditions Website Coconut Oil forums)
Skin Hair and Beauty

1. Skin Suppleness

Most commercial creams and lotions are mostly water. It is quickly absorbed into dry, wrinkled skin. As it enters the skin, it expands the tissues, rather like filling a balloon with water. Wrinkles ‘miraculously’ fade away and skin feels smoother. Obviously this is a temporary effect. When the water evaporates or is absorbed by the

blood stream and lymph system, dry, wrinkled skin returns. No matter how hard we try, we never seem capable of permanently improving ageing skin with any commercial body lotion. Body care products using refined vegetable oils with all the antioxidants stripped out are exceptionally prone to free-radical generation both in and outside the body. That is why eating processed vegetable oils can cause a deficiency in vitamin E and other antioxidants - and the same applies to our skin. Free radicals cause permanent damage to connective tissues. You should, therefore, be careful about oils used on your skin, in lotions, creams and balms. Using a lotion or cream with refined oil causes faster skin deterioration. Dr Ray Peat, a biochemist who has written about the antioxidant properties of coconut oil, says; "It is well established that dietary coconut oil reduces our need for vitamin E, but I think its antioxidant role is more general than that, and that it has both direct and indirect antioxidant activities." Virgin coconut oil is especially useful in fighting free-radicals, as it is unrefined and hasn't been stripped of any of its natural benefits through the refining process. Coconut oil will not clog pores, making it an ideal oil for oily or troubled skin. Many people troubled by acne have reported amazing results. Coconut oil will not only bring temporary relief to the skin, but it will assist the body to heal and repair. Unlike many lotions, it will have lasting benefits. It really can help bring back a youthful appearance. It will also aid in removing the outer layer of dead skin cells, making the skin smoother. The skin gets a real healthy "shine". The coconut oil will also penetrate into the deeper dermal layers and underlying tissues.

2. Virgin Coconut oil and Age Spots

One of the classic signs of ‘old age’ is the appearance of brown, freckle-like spots or liver spots. They are a sign of free radical damage to the lipids (fats) in our skin, liver, brain, and heart muscle. Free radical oxidation of polyunsaturated fats and proteins in the skin is recognized as the major cause of liver spots. Liver spots may have no health effect but they do affect our appearance and remind us of the ageing process. Cells cannot dispose of the pigment, so it gradually accumulates as we age. Once age spot pigment develops, it will be visible for life, but further damage can be slowed or

perhaps even reduced by use of coconuts oils orally and dermal. It prevents destructive free-radical formation and even provides protection against them, so it can assist us to prevent developing liver spots, and other blemishes caused by aging and excess sunbathing. It helps to keep connective tissues strong and supple so that the skin doesn't sag and wrinkle. Coconut oil penetrates the skin and enters the cell structure of the connective tissues, limiting the damage excessive sun exposure can cause. Coconut oil will not only bring temporary relief to the skin, but unlike most lotions it will aid in healing and repairing. It will have lasting benefits. It can help bring back a youthful appearance. Coconut oil also aids defoliating the outer layer of dead skin cells, making the skin smoother. The skin will become more evenly textured with a healthy "shine". While doing this the coconut oil will penetrate into the deeper layers of the skin and underlying tissues.

4. Virgin Coconut oil and Sunscreen

One of the most interesting facts about people who live in tropical climates like the Philippines, where the people are constantly exposed to the rays of the sun year round, is that skin cancer is almost unheard of in these places. Coconut oil may well be one of the reasons people in tropical climates can spend so much time in the sun and not suffer from skin cancer due to its wonderful antioxidant properties that protect the skin from free radical damage, plus the absence of oxidative polyunsaturated oils under the skin of the people of these regions. Coconut oil that is consumed and used topically helps us absorb other nutrients more effectively as well, such as Vitamin E, another powerful antioxidant skin protecting nutrient. Oils you put *into* your body may well be just as important as what you apply to your body for sun protection. It has been theorized earlier, that when we eat foods cooked in polyunsaturated oils containing trans fatty acids, we are depositing oxidized lipids into skin tissue, causing greater susceptibility to sunburn. You are actually ‘deep frying’ your skin! A 2004 study on sunscreens found significant penetration of all sunscreens into the skin. From this we can assume that when you use normal sunscreen your body is absorbing synthetic

chemicals. Sunscreens also prevent the sun from assisting our bodies produce Vitamin D, which has been shown to assist in preventing cancer, type 1 diabetes, osteoporosis and auto immune diseases.

5. Virgin Coconut oil on your hair and scalp

What coconut oil can do for your skin it can also do for your hair. It is a wonderful hair conditioner. Beauticians familiar with coconut love it because it softens the hair and conditions the scalp. Using the coconut oil as a pre-wash conditioner can rid a person of dandruff better than a medicated shampoo. Coconut oil also has high affinity for hair proteins and can penetrate the hair shaft. This is because of its low molecular weight and straight linear chain, Mineral oil (used in commercial hair conditioners) and sunflower oil (used in natural hair conditioners) does not penetrate the fiber of hair, and has no favorable impact on protein loss.

6. The protective environment of the skin and how Virgin Coconut Oil helps

Oral consumption of antiseptic fatty acids in coconut oil help prevent fungal and bacterial infections of the skin and to some extent, when it is applied directly to the skin. When the skin's defenses break down, infections may result, including acne, ringworm, herpes, boils, athlete's foot, and warts. The largest chemical barrier to infectious organisms is the acid layer on the skin. Healthy skin has a pH of about 5, making it slightly acidic. Our sweat (containing uric and lactic acids) and body oils promote this acidic environment. For this reason, sweat and oil are good for us! Harmless bacteria can tolerate the acid mantle and live on the skin, but troublesome bacteria can't thrive. Our body oil is called sebum and comes from sebaceous glands at the root of every hair. Sebum is very important to skin health. It softens and lubricates skin and hair. It also contains medium chain fatty acids that are released to fight harmful bacteria. At least

one variety of bacteria is essential to the healthy environment on our skin. Feeding on the sebum, it breaks down fatty acids into free fatty acids so it can be utilised. This bacteria feeds on the glycerol in the fatty acid and leaving fatty acids which are now "freed" from the glycerol unit that held them together. Medium chain fatty acids which are bound to the glycerol unit as they are in coconut oil have no antimicrobial properties in their original form. However, when they are broken apart into free fatty acids, they become powerful antimicrobials, antivirals and antifungals. A combination of slightly acid skin pH and medium chain fatty acids will provide a protective chemical layer on the skin that is better able to prevent infection. Friendly bacteria ensure that the oil on your skin and hair is composed of 40 to 60 percent free fatty acids. The medium chain fatty acids in the sebum provide the protective layer on the skin that kills harmful germs. Coconut oil is nature's richest source of medium chain fatty acids. By using coconut oil results in an increase in the number of antimicrobial fatty acids on the skin and protection from infection. When we shower, soap washes the protective layer of oil and acid off our skin. Due also to the effect of chlorine, the skin later becomes tight and dry. Adding water based moisturizers might help the skin look better, but they simply cannot replace the acid or the protective medium chain fatty acid layers that were washed off. Skin is most vulnerable to infection after showering. One would surmise that we are at our cleanest after a bath, but germs are everywhere, floating in the air, on our clothes and everything we touch. Many germs survive washing by hiding in folds of the skin. It takes very little time for your skin to again teem with microorganisms, good and bad. Until sweat and oils re-establish the body's chemical barrier we are vulnerable. A cut or cracked skin can allow streptococcus, staphylococcus and other harmful germs to enter the body. A coconut oil cream, lotion or just pure coconut oil will quickly help reestablish the skin's natural antimicrobial and acid barrier. We use coconut oil on their skin after every shower. It absorbs easily, keeps our skin soft, but without feeling greasy. It is not like other oils used to soften rough, dry skin. It will also help reduce chronic skin inflammation within days and soothe and heal wounds, blood blisters, rashes, etc. It’s an excellent ingredient to use in healing salves and ointments. Try a coconut oil/crushed garlic mixture at night to help eliminate plantar warts and athlete's foot. Massage oils also use polyunsaturated fat, which will quickly oxidize when exposed to

light and rubbed on the warm surface of the human body. Such commonly used massage oils include: almond, safflower, sunflower, and other vegetable oils.

The use of saturated fats like coconut oil, is a far smarter choice, not only because of its stability and its ready absorption into the skin, but also because of its immunity enhancing and antimicrobial effects. Coconut oil and other saturated fats may also be used as carrier oil for essential oils, which have many therapeutic applications, such as antioxidants, antimicrobials, anodynes, and vulneraries. For example, the use of coconut oil with cinnamon (Cinnamomum spp.) and clove (Syzygium aromaticum) essential oils in the treatment of fungal infections, or the use of coconut oil with Lavender (Lavandula angustifolia) essential oil in cases of sunburn.

CHAPTER 3

METHODOLOGY

This chapter will discuss about the process for producing virgin coconut oil (VCO). In this study, the cold method process will be run by using high speed centrifuge in room temperature, besides for hot temperature oven used for emulsion (stability experiment) ,2 types surfactant which is Triton-X-100 and SDDS used in order to study the properties of virgin coconut oil (VCO). Finally the sample (VCO) will be analysis by using Gas Chromatography to compare the quality (measure the middle bond fatty acid) between the commercial (in the market) and produced by experimental method.

3.1 Coconut milk

Coconut milk is the raw material for this experiment and was purchased from the local market. However the quality of the coconut milk will be different for every usage, so for this experiment, it assumed all the coconut milk that used has the same quality.

3.2 Surfactant

Surfactants are wetting agents that lower the surface tension of a liquid, allowing easier spreading, and lower the interfacial tension between two liquids**.** For stability experiment the non ionic surfactants were used such as t-octylphenoxypolyethoxyethanol (Triton-X-100) and PEG (20) sorbitan monolaurate (Tween 20) and ionic surfactant such as Sodium dodecyl sulfate (SDDS).

3.3 Centrifuge method. (Cold method)

High speed centrifuge separator-Sorval was use in this method. 3000ml fresh coconut milk were use and centrifuge 150ml coconut milk for each bottle (4 bottle) at 6000rpm for 30 minutes at 25^{o}C.and after 30 minutes the volume of virgin coconut oil, coconut oil cream (protein) and water was measured and record in order to get the separation volume of the component The 1st step will repeat by using 8000, 10000 and 12000rpm and different processing time (45, 60, 75, 90 and 105 minutes) at 25^{o}C

3.4 Oven method (Hot method)

3000mL of coconut milk was filled into a beaker and left overnight for the water and the protein entities to separate through gravitational nature. After being left overnight to separate, the coconut milk was then placed in an oven and heated to 60°C for 5 hours. After 5 hours the volume separated between virgin coconut oil, coconut milk cream and water was measured and record. The previous step was repeated for different temperature 50^{o}C, 40^{o}c and 30^{o}C at same processing time (5 hours).

3.5 Stability experiment

100 ml distillate water, 100 ml virgin coconut oil, 2% surfactant (Triton-X-1000) and mixer and plastic jar were used. 2-3 droplets red color paste was used to get the color contra between virgin coconut oil (colorless) and water (colorless) and all these solution mixed with 100mlm distillated water at 6000rpm (mixer) and the surfactant (Triton-X-100) was added in little by little to the mixture and waited until 7 minutes to get well mixed solution. After 7 minutes 100ml virgin coconut oil was added in little by little and waited for 3 minutes to mix. After 3 minutes, this solution was put in to measurement cylinder and the volume water separate was record for each 15 minutes. All previous steps were repeated for different type and surfactant percentage (5% and 7%); SDDS and Tween 20 and also different oil/water ratio (30:70 and 50:50)

3.6 Gas Chromatography analysis of fatty acids

The fatty acid compositions of total lipids from VCO and CO were analyzed by gas chromatography. Fats were methylated with trimethylsulfonium hydroxide (Butte, 1983). Fatty acid methyl esters were separated by gas chromatography using a system (HP 5890, Hewlett–Packard GmbH, Waldbronn, Germany) equipped with an automatic on-column injector, a polar capillary column (30 m FFAP,0.53 mm ID, Macherey and Nagel, Du¨ren, Germany) and a flame ionisation detector (Eder & Brandsch, 2002). Helium was used as carrier gas at a flow rate of 5.4 mL/ min. Fatty acid methyl esters were identified by comparing their retention times with those of individually purified standards.

CHAPTER 4

RESULT & DISCUSSION

4.1 Introduction.

In this study of the production of virgin coconut oil via centrifuge and oven, the different parameter; speed of centrifuge, effect of temperature on production was studied. The rotation of centrifuge will affect the rate of production of virgin coconut oil from coconut milk and the optimum time also contributes to the production. By using oven as hot method, the coconut milk will be heat below $60^{O}C$ in order to determine the optimum temperature of the production virgin coconut oil. Virgin coconut oil is oil in water solution, the physical and chemical properties will be analysis by stability experiment and gas chromatography; by doing these method we can know the quality and potential of virgin coconut oil.

4.2 The effect of speed of centrifuge.

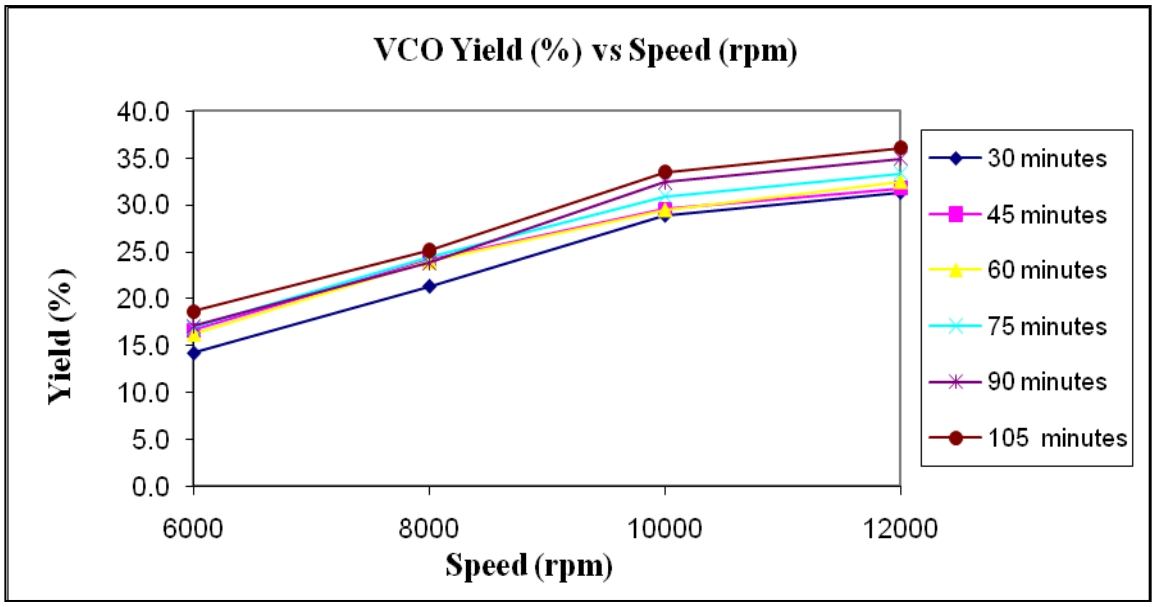


Figure 4.1: Virgin coconut oil Yield (%) versus Speed (rpm)

Rotation of centrifuge is essential in this experiment in order to study the production that effected by centrifuge, this is because rotation of centrifuge is directly proportional with virgin coconut oil production, the higher of rotation of centrifuge the production or separation also higher. Based from the result figure 1 rotation 12000rpm produced almost more then 30% from fresh coconut milk besides 6000rmp just produced almost 15% yield (virgin coconut oil). Separation by centrifuge is influent by density and settling velocity of component inside of the coconut milk. During the experiment there ware 3 layer form by apply several rotation on the sample; top layer is virgin coconut oil, second layer is coconut milk cream and the third layer is water and ash. The objective of using centrifuge is to separate coconut oil from the water, therefore the centrifugationradiation is increase the temperature, which leads to reduction of viscosity and coalescase, the result is separation of oil from water. Initially coconut milk cream is in liquid form but after centrifuged it change to the white gel. Production virgin coconut oil through centrifuge maintains the flavor and odor of coconut it's totally differ with

coconut oil furthermore the nutrient and antioxidant inside the virgin coconut oil also protected. .

4.3 Rate of virgin coconut oil production (centrifuge)

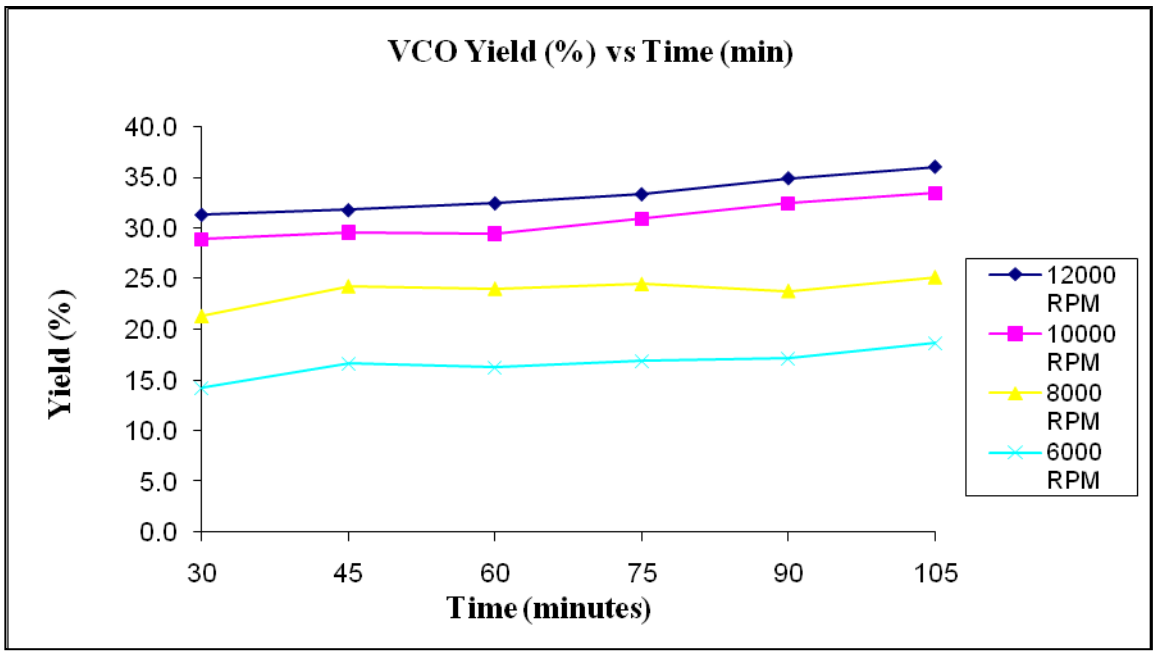


Figure 4.2: Virgin coconut oil Yield (%) versus time (min)

Separation of the component inside coconut milk is directly proportional with time. This method is important to determine the optimum time to achieve the optimum of yield. Figure 2 shows the maximum (105minutes) and minimum (30minutes) time for production of best percentage of virgin coconut oil. The optimum time depends on the centrifugation speed.

4.4 Effect of temperature on production of virgin coconut oil.

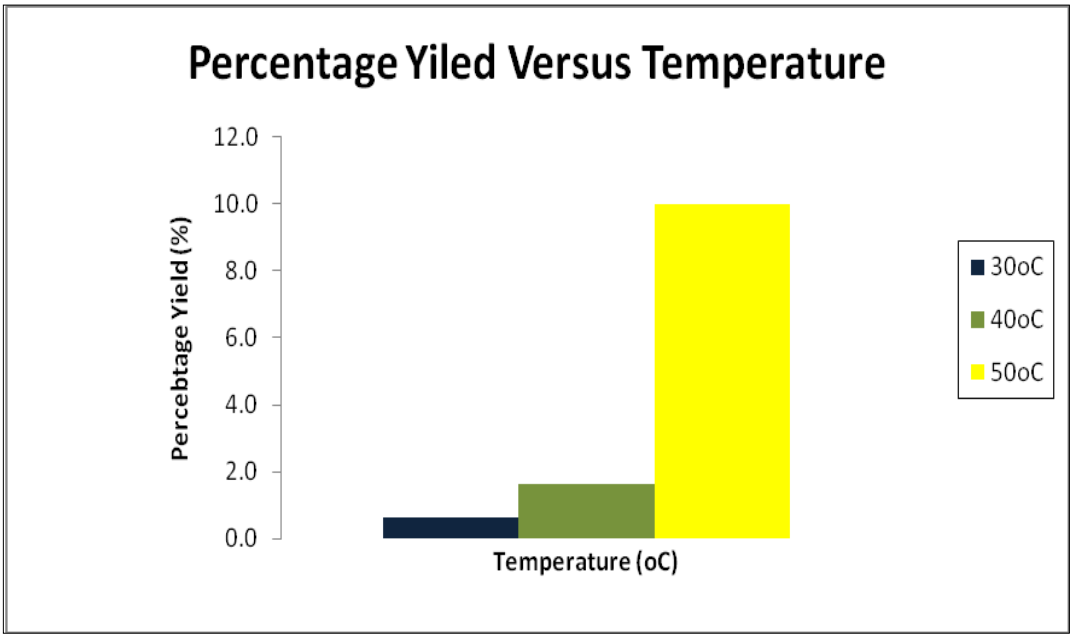


Figure 4.3: Percentage of yield versus temperature.

Temperature also plays a main role in production; however to produce virgin coconut oil, the temperature must be lower that 60°C to maintain the nutrient inside the virgin coconut oil. In order to get the optimum result the temperatures need to change below 60°C by using oven (hot method); 1000mL of coconut milk was filled into a beaker and left overnight for the water and the protein entities to separate through gravitational nature. After being left overnight to separate, the coconut milk was then placed in an oven and heated to 60°C for 5 hours. After being left to settle for about an hour, the virgin coconut oil that appeared at the surface was present in only little amount (thin layer on the top surface) and its volume could not be measured directly. An hour after that, it is safe to say that there wasn't any change to its volume that could have been observed. However, a few dark brown spots could be observed. 5 hours later, there wasn't any virgin coconut oil being produced. There were only dark brown spots that were observed. Base on figure 4.3, when the coconut milk heated at 50°C there was 9.99% virgin coconut oil produced however theoretically at 60°C the production should

be more then 50^{O}C there are several reason behind it such as at 60^{O}C the bacteria easily activate and biodegrade the protein inside the coconut milk, from the observation. the coconut milk become to roughen and produce bad smell and foam also exist. At 40^{O}C the yield of virgin coconut oil reduce because the heat transfer by oven doesn't efficient to produce virgin coconut oil same as 30^{O}C. From these data, found get the optimum temperature (50^{O}C) and yield.

4.5 Emulsion of virgin coconut oil.

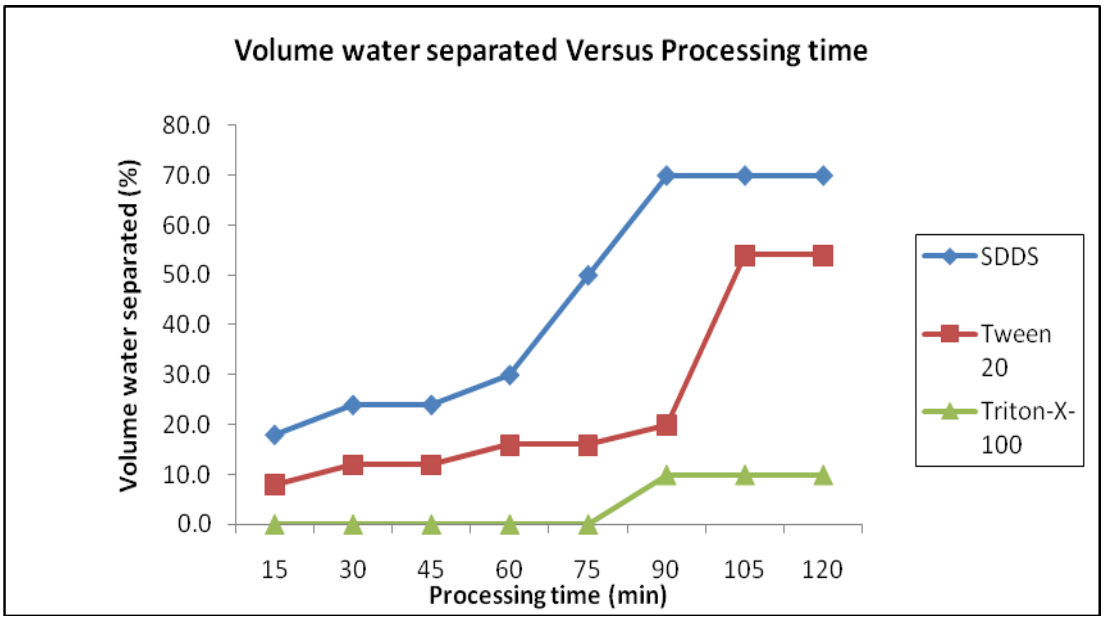


Figure 4.4: Volume water separated versus processing time. (50/50; o/w, 7% surfactant)

In the present investigation, the various factors affecting the stability of virgin coconut oil emulsion stabilized by a non ion water soluble surfactant Triton-X-100, Tween 20 and ionic surfactant sodium dodecyl sulphate SDDS, were thoroughly studied. The factors are the water and oil content of the emulsion, and also surfactant concentration. Based on Figure 4.4, it found that Triton-X-100 is the most stable surfactant (volume water separated by time is to slow compare other surfactant) because it capable of adsorbing at the oil or water interface by displacing the interfacial film. Interfacial active fraction presence in the oil posses a sufficient numbers of functional groups that can penetrate into the oil or water interface, and form an interfacial layer which can be broken by demulsifiers (Zaki et al., 1996). From this study it can be said that Triton-X-100 can be adsorbed at the interface between the model oils and the synthetic formation water. The adsorption of the Triton-X-100 increased the interfacial

shear viscosity and the shear viscosity and the strength of the interfacial film between the oil and the water, which enhanced the stability of the emulsion. It is important that the adsorption of Triton-X-100 onto the surface of the oil droplets gives the surface a high negative potential. This proved that the oil droplets were not only stabilized by steric stabilization of the Triton-X-100 but also by electrostatic stabilization. It seems that, in practice, electrostatic stabilization of the Triton-X-100 dominated the stability of the oil in water emulsion. From these observations, the increasing stability efficiency is therefore the following; Triton-X-100> Tween 20> SDDS, respectively.

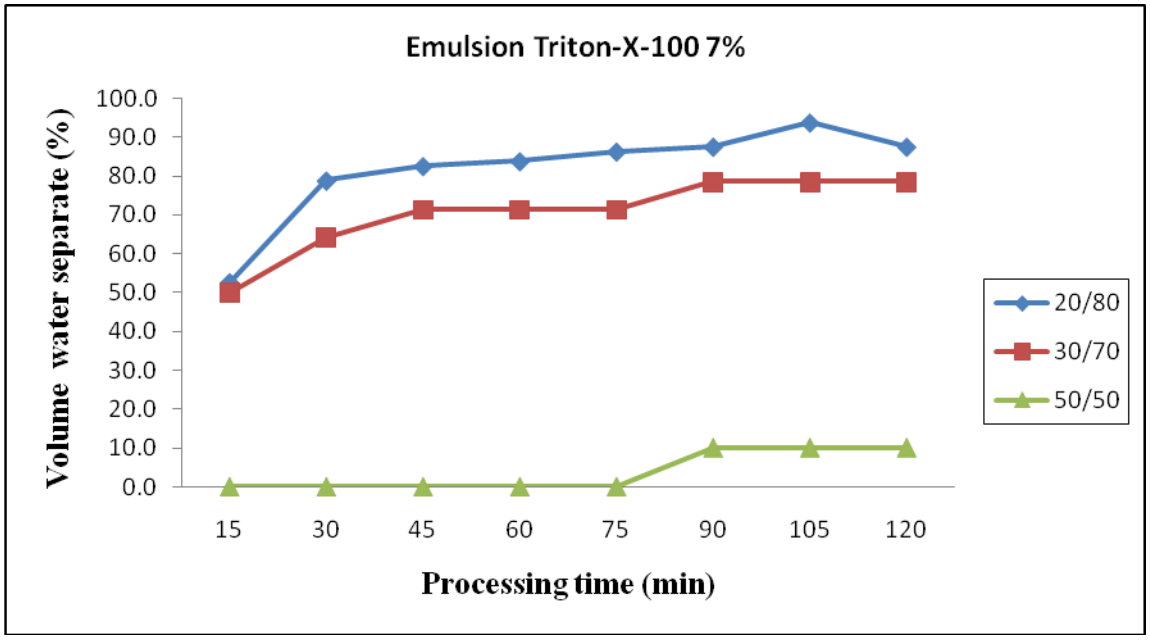


Figure 4.5: Volume water separate versus processing time **(**Emulsion Triton-X-100) with different ratio oil and water

From Figure 4.5, the emulsion was prepared by mixed surfactant together with different ratio between water and oil, ratio 50/50 is the stable solution because the value shown the volume separation was slowly separate directly proportional with processing time. Furthermore, in 50:50 water and oil ratio the tendency the surfactant to increase the interfacial shear viscosity and the shear viscosity and the strength of the interfacial film between the oil and the water is higher then other ratio, which enhanced the stability of

the emulsion. Volume of oil and water equally same and the surfactant will brake the film between water and oil and the emulsion become more stable.

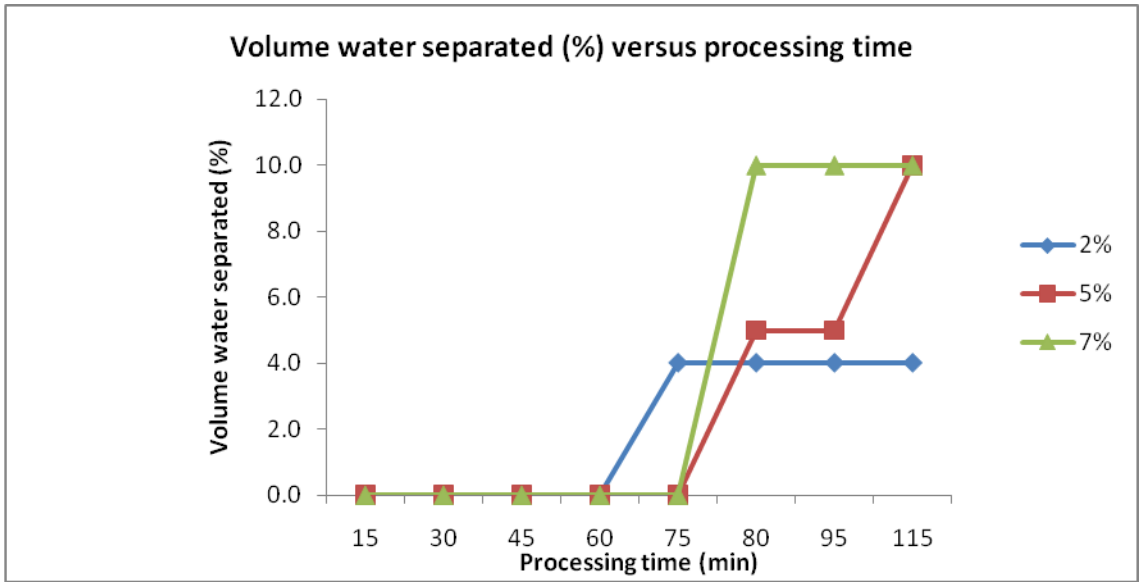


Figure 4.6: Volume water separated versus processing time (50/50; ratio water and water with different concentration surfactant; Triton-X-100.

From figure 4.6 2% concentration of Triton-X-100 is the most stable compared with other percentage concentration. Theoretically; high concentration of surfactant may increased emulsion stability, therefore for high concentrations, the viscosity of oil in water emulsion increased considerably and the emulsion droplets lost their shape.

4.6 Gas Chromatography analysis

Table 4.0: Data Gas Chromatography analysis (12000 rpm-30min, 45min & 105min)

12000 RPM (30 min)		12000 RPM (60 min)		12000 RPM (105 min)	
Fatty Acid Content (%)		Fatty Acid Content (%)		Fatty Acid Content (%)	
C6	0.54	C6	0.57	C6	0.63
C8	8.77	C8	8.96	C8	9.20
C10	6.96	C10	7.05	C10	7.19
C12	47.16	C12	47.31	C12	47.64
C14	16.87	C14	16.85	C14	16.70
C16	8.58	C16	8.57	C16	8.32
C18:0	2.43	C18:0	2.40	C18:0	2.35
C18:1	6.60	C18:1	6.57	C18:1	6.39
C18:2	1.32	C18:2	1.32	C18:2	1.27
C20 + C18:3	0.21				
C20:1	0.20				
Rancimat @ 110 = 117.64		Rancimat @ 110 = 108.87		Rancimat @ 110 = 123.73	
Moisture : 0.16 %		Moisture : 0.07 %		Moisture : 0.14 %	

Table 4.0 show the optimum speed at different time (analysis) of virgin coconut oil. Gas Chromatography was function to analysis the fatty acid content inside virgin coconut oil besides that it also measured the moisture and rancid taste. The type of acid was symbol by the carbon content inside the formula molecule, the main medium chain

fatty acid (MCFA) is C12 (Lauric acid) almost achieve 47%, second highest is C14 (Myristic acid) 17% and for the second component is long chain fatty acid (LCFA) are C16 (Palmatic acid) 9% and C18 (Stearic acid) 3%, by doing this gas chromatography analysis, the production virgin coconut oil via centrifuge achieve the standard nutrient inside the virgin coconut oil compare the virgin coconut oil in the market. Every types of oil have their on rancimat value at $100^{O}C$ (standard method for food product) and the rancimat value is proportional with the moisture; the higher moisture content inside virgin coconut oil the higher of rancid value. Since no heat was applied to this sample, it is expected that the initial moisture content and microflora of the sample may be high which may facilitate hydrolytic rancidity. Hydrolytic rancidity often referred as "soap rancidity" is a problem mainly uncounted in Lauric products and caused by a combination of moisture and microorganisms (Allen & Hamilton,1983) . The lipases released by the microorganisms catalyse the action of moisture to hydrolyse the triglycerides (Freeland-Graves & Peckham, 1996). Hydrolysis liberates the free fatty acids from the parent oil and thus releasing the free fatty acids that are responsible for the rancid aroma. Another possible in the sample degraded the oil to methyl ketones. Methyl ketones provide undesirable odors noted as "perfume rancidity" (Belitz & Grosch, 1987). The presences of moisture aggravated the release of free C8-C12 fatty acid and their partial degradation to methyl ketones (Belitz & Grosch, 1987)

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The production virgin coconut oil was carried out with rotation of centrifuge, optimum temperature, and physical and chemical properties. The effect of rotation of centrifuge the temperature in virgin coconut oil production was studied. During the experimental of cold method (centrifuge), 30% yield (virgin coconut oil) were successfully produced Based on the observation for the centrifuge method, the virgin coconut oil production became higher when the speed or rotation of centrifuge higher. The highest yield of virgin coconut oil produced was at 50°C. By compare the hot (oven) and cold method (centrifuge), the cold method produce more yield and VCO samples were nearly colorless, had slightly detectable acid aroma, sweet and salty tastes, and perceptible nutty aroma and flavor.

5.2 Recommendation

In order to improve this research, there are several things should be stress out in the future. Firstly, the time of centrifuge need to be longer to get the optimum yield and because the lacks of the machine and maintenance operation the experiment can't be proceed longer. Secondly the apparatus for hot method should be clean or autoclave it before use to prevent the bacteria biodegrade the sample (coconut milk). Nowadays the is many hybrid or type of coconut have been develop, to get the higher yield we need to choose the best type or hybrid such as mataq coconut oil have produce coconut milk and oil. Furthermore the maturities of coconut also necessary because it can determine the production of oil by choose the middle level of maturity coconut. Lastly, to improve the analysis of virgin coconut oil (VCO), the sample need to directly analysis to gas chromatography after produce it in order to determine the quality of VCO. By all the recommendations the yield and the quality of virgin coconut oil (VCO) and are improving day by day for consumer usage.

REFERENCES:

Journals:-

Allen, J. C., & Hamilton, R. J. (1983). Rancidity in foods. London: Applied Science Publishers.

Bergsson, G., Arnfinnsson, J., Karlsson, S. S. M., Steingri0Msson, O., & Thormar, H. (1998). In vitro inactivation of Chlamydia trachomatis by fatty acids and monoglycerides. Antimicrobial Agents and Chemotherapy, 42(9), 2290–2294

Belitz, H. D., & Grosch, W. (1987). Food chemistry. New York: Springer.

Bureau of Product Standards (BPS). (2004). Philippine National Standards:Virgin coconut oil. Philippines: Department of Trade and Industry.

Chih,C.C and C.C Yeong, 2002 . Demulsification of W/O Emulsion by Microwave Radiation. Marcel Dekker, Inc

Delmo, G. C. (2004). Virgin coconut oil. Marid Agribusiness Digest, 13–16.

Fang, C.S.,M.C. Lai. Peter and Bruce K.L Chang, 1989. Oil Recovery and Waste Reduction by Microwave Radiation. J. Environ Progress. 8:4.

Freeland-Graves, J. H., & Peckham, G. C. (1996). Foundations of food preparation. Englewood Cliffs, NJ: Prentice-Hall.

G. Delvigne. 1993 Oil Spill Conference Report (1993)

German, J. B., & Dillard, C. J. (2004). Saturated fats: What dietary intake? American Journal of Clinical Nutrition, 80, 550–559. otherapy, 42(9), 2290–2294.

Hui, Y. H. (1996). Edible oil and fat products: Oils and oil seeds. In Bailey's industrial oil and fat products, 5th ed., Vol. 2. New York: Wiley.

Klaila, W.J., 1983. Method and apparatus for controlling fluency of high viscosity hydrocarbon fluids. US Patent, 4: 067-683.

Lim-Sylianco, C. Y., Guevarra, A. Y., Serrame, E., De Guzman, N., Casin˜ o, M. P., & Sylianco-Wu, L. (1991). Antigenotoxicity of dietary coconut oil. Philippine Journal of Science, 120(4), 339.

Lixin, X., Lu. Shiwei and Cao. Guoying, 2003. Stability and demulsification of emulsion stabilized by asphaltens or resins. Elsevier Science Ltd.

Nevin, K. G., & Rajamohan, T. (2004). Beneficial effects of virgin coconut oil on lipid parameters and in vitro LDL oxidation. Clinical Biochemistry, 37(9), 830–835.

Nolasco, N. N., Balboa, J. G., Serrame, E., & Lim-Sylianco, C. Y. (1994). Effect of coconut oil, trilaurin and tripalmitin on the promotion stage of carcinogenesis. Philippine Journal of Science, 123(2), 161–169.

Van Immerseel, F., De Buck, J., Boyen, F., Bohez, L., Pasmans, F., Volf, J., et al. (2004). Medium-chain Fatty acids decrease dolonization and invasionthrough hilA suppression shortly after infection of chickensvwith Salmonella enterica Serovar Enteritidis. Applied and Environmental Microbiology, 70(6), 3582–3587.

Villariba, C. (2003) Virgin coconut oil being tested on SARS patients. www.inq7.net

Villariba, C. (2004). Virgin coconut oil wins the war of oils. www.inq7.net

APPENDIX A

Appendix A.1: High speed centrifuge separator (Sorval)

Appendix A.2: Gas Chromatography (GC - Aligent)

Appendix A.3: Oven

APPENDIX B

Appendix B.1: Data for centrifuge method

Speed = 12000 rpm
Volume of coconut milk = 150 mL

Time = 30 minutes	Repetition			Mean	%
Volume separated	1	2	3		
VCO	45	48	48	47.00	31.33
Water	65	64	67	65.33	43.56
Solid	20	25	25	23.33	15.56
	130.00	**137.00**	**140.00**	**135.67**	**90.44**

Time = 45 minutes	Repetition			Mean	%
Volume separated	1	2	3		
VCO	48	48	47	47.67	31.78
Water	65	64	64	64.33	42.89
Solid	18	22	24	21.33	14.22
	131.00	**134.00**	**135.00**	**133.33**	**88.89**

Time = 60 minutes	Repetition			Mean	%
Volume separated	1	2	3		
VCO	48	50	48	48.67	32.44
Water	64	64	60	62.67	41.78
Solid	20	22	18	20.00	13.33
	132.00	**136.00**	**126.00**	**131.33**	**87.56**

Time = 75 minutes	Repetition			Mean	%
Volume separated	1	2	3		
VCO	50	52	48	50.00	33.33
Water	65	64	60	63.00	42.00
Solid	18	18	19	18.33	12.22
	133.00	**134.00**	**127.00**	**131.33**	**87.56**

Time = 90 minutes	Repetition			Mean	%
Volume separated	1	2	3		
VCO	50	55	52	52.33	34.89
Water	64	62	63	63.00	42.00
Solid	18	20	20	19.33	12.89
	132.00	**137.00**	**135.00**	**134.67**	**89.78**

Time = 105 minutes	Repetition			Mean	%
Volume separated	1	2	3		
VCO	55	52	55	54.00	36.00
Water	62	64	62	62.67	41.78
Solid	20	22	18	20.00	13.33
	137.00	**138.00**	**135.00**	**136.67**	**91.11**

Speed = 10000 rpm

Volume of coconut milk = 150 mL

Time = 30 minutes	Repetition			Mean	%
Volume separated	1	2	3		
VCO	42	44	44	43.33	28.89
Water	68	66	67	67.00	44.67
Solid	24	22	22.5	22.83	15.22
	134.00	**132.00**	**133.50**	**133.17**	**88.78**

Time = 45 minutes	Repetition			Mean	%
Volume separated	1	2	3		
VCO	44	44	45	44.33	29.56
Water	68	68.5	66	67.50	45.00
Solid	23	22.5	22	22.50	15.00
	135.00	**135.00**	**133.00**	**134.33**	**89.56**

Time = 60 minutes	Repetition			Mean	%
Volume separated	1	2	3		
VCO	44.5	42	46	44.17	29.44
Water	68	66	66.5	66.83	44.56
Solid	22	26	20	22.67	15.11
	134.50	**134.00**	**132.50**	**133.67**	**89.11**

Time = 75 minutes	Repetition			Mean	%
Volume separated	1	2	3		
VCO	45	48	46	46.33	30.89
Water	68	65	66	66.33	44.22
Solid	26	20	22	22.67	15.11
	139.00	**133.00**	**134.00**	**135.33**	**90.22**

Time = 90 minutes	Repetition			Mean	%
Volume separated	1	2	3		
VCO	50	48	48	48.67	32.44
Water	64	68	66	66.00	44.00
Solid	22	24	25	23.67	15.78
	136.00	**140.00**	**139.00**	**138.33**	**92.22**

Time = 105 minutes	Repetition			Mean	%
Volume separated	1	2	3		
VCO	50	48.5	52	50.17	33.44
Water	60	64	60	61.33	40.89
Solid	25	22	24	23.67	15.78
	135.00	**134.50**	**136.00**	**135.17**	**90.11**

Speed = 8000 rpm
Volume of coconut milk = 150 mL

Time = 30 minutes	Repetition			Mean	%
Volume separated	1	2	3		
VCO	30	36	30	32.00	21.33
Water	68	67	69	68.00	45.33
Solid	40	35	40	38.33	25.56
	138.00	**138.00**	**139.00**	**138.33**	**92.22**

Time = 45 minutes	Repetition			Mean	%
Volume separated	1	2	3		
VCO	40	35	34	36.33	24.22
Water	66	68	68	67.33	44.89
Solid	36	37	37.5	36.83	24.56
	142.00	**140.00**	**139.50**	**140.50**	**93.67**

Time = 60 minutes	Repetition			Mean	%
Volume separated	1	2	3		
VCO	36	36	36	36.00	24.00
Water	69	66	66	67.00	44.67
Solid	35	39	40	38.00	25.33
	140.00	**141.00**	**142.00**	**141.00**	**94.00**

Time = 75 minutes	Repetition			Mean	%
Volume separated	1	2	3		
VCO	38	36	36	36.67	24.44
Water	66	68	68	67.33	44.89
Solid	38	34	34	35.33	23.56
	142.00	**138.00**	**138.00**	**139.33**	**92.89**

Time = 90 minutes	Repetition			Mean	%
Volume separated	1	2	3		
VCO	35	38	34	35.67	23.78
Water	66	68	66	66.67	44.44
Solid	34	38	36	36.00	24.00
	135.00	**144.00**	**136.00**	**138.33**	**92.22**

Time = 105 minutes	Repetition			Mean	%
Volume separated	1	2	3		
VCO	36	40	37	37.67	25.11
Water	66	65	65	65.33	43.56
Solid	38	35	38	37.00	24.67
	140.00	**140.00**	**140.00**	**140.00**	**93.33**

Speed = 6000 rpm
Volume of coconut milk = 150 mL

Time = 30 minutes	Repetition			Mean	%
Volume separated	1	2	3		
VCO	20	22	22	21.33	14.22
Water	68	66	66	66.67	44.44
Solid	50	52	53	51.67	34.44
	138.00	**140.00**	**141.00**	**139.67**	**93.11**

Time = 45 minutes	Repetition			Mean	%
Volume separated	1	2	3		
VCO	26	23	26	25.00	16.67
Water	65	64	64	64.33	42.89
Solid	48	50	50	49.33	32.89
	139.00	**137.00**	**140.00**	**138.67**	**92.44**

Time = 60 minutes	Repetition			Mean	%
Volume separated	1	2	3		
VCO	24	24	25	24.33	16.22
Water	62	62	66	63.33	42.22
Solid	48	48	44	46.67	31.11
	134.00	**134.00**	**135.00**	**134.33**	**89.56**

Time = 75 minutes	Repetition			Mean	%
Volume separated	1	2	3		
VCO	26	28	22	25.33	16.89
Water	64	66	66	65.33	43.56
Solid	48	47	50	48.33	32.22
	138.00	**141.00**	**138.00**	**139.00**	**92.67**

Time = 90 minutes	Repetition			Mean	%
Volume separated	1	2	3		
VCO	28	25	24	25.67	17.11
Water	65	68	67.5	66.83	44.56
Solid	50	48	48	48.67	32.44
	143.00	**141.00**	**139.50**	**141.17**	**94.11**

Time = 105 minutes	Repetition			Mean	%
Volume separated	1	2	3		
VCO	26	30	28	28.00	18.67
Water	68	65	63	65.33	43.56
Solid	46	46	50	47.33	31.56
	140.00	**141.00**	**141.00**	**140.67**	**93.78**

Appendix B.2: Data for the effect of temperature (hot method-oven)

1. 50^{o}C (5hours)

Component	Volume separated (ml)	Percentage (%)
Virgin coconut oil	292.0	9.99
Coconut milk cream (protein)	1579.0	52.60
Water	1050.0	35.90
	Total= 2921	98.49

2. 40^{o}C (5hours)

Component	Volume separated (ml)	Percentage (%)
Virgin coconut oil	48.0	1.62
Coconut milk cream (protein)	2160.0	73.02
Water	720.0	24.34
	Total= 2921	98.98

3. 30^{o}C (5hours)

Component	Volume separated (ml)	Percentage (%)
Virgin coconut oil	18.0	0.61
Coconut milk cream (protein)	2200.0	74.48
Water	734.0	24.85
	Total= 2921	99.93

Appendix B.3: Data for the stability of emulsion experiment

SDDS 2%
40/160 20/80

Bil/Solution	Time (min)	Oil (ml)	Water (ml)	Volume water separated %
1	15	42.8	84.5	52.81
2	30	52.3	114.7	71.69
3	45	66.8	123.4	77.13
4	60	63.8	129.4	80.88
5	75	61.8	131.4	82.13
6	90	59.6	133.9	83.69
7	105	61.6	134.1	83.81
8	120	59.6	136.1	85.06

SDDS 2%
60/140 30/70

Bil/Solution	Time (min)	Oil (ml)	Water (ml)	Volume water separated %
1	15	46.3	86.5	61.79
2	30	52.3	114.7	81.93
3	45	66.8	123.4	88.14
4	60	63.8	129.4	92.43
5	75	61.8	131.4	93.86
6	90	61.8	134.1	95.79
7	105	61.6	134.1	95.79
8	120	59.6	136.1	97.21

SDDS 2%
100/100 50/50

Bil/Solution	Time (min)	Oil (ml)	Water (ml)	Volume water separated %
1	15	40	10	10
2	30	127	13	13
3	45	155	15	17
4	60	183	17	17
5	75	182	18	18
6	90	180	20	20
7	105	178	22	22
8	120	178	22	22

SDDS 5%

40/160 20/80

Bil/Solution	Time (min)	Oil (ml)	Water (ml)	Volume water separated (%)
1	15	63	88	55.00
2	30	61	113	70.63
3	45	61	119	74.38
4	60	63	119	74.38
5	75	59	127	79.38
6	80	59	127	79.38
7	95	56.5	129.5	80.94
8	115	56.5	129.5	80.94

SDDS 5%

60/140 30/70

Bil/Solution	Time (min)	Oil (ml)	Water (ml)	Volume water separated (%)
1	15	30	20	14.29
2	30	50	60	42.86
3	45	70	70	50.00
4	60	90	80	57.14
5	75	100	80	57.14
6	80	95	85	60.71
7	95	90	90	64.29
8	115	90	110	78.57

SDDS 5%

100/100 50/50

Bil/Solution	Time (min)	Oil (ml)	Water (ml)	Volume water separated (%)
1	15	20		0.00
2	30	40		0.00
3	45	80		0.00
4	60	90	10	10.00
5	75	124	13	13.00
6	80	136	24	24.00
7	95	140	31	31.00
8	115	154	37	37.00

SDDS 7%
40/160 20/80

Bil/Solution	Time (min)	Oil (ml)	Water (ml)	Volume water separated (%)
1	15	20	80	50.00
2	30	20	120	75.00
3	45	25	125	78.13
4	60	30	130	81.25
5	75	25	135	84.38
6	90	30	140	87.50
7	105	35	140	87.50
8	120	40	140	87.50

SDDS 7%
60/140 30/70

Bil/Solution	Time (min)	Oil (ml)	Water (ml)	Volume water separated (%)
1	15	10	40	28.57
2	30	30	60	42.86
3	45	20	80	57.14
4	60	30	90	64.29
5	75	35	95	67.86
6	90	40	100	71.43
7	105	50	100	71.43
8	120	70	110	78.57

SDDS 7%
100/100 50/50

Bil/Solution	Time (min)	Oil (ml)	Water (ml)	Volume water separated (%)
1	15	2	18	18.00
2	30	1	24	24.00
3	45	1	24	24.00
4	60	10	30	30.00
5	75	30	50	50.00
6	90	80	70	70.00
7	105	80	70	70.00
8	120	80	70	70.00

Triton-X-100 2%
40/160 20/80

Bil/Solution	time (min)	Oil (ml)	Water (ml)	Volume water separated (%)
1	15	180		0.00
2	30	192		0.00
3	45	194		0.00
4	60	194		0.00
5	75	194		0.00
6	90	200		0.00
7	105	82	30	18.75
8	120	52	144	90.00

Triton-X-100 2%
60/140 30/70

Bil/Solution	time (min)	Oil (ml)	Water (ml)	Volume water separated (%)
1	15	180		0.00
2	30	200		0.00
3	45	170	30	21.43
4	60	170	30	21.43
5	75	150	45	32.14
6	90	143	47	33.57
7	105	140	51	36.43
8	120	80	120	85.71

Triton-X-100 2%
100/100 50/50

Bil/Solution	time (min)	Oil (ml)	Water (ml)	Volume water separated (%)
1	15	88		0.00
2	30	180		0.00
3	45	194		0.00
4	60	196		0.00
5	75	194	4	4.00
6	90	186	4	4.00
7	105	186	4	4.00
8	120	196	4	4.00

Triton-X-100 5%

40/160 20/80

Bil/Solution	time (min)	Oil (ml)	Water (ml)	Volume water separated (%)
1	15	190		0.00
2	30	188	12	7.50
3	45	188	12	7.50
4	60	171	37	23.13
5	75	153	46	28.75
6	90	147	61	38.13
7	105	129	79	49.38
8	120	106	90	56.25

Triton-X-100 5%

60/140 30/70

Bil/Solution	time (min)	Oil (ml)	Water (ml)	Volume water separated (%)
1	15	155		0.00
2	30	180	5	3.57
3	45	175	10	7.14
4	60	165	10	7.14
5	75	155	15	10.71
6	90	143	15	10.71
7	105	136	25	17.86
8	120	126	30	21.43

Triton-X-100 5%

100/100 50/50

Bil/Solution	time (min)	Oil (ml)	Water (ml)	Volume water separated (%)
1	15	25		0
2	30	30		0
3	45	70		0
4	60	130		0
5	75	175		0
6	90	190	5	5
7	105	195	5	5
8	120	190	10	10

Triton-X-100 7%
40/160 20/80

Bil/Solution	time (min)	Oil (ml)	Water (ml)	Volume water separated (%)
1	15	90	84	52.50
2	30	80	126	78.75
3	45	72	132	82.50
4	60	72	134	83.75
5	75	72	138	86.25
6	90	70	140	87.50
7	105	69	150	93.75
8	120	69	140	87.50

Triton-X-100 7%
60/140 30/70

Bil/Solution	time (min)	Oil (ml)	Water (ml)	Volume water separated (%)
1	15	70	70	50.00
2	30	90	90	64.29
3	45	100	100	71.43
4	60	100	100	71.43
5	75	110	100	71.43
6	90	100	110	78.57
7	105	100	110	78.57
8	120	100	110	78.57

Triton-X-100 7%
100/100 50/50

Bil/Solution	time (min)	Oil (ml)	Water (ml)	Volume water separated (%)
1	15	82		0
2	30	124		0
3	45	148		0
4	60	182		0
5	75	190		0
6	90	198	10	10
7	105	198	10	10
8	120	198	10	10

Tween 20 2%
40/160 20/80

Bil/Solution	Time (min)	Oil (ml)	Water (ml)	Volume water separated (%)
1	15	54	130	81.25
2	30	48	140	87.50
3	45	48	142	88.75
4	60	44	146	91.25
5	75	44	148	92.50
6	90	44	148	92.50
7	105	44	148	92.50
8	120	44	148	92.50

Tween 20 2%
60/140 30/70

Bil/Solution	Time (min)	Oil (ml)	Water (ml)	Volume water separated (%)
1	15	118	54	38.57
2	30	90	98	70.00
3	45	80	110	78.57
4	60	78	114	81.43
5	75	78	114	81.43
6	90	72	120	85.71
7	105	72	122	87.14
8	120	68	126	90.00

Tween 20 2%
100/100 50/50

Bil/Solution	Time (min)	Oil (ml)	Water (ml)	Volume water separated (%)
1	15	158	2	2
2	30	168	8	8
3	45	164	12	12
4	60	156	22	22
5	75	150	30	30
6	90	144	36	36
7	105	137	48	48
8	120	118	64	64

Tween 20 5%
40/160 20/80

Bil/Solution	Time (min)	Oil (ml)	Water (ml)	Volume water separated (%)
1	15	28	122	76.25
2	30	29	138	86.25
3	45	30	140	87.50
4	60	32	145	90.63
5	75	34	147	91.88
6	90	35	148	92.50
7	105	37	153	95.63
8	120	38	154	96.25

Tween 20 5%
60/140 30/70

Bil/Solution	Time (min)	Oil (ml)	Water (ml)	Volume water separated (%)
1	15	40	86	61.43
2	30	42	106	75.71
3	45	46	122	87.14
4	60	47	126	90.00
5	75	49	130	92.86
6	90	54	130	92.86
7	105	58	132	94.29
8	120	58	132	94.29

Tween 20 5%
100/100 50/50

Bil/Solution	Time (min)	Oil (ml)	Water (ml)	Volume water separated (%)
1	15	170	2	2
2	30	168	6	6
3	45	176	6	6
4	60	176	8	8
5	75	174	12	12
6	90	128	78	78
7	105	8	78	78
8	120	8	78	78

Tween 20 7%
40/160 20/80

Bil/Solution	Time (min)	Oil (ml)	Water (ml)	Volume water separated (%)
1	15	21	115	71.88
2	30	21	140	87.50
3	45	38	155	96.88
4	60	47	158	98.75
5	75	47	158	98.75
6	90	47	158	98.75
7	105	47	158	98.75
8	120	47	158	98.75

Tween 20 7%
60/140 30/70

Bil/Solution	Time (min)	Oil (ml)	Water (ml)	Volume water separated (%)
1	15	82	14	10.00
2	30	68	58	41.43
3	45	34	102	72.86
4	60	42	116	82.86
5	75	38	124	88.57
6	90	38	124	88.57
7	105	32	132	94.29
8	120	32	132	94.29

Tween 20 7%
100/100 50/50

Bil/Solution	Time (min)	Oil (ml)	Water (ml)	Volume water separated (%)
1	15	92	8	8
2	30	120	12	12
3	45	124	12	12
4	60	144	16	16
5	75	152	16	16
6	90	150	20	20
7	105	130	54	54
8	120	130	54	54