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FORMULATION OF LOTION FROM VIRGIN COCONUT OIL

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DECLARATION

I declare that this thesis entitled “Formulation of Lotion from Virgin Coconut Oil” is the result of my research except as cited in the references.

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FORMULATION OF LOTION FROM VIRGIN COCONUT OIL

ABSTRACT

Virgin coconut oil (VCO) lotion formulations take a new approach to creating care products by using the healthy and natural qualities of VCO to enhance consumer benefits. This study emphasizes the formulation of lotion from VCO with the production of virgin coconut oil by extracting coconut using the distillation method. The formulation takes into account the need to produce a stable emulsion, improve quality, and improve the overall user experience. The lotion production was investigated using scanning Fourier Transform Infrared Spectroscopy (FT-IR), Gas Chromatography-Mass Spectrometry (GC-MS), and viscosity. Choose premium virgin coconut oil and incorporate it into a well-planned blend with thickeners, emulsifiers, and other ingredients. This research examines the compatibility temperature and effects of different chemicals on the texture, viscosity, and stability of lotions. The research sheds light on the difficulties in forming stable emulsions of coconut oil, addressing issues such as phase separation or viscosity variation under various storage scenarios. There is talk on how to address these problems and how VCO is used to produce lotions that are safe for usage. The creation of the proper lotion is significantly influenced by the variations in components.

Keywords: GC-MS, lotion, VCO, coconut oil, and FT-IR

FORMULASI LOSYEN DARI MINYAK KELAPA DARA

ABSTRAK

Formulasi losyen minyak kelapa dara (VCO) mengambil pendekatan baharu untuk mencipta produk penjagaan dengan menggunakan kualiti VCO yang sihat dan semula jadi untuk meningkatkan faedah pengguna. Kajian ini menekankan formulasi losyen daripada VCO dengan penghasilan minyak kelapa dara dengan mengekstrak kelapa menggunakan kaedah penyulingan. Formulasi ini mengambil kira keperluan untuk menghasilkan emulsi yang stabil, meningkatkan kualiti, dan menambah baik pengalaman pengguna secara keseluruhan. Pengeluaran losyen telah disiasat menggunakan pengimbasan Fourier Transform Infrared Spectroscopy (FT-IR), Gas Chromatography-Mass Spectrometry (GC-MS), dan kelikatan. Pilih minyak kelapa dara premium dan masukkan ke dalam adunan yang terancang dengan pemekat, pengemulsi dan bahan-bahan lain. Penyelidikan ini mengkaji suhu keserasian dan kesan bahan kimia yang berbeza pada tekstur, kelikatan dan kestabilan losyen. Penyelidikan memberi penerangan tentang kesukaran dalam membentuk emulsi minyak kelapa yang stabil, menangani isu seperti pemisahan fasa atau variasi kelikatan di bawah pelbagai senario penyimpanan. Terdapat perbincangan tentang cara menangani masalah ini dan bagaimana VCO digunakan untuk menghasilkan losyen yang selamat untuk digunakan. Penciptaan losyen yang betul dipengaruhi dengan ketara oleh variasi dalam komponen.

Kata kunci: GC-MS, losyen, VCO, minyak kelapa, and FT-IR

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LIST OF ABBREVIATIONS

VCO	Virgin coconut oil
MCFA	Medium chain fatty acids
MCT	Medium chain triglycerides
ML	Mililiter
FTIR	Fourier Transform Infrared
GC	Gas Chromatography
MS	Mass Spectrometry
cP	Centipoise

LIST OF SYMBOLS

%	Percentage
ºC	Temperature
cm^{-1}	Reciprocal centimeter
Min	Minutes

CHAPTER 1

1.0 INTRODUCTION

1.1 Background of the study

Virgin coconut oil is a product produced by (Biotechnology) from coconut milk (*Cocos nucifera*) through a distillation process and does not use chemicals. It is considered a healthier alternative to regular coconut oil because it undergoes less processing and retains more of the natural nutrients and antioxidants found in coconuts. In 1966, a professor of pharmacology from the University of Michigan made a great discovery by uncovering the secret of nature hidden in coconuts, which is virgin coconut oil or Virgin Coconut Oil (VCO). The restated statement found virgin coconut oil can kill viruses, bacteria, parasites, and fungi. Seeing the power found in virgin coconut oil, western experts continue to look for further effects that virgin coconut oil can have against various diseases. Coconut trees have many functions for humans. Each part of the coconut tree has various uses from food, and beauty care to traditional medicine. The coconut tree has been recognized as the closest tree to human daily life. Smith, & Johnson, (2021).

The VCO manufacturing process involves separating the coconut milk from the shell and then pressing or squeezing the coconut milk to extract the oil. Unlike refined coconut oil, VCO is not bleached, deodorized, or hydrogenated, which means it is free of any chemicals or solvents. VCO is rich in medium-chain fatty acids, including lauric acid, which has been shown to have antimicrobial and anti-inflammatory properties. It also contains vitamins E and K, as well as iron, which can support overall health and well-being (Smith, & Johnson. 2021). VCO has many uses, including cooking, baking, and as a natural moisturizer for skin and hair. It has gained popularity in recent years due to its potential health benefits and versatility in kitchen and personal care products.

virgin coconut oil contains oleic and lauric acids, two saturated fatty acids that can help soothe harsh, dry skin. VCO is a material with antioxidant properties that are beneficial to the body's health and a unique, eye-catching hue that makes it an ideal choice for usage as a natural ingredient in cosmetics, particularly skin creams. works to preserve the moisture and water resistance of the skin layer, allowing the skin to remain smooth and soft. Furthermore, research investigations may be used to ascertain the chemical and physical characteristics of lotions based on VCO (Varma, 2019). Research assessed elements such VCO's moisturizing efficacy, impact on skin hydration and suppleness, and capacity to quicken skin healing. VCO-based lotions have been found to be safe and effective for a wide range of skin types, including dry and sensitive skin. They can help improve skin hydration, increase elasticity, and repair the skin's barrier function. (Journal of Medicinal Food 2021).

In addition, coconut oil including VCO has been used in traditional medicine for centuries and is believed to have various health benefits. Coconut oil is used to moisturize and treat skin infections. The emollient effect of coconut oil has been successfully demonstrated in patients with atopic dermatitis, thus demonstrating that coconut oil is a powerful natural emollient. (Smith, & Johnson. 2021). Therefore, lotions made from virgin coconut oil are moisturizing skin care products that can provide hydration, improve skin elasticity, and protect skin from damage. It is often enriched with natural plant extracts for added benefits. However, it's a good idea to consult with a dermatologist to determine the best skincare routine for your specific needs. (Leiva, 2020).

Studies are conducted to understand prospective health advantages. More research is needed to fully understand the effects of VCO on human health and lotions from virgin coconut oil, despite the fact that it is thought to have some positive health effects. (Varma, 2019). Due to its many qualities, VCO virgin coconut oil used in the manufacture of lotions also offers a wide range of possible applications, including skin and hair care, massage and aromatherapy, and personal care products. Therefore, research may be able to determine the exact way that VCO can improve health as well as any harm or negative effects and also in health products. (Carandang. 2008)

1.2 Problem statement

The issue frequently arises during the creation of non-becoming cream. This is because the wrong guidelines are not followed when making cream. The creation of cream goods utilizing VCO is typically carried out since it is necessary to utilise the correct dosage in order for the cream to have a lovely texture. VCO compatibility with other ingredients must be taken into account when using it in cosmetics. This is due to the use of materials that were inappropriate for the product's creation. Despite the fact that VCO is typically regarded as safe and advantageous for a variety of uses, individual sensitivities and reactions can nevertheless happen. The studies carried out should ensure that VCO is mixed with natural plant extracts and other cosmetic ingredients to produce an effective and stable formulation.

1.3 Expected outputs

Research can help identify the potential health benefits of VCO, such as its anti-inflammatory, antioxidant, and antimicrobial properties, as well as its effects on the skin. This information can be used to develop evidence-based recommendations for the use of VCO in health and beauty practices. Additionally, standardized production methods that ensure consistency in VCO quality and composition make it easy for consumers to know exactly what they are getting when they buy a VCO. This can also help ensure the safety and effectiveness of the VCO. Research on VCO can also lead to the development of new products and formulations, such as VCO-based supplements, skin care products, and food products. These beauty products can provide consumers with new options to incorporate VCO into their health and wellness practices. (Smith, & Johnson. 2021).

1.4 Objective

The objectives of this research are:

1. To produce virgin coconut oil by extracting coconut
2. To formulate lotion from virgin coconut oil

1.5 Scope of the Study

The emphasis of this study is on VCO produced through the distillation method from selected coconuts and to produce lotion. To begin with, the coconut has been refined using a distillation method to separate the coconut milk essence from the oil in the grated coconut that has been made into coconut milk and left overnight and continued with the lotion making. The purpose of this procedure is to find out the benefits of virgin coconut oil and its effectiveness on the skin. To get a lot of oil made using the process of filtering and squeezing coconuts.

1.6 Significant of the study

His study will be helpful in getting and describing virgin coconut oil, which is extracted from certain coconuts and used as the greatest skin lotion. Pharmacological characteristics of VCO, such as its anti-inflammatory, analgesic, antipyretic, antioxidant, anti-stress, and antibacterial qualities, have been the subject of several investigations. Moreover, additional research has looked at the skin effectiveness and cardioprotective properties of VCO. Because coconut oil may hydrate skin and aid in moisture retention through the creation of lotions, VCO also promotes health and attractiveness. In addition, it has antimicrobial qualities and can aid in wound healing and inflammation reduction. Researchers are investigating the potential of coconut oil as a topical remedy for issues related to sensitive skin. (Dumancas, 2016).

CHAPTER 2

2.0 LITERATURE REVIEW

2.1 Chemical composition of virgin coconut oil

Virgin Coconut Oil (VCO), has a milky appearance and is created by pressing liquid from coconut pulp before extracting the oil from coconut milk and water. Virgin and refined coconut oil are two common types (Sowmya, 2021). Virgin coconut oil (VCO) is increasingly favored and respected, even among scientists, for its health benefits and use as a functional food oil.8 The high concentration of polyphenols found in VCO, including ferulic acid, vanillic acid, syringic acid, quercetin, and caffeic acid, has been connected to the drug-like properties of the substance. However, VCO is an unprocessed, fatty acid-rich saturated oil made from fresh coconut kernels.

The most important properties, related uses, and effects on physical characteristics and human health are also determined by the degree of saturation and the length of the carbon chain of fatty acids that make up a particular fat or oil. The harder the coconut oil and the higher the melting point (Fife, 2001), the more saturated the fat and the longer the chain. Because it does not have the highest concentration of medium chain fatty acids (MCFA), which gradually soften with increasing carbon chain length, coconut oil stands out from other fats and oils. Temperature increases due to VCO behavior. The human body has different metabolic processes. (Bawalan, 2006).

Table 2.1. Profile of Fatty Acids Methyl Esters of the Virgin Coconut Oil

Fatty acid	Virgin coconut oil
Butyric acid (C4:0)	3.7 ± 0.5
Capric acid (C10:0)	5.4 ± 0.4
Lauric acid (C12:0)	53.6 ± 0.4
Myristic acid (C14:0)	18.8 ± 0.1
Palmitic acid (C16:0)	10.7 ± 0.6
Estearic acid (C18:0)	1.8 ± 0.2
Oleic acid (C18:1)	4.6 ± 0.2
Linoleic acid (C18:2)	1.1 ± 0.0

The popularity of coconut especially virgin coconut oil has skyrocketed due to its health benefits. therefore, consumer demand for plant-based foods is increasing, coconut oil has become a popular choice of fat due to its rich taste and mild coconut aroma. VCO has been found to have a variety of health benefits, including antioxidant, anti-inflammatory, antibacterial, and antiviral properties. These properties make it a promising ingredient for use in skin care products. (*Coconut Oil*, 2018).

Saturated and total fat are the sources of coconut oil. At room temperature or below, this results in a thick texture. Coconut oil contains various forms of saturated fatty acids, which are the smaller molecules that makeup fats. Lauric acid is the primary variety. Only minute amounts of vitamins, minerals, and plant sterols may be found in coconut oil, along with no fiber and no cholesterol. Because of their similar chemical structure to blood cholesterol, plant sterols may be able to stop the body from absorbing cholesterol (Rini, 2020). VCO has been discovered to be a successful skin and hair moisturizer. Due to the high concentration of saturated fatty acids it contains, such as oleic and lauric acids, it can help soothe rough, dry skin. Lauric acid, which is mostly found in coconut oil, is not an MCT. Similar to other long-chain fatty acids, lauric acid is digested more slowly after absorption. Therefore, commercial coconut oil cannot directly benefit from the purported health advantages of specifically produced MCT coconut oil that contains "medium-chain triglycerides" (other than lauric acid) (Coconut Oil, 2018).

2.2 Use of virgin coconut oil in beauty products

The beauty, wellness, and healthcare sectors are expanding rapidly due to growing incomes and increased public knowledge of preventative healthcare and lifestyle choices. Conventional nutritional and cosmetic products were created using natural ingredients that have some degree of pharmacological action. Virgin coconut oil is the purest type of coconut oil, retaining its authentic coconut flavor and aroma. Because VCO preserves the majority of its useful components, it has greater positive nutritional impacts than copra oil. Because of the medium-chain fatty acids (MCFA) it contains, it is simple to digest and rich in antioxidants and vitamin E. (Coconut Oil, 2018). Use of Virgin Coconut Oil in Beauty Products such as skin care products such as moisturizers, cleansers, and lotions. In addition, there are also products that protect from the sun.

Furthermore, natural moisturizers with antibacterial properties are more appealing to consumers. Because VCO contains a considerable amount of skin-active substance, it may be considered a safe and clever alternative to emollients based on minerals and petroleum. The high antioxidant content of VCO is directly associated with its anti-aging benefits. Its high vitamin E concentration keeps the body youthful and guards against premature aging. VCO has antiaging properties when used as a basis in topical treatments like creams and lotions. One of the natural skin moisturizers that can shield the skin and stop tissue damage is VCO. Even on skin that is primarily sensitive, VCO can be utilized without irritating the skin (Gopala, 2019). According to clinical research, VCO is a safe and effective moisturizer that can also hasten skin healing and increase skin moisture. By calming and hydrating the skin, it lessens inflammation. Consequently, the creation of hypoallergenic cosmetics and skin care products is one of the primary uses of VCO. The greatest treatment for a variety of skin conditions is VCO. (Varma, 2019). Goods that are applied topically, such as lotions, since VCO is able to create skin-beneficial creams. The components used in the production of lotions are listed in Table 2.1.

Table 2.2: Ingredients used in body lotion blend and formulations

Sl. No.	Ingredients	Abbreviation	Formulation (%)					
			T1	T2	T3	T4	T5	T6
1	Virgin coconut oil	O	66	68	70	72	74	76
2	*Aloe vera*	A	2	4	6	8	10	12
3	Beeswax	B	18	16	14	12	10	8
4	Cocoa butter	C	12	10	8	6	4	2
5	Fragrance	F	2	2	2	2	2	2

High oxidative resistance is exhibited by moisturizing creams and lotions that contain biocompatible chemicals and use VCO as their foundation. Using these plant-based chemicals to create skincare products for dermatological therapy has a lot of potential. It will be more marketable as a skin conditioner if it has an appealing or healing scent, either from oil infusion or the use of essential oils. (2020, Satheeshan). It is important to highlight the chemicals used in the production of this lotion in order to prevent skin harm when used topically. VCO has demonstrated skin-protective and anti-inflammatory qualities. It has been used traditionally as a moisturizer and has been shown to improve symptoms of skin disorders by moisturizing and soothing the skin (Varma, 2019). Therefore, table 2.2 shows the combined treatment for body lotion.

Table 2.3: Combination treatments for body lotion

Combinations	VCO	*Aloe vera*	Beeswax	Cocoa butter	Fragrance (F)		
	(O)	(A)	(B)	(C)	F1	F2	F3
T1	66	2	18	12	2	-	-
T2	68	4	16	10	-	2	-
T3	70	6	14	8	-	-	2
T4	72	8	12	6	2	-	-
T5	74	10	10	4	-	2	-
T6	76	12	8	2	-	-	2

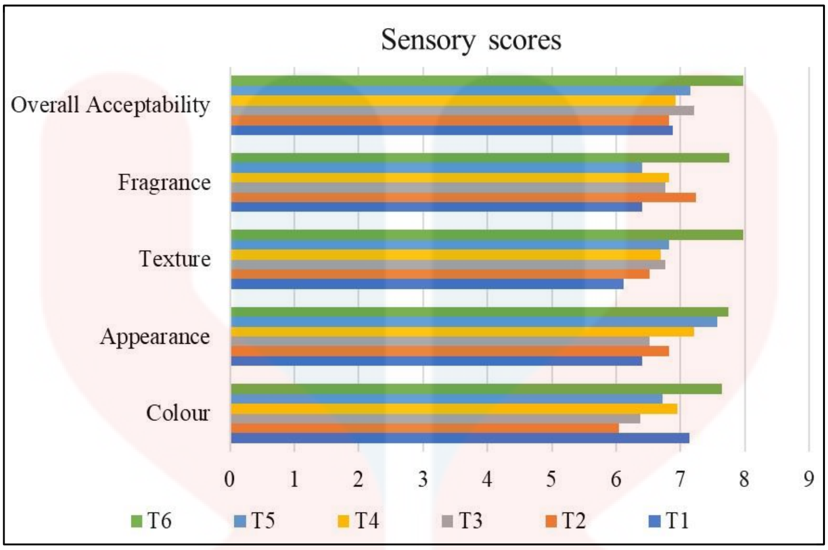


Figure 1: Sensory scores of body lotion

One of the most common concerns with possible negative health effects for those who are exposed to numerous hazards at work is skin contamination. The harsh, unpleasant, and often dangerous nature of many skin care products with chemical formulations on the market emphasizes the necessity of identifying and creating a research strategy for natural goods. The topical body lotion formulation created in this study is significant in lowering the hazards to human health and environmental pollution in this setting. The majority of the recipe, virgin coconut oil, serves as a preservative to prolong the body lotion's shelf life and shield it from microbial deterioration. The body lotion is developed free of skin irritation, has a long shelf life, and is calm, stable, and safe (Satheeshan, 2020).

Lotion formulation listed as excellent with VCO content along with other ingredients without any preservatives is acceptable. This process technology and formulation for natural body lotion using VCO and its mentioned ingredients can be used on an industrial scale and adopted for mass production.

2.3 Advantages and challenges of using virgin coconut oil in beauty products

The advantages of using VCO as a base ingredient for body lotions because it has been traditionally used as a moisturizer and has shown anti-inflammatory and skin protective properties. The efficacy and safe use of VCO for its use as a therapeutic moisturizer has been previously reported for mild to moderate xerosis. However, there are no reports available on the anti-inflammatory and skin barrier functions of VCO in vitro (Varma, 2019). Using VCO contains solid lipid particles because it has been shown to increase hydration and elasticity of the skin because it has its own properties. This processing uses VCO with low water content and low free fatty acids to produce clear oil. Consider using VCO in combination with other natural ingredients such as shea butter, aloe vera, and essential oils to enhance the moisturizing and soothing properties of body lotions (Leiva, 2020).

The challenge is, that products that use VCO should be avoided using VCO if you are prone to clogged pores or acne because it can cause comedogenic concerns. This is because coconut oil is a great beauty staple that can be used for a variety of things, including skin and hair care treatments. It's a great moisturizer used in many beauty products and skincare routines and also works well on its own. Coconut oil works as a great moisturizer, plus some of the fatty acids it contains, such as lauric acid, have antimicrobial effects that can help fight bacterial, viral, and fungal pathogens (Fasanella, 2014). In addition, in the production of the product do not use VCO with a high water content or a high free fatty acid content because it can result in cloudy oil. Cloudy oils are not good for the skin. Therefore, Avoid using VCO with other substances that may cause skin irritation or allergic reactions, as the substances used may contain chemicals. (Varma, 2019). Overall, developing a VCO-based body lotion could be a great way to utilize the benefits of VCO in beauty products.

The nutritional benefits of virgin coconut oil include the fact that it is full of good fats such as medium chain triglycerides (MCTs), which the body can use as a quick source of energy. To add to the overall nutritional content, it also has vitamins and minerals. This VCO contains unique qualities that are beneficial for body growth. VCO is also beneficial for skin and hair care. This is because VCO has moisturizing qualities and can be used topically to nourish the skin, increase hydration, and promote healthy hair growth. It may also have antibacterial qualities that are beneficial to the skin. (Lang, 2020).

VCO has Antioxidant Properties containing antioxidants that can help protect the body from damage caused by free radicals, potentially reducing the risk of chronic disease. The antioxidant properties of virgin coconut oil produced through cooling and fermentation were investigated and compared with refined, bleached, and deodorized coconut oil. Virgin coconut oil shows better antioxidant capacity than refined, bleached, and deodorized coconut oil. (Marina, 2009).

CHAPTER 3

3.0 MATERIAL AND METHODS

3.1 Materials

The ingredients used are coconuts brought to the laboratory of Universiti Malaysia Kelantan, Kelantan Jelly Campus, which are extracted into virgin coconut oil. Coconuts are collected and the contents of the coconut are taken to be made into grated coconut. After grating, the grated coconut is mixed with water and squeezed to get coconut milk. The sample was cooled in the refrigerator for 24 hours and then left at room temperature. When 2 layers are visible, the material is filtered and separated to obtain the resulting oil. (Sowmya Binu., 2021). The next process produces a lotion from coconut oil. The ingredients used are coconut oil, emulsifying wax or beeswax, aloe vera, shea butter, and fragrance.

3.2 Methods

In this method section, several methods were carried out including the preparation of samples of selected coconut materials, the preparation and processing of selected coconuts, and the preparation of VCO from grated coconut, and the coconut milk was taken to be used as VCO. After that, the production of lotion from VCO with other additives.

3.2.1 Preparation material from coconut

The coconut must be extracted from selected coconut trees. The coconut was grated to obtain a smooth coconut core using a coconut grater. After grating, the coconut content was mixed with water to make coconut milk. After mixing with water, the coconut content was squeezed to obtain thick coconut milk. After the coconut milk is squeezed, it is put in a container to be put in the refrigerator overnight. When there are 2 layers after freezing, the coconut milk essence is on top and the core will be put into a new container. After that, the container was left at room temperature overnight. Therefore, there were 2 layers of oil with coconut milk. The oil in the container will be separated into a new container. This process follows the method of cooling, freezing, and thawing, and finally uses the method of fermentation. (Alphafoodie, 2020). The resulting oil was examined with oil texture, FT-IR, and GC-MS.

3.2.1.1 Texture oil

Different conditions can be attributed to the texture of the oil. When heated, the texture changes. The color and smell of the oil also change when heated. The texture of crude oil is smooth and thick like a liquid. Although this oil has certain qualities, it does not disappear when heated. The only thing that changes is the texture.

3.2.1.2 Fourier Transform Infrared Spectroscopy (FT-IR)

Fourier-transform infrared spectroscopy, or FTIR spectroscopy, is a flexible technique that may be used to identify additives, common pollutants, and consequences of lubricant deterioration. It is especially intended to identify deterioration, diluting, or illicit additions in various kinds of oils. (AZoM, 2019). Three steps are involved in FTIR analysis of used oil samples: first, the FTIR spectrum of a fresh oil sample is recorded to provide a baseline; next, the used oil sample's FTIR spectrum is recorded; finally, the difference spectrum is obtained by subtracting the new oil baseline from the used oil spectrum. This makes it possible to assess changes in the oil's chemical composition—such as impurities and oil oxidation—without being interfered with by the new oil molecular resonances. Wright (2015).

3.2.1.3 Gas Chromatography-Mass Spectrometry (GC-MS)

Gas Chromatography Mass Spectrometry (GC-MS) is a powerful analytical technique used to study liquid, gaseous or solid samples, including various applications in oil analysis. In the context of oil analysis, GC-MS can be used to determine oil composition. GC-MS is particularly suitable for the identification of off-target metabolites in oil and gas analysis, making it a valuable tool for understanding the chemical composition of oil and related products. GC-MS is a versatile tool that offers detailed insight into oil composition, making it a valuable technique for a wide range of applications in the oil and gas industry. (*Thermo Fisher Scientific,* 2015).

3.2.2 Formulated lotion from virgin coconut oil.

The necessary steps in producing this lotion are melting emulsifying wax and shea butter, in a beaker and using a hot plate. Once melted, add VCO and aloe vera. After adding all the oil mixture is beaten continuously. Continue whisking until the lotion is thick and creamy. Pour the lotion into a clean, sterilized jar or bottle. Allow the lotion to cool and solidify before use. (Merissa, 2019). The material then uses the correct parameters. The finalized cream underwent FTIR, and texture tests.

3.2.2.1 Texture of lotion

Texture for lotion refers to the consistency or feel of the product. Lotions are lighter in texture than creams, making them ideal for those who prefer layered products. They get absorbed quickly and don't stick to the skin or prevent other products from working. They also contain a small amount, if any, of oil, making them ideal for summer when the air is humid. On the other hand, creams are thicker in consistency and are great for applying on top of serums, concentrates, and lotions. Gels are lightweight and oil-free, making them ideal for oily or blemished skin, while oils have a rich, silky texture that absorbs slowly and is perfect for very dry and sensitive skin. (Beauty Unboxed, 2017).

3.2.2.2 Viscosity of lotion VCO

Viscosity is the measure of the thickness and density of a liquid or semi-fluid substance. In the case of lotion, viscosity is an essential parameter that shows the thickness of the product and its resistance to flow. The viscosity of lotion products can vary depending on the formulation and the ingredients used. The standard viscosity value for lotion is 2000-50000 cP (centipoise). (Perry44, 2011). To measure the viscosity of lotion, a viscometer is used, and a spindle and speed combination is selected to achieve the target viscosity. Lotions can also exhibit thixotropic behavior, which means their viscosity decreases with increasing shear rate and is a result of structural changes in the product. (RheoSense, 2020).

3.2.2.3 Fourier Transform Infrared Spectroscopy (FT-IR)

FTIR stands for Fourier transform infrared spectroscopy, which is a powerful instrumental technique used for the analysis of various substances, including cosmetic lotions. (Rohman, 2012). FTIR spectroscopy provides detailed information about the chemical composition of a sample by measuring the absorption or transmission of infrared radiation by the sample. A study used ATR-FTIR spectroscopy, a type of FTIR spectroscopy, to differentiate between face creams and classification into herbal and non-herbal creams. (Assi, 2020).

CHAPTER 4

4.0 RESULT AND DISCUSSION

4.1 Virgin coconut oil from coconut

Figure 4.1, Shows the texture of VCO before and after heating. Virgin coconut oil (VCO) contains fatty acids, and it melts when heated. Each of the many fatty acids that make up VCO has a different melting point. VCO oil melts because it liquefies its fatty acids, which happens when the temperature rises. Oil melting results from the breakdown of triglycerides in VCO caused by increased temperature. VCO becomes solid again when the temperature drops below its melting point. The quality of the oil is not affected by this liquefaction and solidification process. (Leiva, 2020).

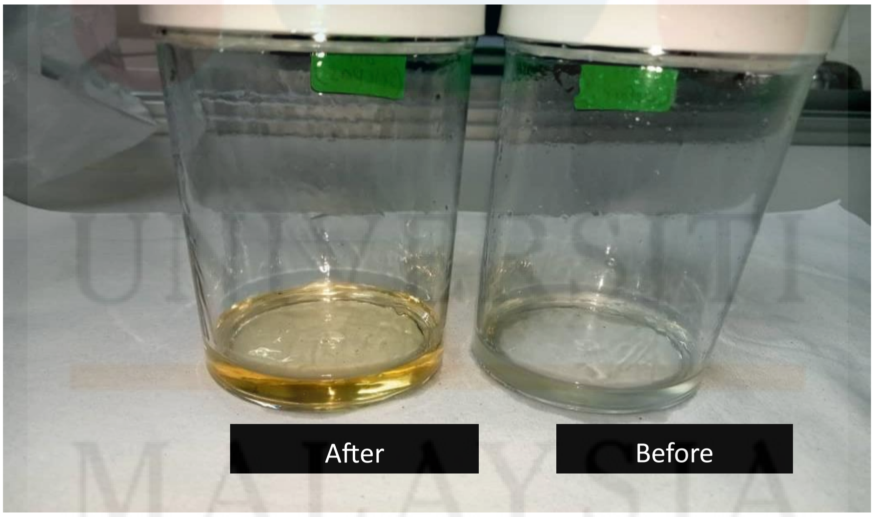


Figure 4.1: Shows the texture of VCO before and after heating.

Virgin coconut oil is shown in Table 4.1 both before and after heating. There are differences in the scent, color, and viscosity of the oil texture. The nutritional content remains constant despite variations in texture.

Table 4.1: Shows virgin coconut oil before and after being heated.

Type of properties / Time	Before	After
Color	Clear	Brownish-yellow
Smell	Coconut oil	Cooking oil
Viscosity	Concentrated	Slightly liquid

VCO is known for its high saturated fat content and has many health benefits before it is heated. The color of the unheated VCO is transparent, and it smells like pure coconut oil. The texture is a little sticky. VCO is rich in minerals and fatty acids. The VCO advantage is retained in the VCO, when not heated. A heated VCO smells like cooking oil and turns from clear to yellowish when heated. In addition, Virgin Coconut Oil is cold pressed, meaning it is extracted without the use of heat, which helps retain more nutrients. When a VCO is heated, its properties and composition can change. When coconut oil is heated, its smoke point decreases, and it can break down, releasing free fatty acids and potentially losing some of its nutritional value. heating VCO can cause a decrease in its antioxidant properties, which may affect its health benefits. (Morteza Asamani, 2020)

The chemical and physical properties of virgin coconut oil (VCO) can change when heated. Heating oil can change its chemical makeup, which may affect its flavor and nutritional quality. Coconut oil can change color, density, viscosity, specific gravity, and foam when heated repeatedly. It can also lose some of its unsaturated fatty acid content. (Dr. Althea, 2019). Furthermore, the color of the oil can be affected by the extraction process; for example, different extraction techniques can produce yellow coconut oil. Consequently, after heating, the variation in VCO can be attributed to its interaction with the surrounding conditions, temperature, and extraction procedure. (Your Glassy, 2017).

The natural discoloration process has nothing to do with the effectiveness of the oil. This organic and biological procedure reveals the superior quality of the oil. The temperature at which coconut oil changes from a white solid to a golden liquid can also affect the color of the oil. Heating, however, is known to change the chemical makeup of the oil, which can contribute to the color shift seen. (Dumancas,2016)

In conclusion, heating Virgin Coconut Oil can cause changes in its composition and properties, which can affect its nutritional value and health benefits. To preserve the nutritional value and properties of VCO, it is best to use it in cooking at a temperature below its smoke point and store it properly away from heat and light. (Dumancas,2016). The texture and smell of VCO are different after and before heating, but there is no variation in terms of nutrients. As a result, a white lotion can be produced using an unheated VCO. (Yan Jer Ng, 2021).

4.2 Fourier Transform Infrared Spectroscopy (FT-IR) for oil

The FTIR graph of the lab-used oil is displayed in Figure 4.2. The VCO's functional group is displayed on this graph. Two graphs show the oil both before and after heating. To find out which oil is purer in this VCO, FTIR testing should be performed. The graph of oil 1 is not heated, while oil 2 is after heating.

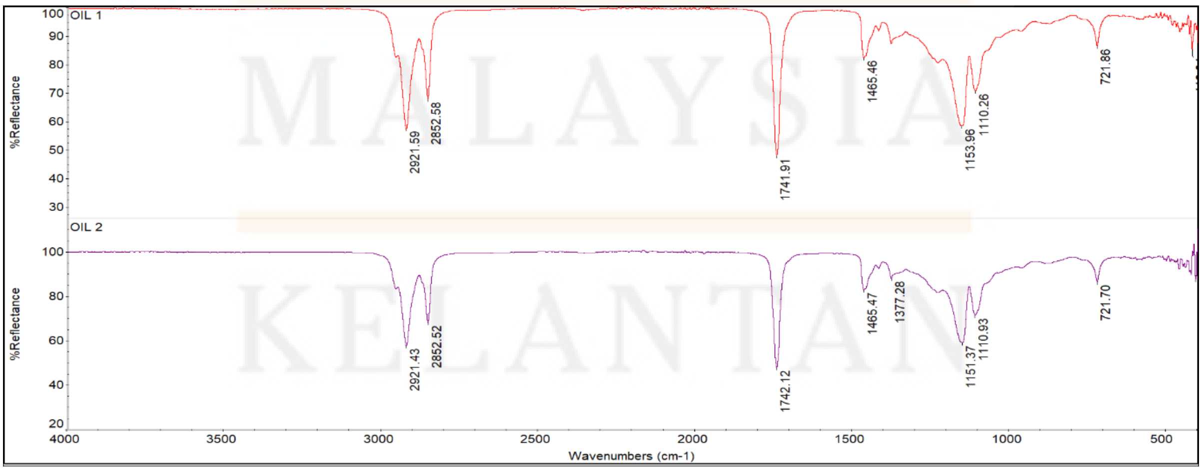


Figure 4.2: shows the graph of FTIR for oil

The FTIR function group for oil is displayed in Table 4.2. Alkane, hydroxyl, and carbonyl groups are among the functional groups that are frequently identified in oil spectra using Fourier transform infrared (FTIR) spectroscopy. Because it can concurrently detect various factors, such as water, glycol, oil oxidation, and specific additives, FTIR is a helpful instrument for oil analysis. This commonly used method in oil analysis labs is founded on the fundamentals of molecular spectroscopy. (Morteza Asemani, 2020).

Table 4.2: Function group of FTIR for oil

Functional group	Peaks (cm^{-1})	Compound name bond	Bond
Olefins (general)	1688.37 cm^{-1} 3001.66 cm^{-1}	Non-conjugated	CH str.
Aliphatic acetate esters	1042.34 cm^{-1} 1204.33 cm^{-1} 1719.23 cm^{-1}	Unsaturated Butyl acrylates	C=O stretch
Aliphatic hydrocarbon	1387.53 cm^{-1} 1467.14 cm^{-1} 2841.60 cm^{-1}	2-methyl hexane	$-CH_3$ and $-CH_2$

Oil analysis uses Fourier Transform Infrared Spectroscopy (FTIR) because it can produce important details about the chemical composition and functional groups in the oil. Based on the absorption of infrared light, FTIR can distinguish between certain functional groups in molecules. Oils contain the following functional groups: aliphatic hydrocarbons, olefins (general), and aliphatic acetate esters. (Morteza Asamani, 2020). Figure 2 displays the peaks in this functional category. Both oils contain the same functional groups. Olefins are unsaturated hydrocarbons with one or more carbon-carbon double bonds as their functional group. Olefins can be identified and measured using Fourier Transform Infrared (FTIR) spectroscopy for oil analysis because of their distinctive infrared absorption bands. The presence of olefins in the oil may indicate the degree of contamination or deterioration. (Azom, 2019). Other chemical properties of engine oil as well as kinetic changes in olefins can be examined using FTIR spectroscopy. 3001.66 cm and 1688.37 cm are the peaks of this functional group.

Aliphatic acetate ester functional groups were also present in this oil, peaking at 1042.34, 1204.33, and 1719.23. It is a common organic molecule found in oil. It can be identified through Fourier-transform infrared spectroscopy (FTIR) thanks to its distinct infrared absorption pattern. Acetate esters can be distinguished from each other because of their high wavenumber C-C-O stretching characteristics. (Azom, 2019). Additionally, esters can be identified by the intensity pattern of their characteristic C-C-O stretching peaks, where the third peak is somewhat less intense than the previous two. Furthermore, in the FTIR examination of oil, the term "aliphatic hydrocarbon" denotes a type of hydrocarbon with an open chain structure. Spectroscopic data obtained can be used to determine the presence and nature of aliphatic hydrocarbons in the context of FTIR analysis for oil. FTIR analysis can reveal the existence of alkanes with more carbon atoms as well as structural characteristics of aliphatic hydrocarbons including long, straight chains and the presence of methylene groups. Understanding the chemical makeup and structural characteristics of oil, as well as observing processes such as oil degradation and modifications to the chemical composition of engine oil, are all possible with the use of this knowledge. (Wright, 2015).

Therefore, FTIR is a powerful tool for analyzing the chemical composition and degradation of oil. It may offer important information about the existence of oxidation products and certain fuel components. This makes FTIR useful in oil analysis, especially when monitoring oil degradation. FTIR can also be used to evaluate certain components such as asphaltenes and describe crude oil. All things considered, FTIR analysis is a valuable technique in the field of oil analysis and condition monitoring as it helps to understand the chemical characteristics and degradation of oil. (Wright, 2015).

4.3. Gas Chromatography-Mass Spectrometry (GC-MS)

Figures 4.3 and 4.4 display the oil GCMS graphs 1 and 2. One of the most effective methods for determining the contents of oils, including essential and crude oils, is gas chromatography-mass spectrometry (GC-MS). Using mass spectrometry to identify and quantify the different components of the volatile chemicals in the oil, GC-MS generates a linear graph. The purity, quality, safety, and therapeutic uses of oils, as well as the identification of reliable essential oil suppliers, may all be learned by GC-MS analysis. GC-MS chromatogram examples for crude and essential oils. (New Direction Aromatics, 2020).

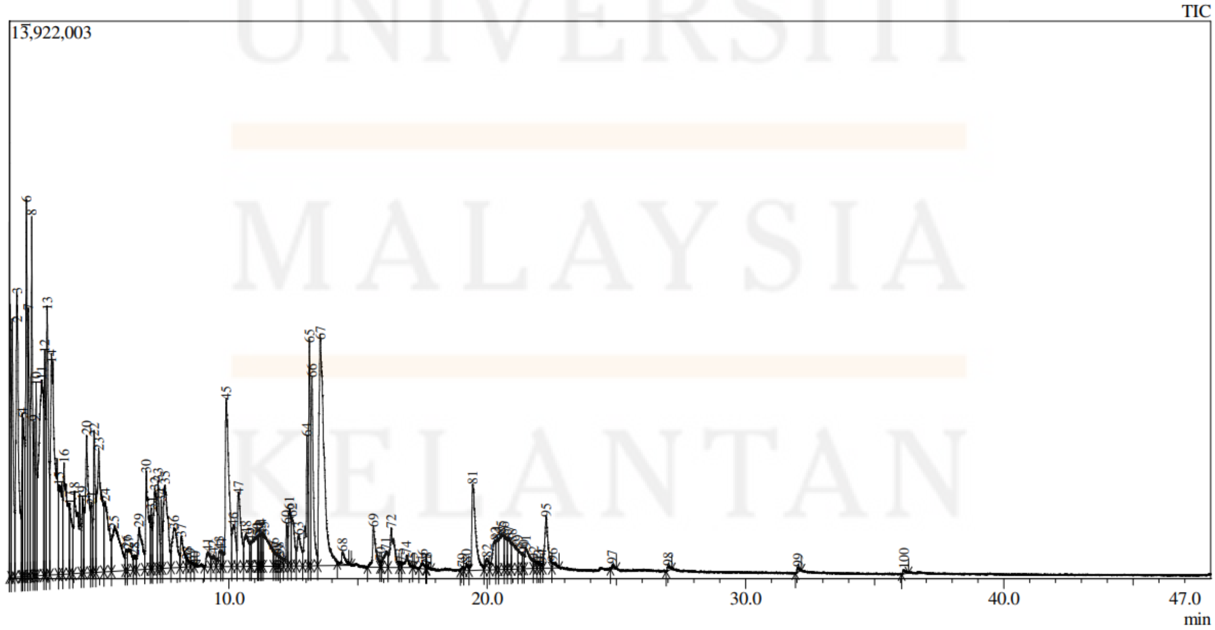


Figure 4.3: the graph 1 of GCMS for oil

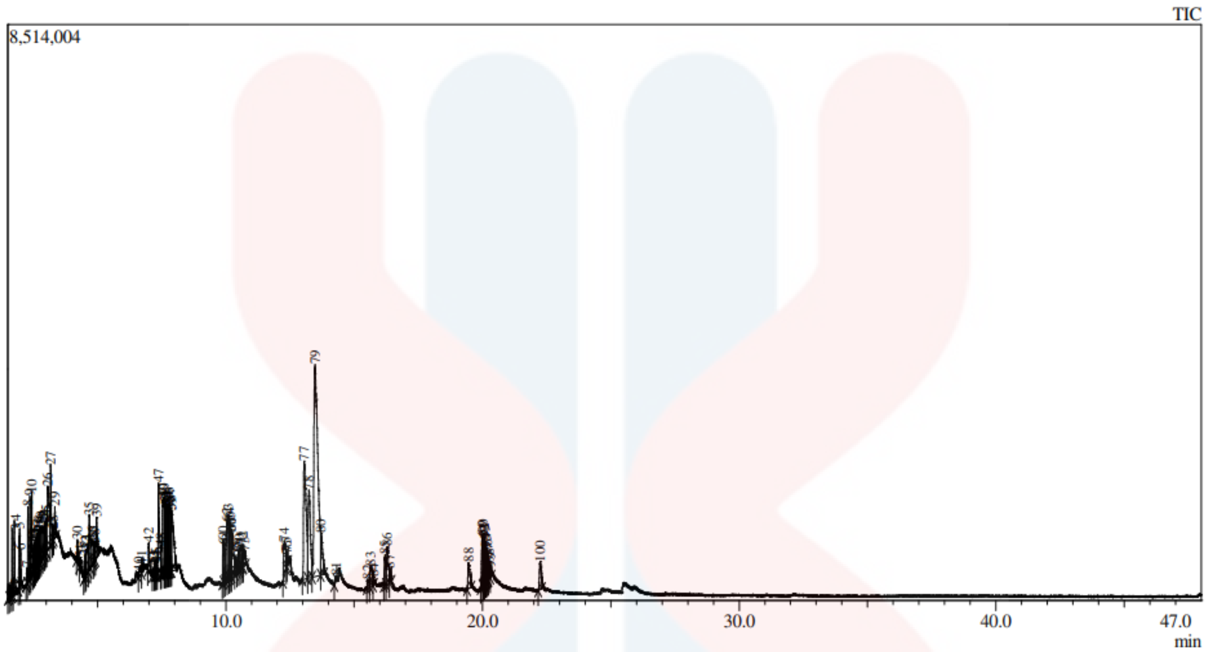
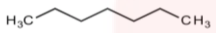
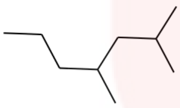
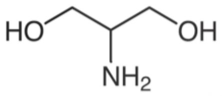
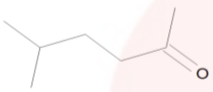
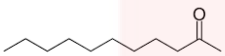
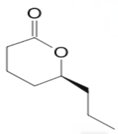
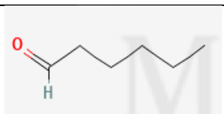
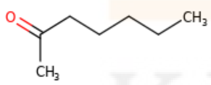
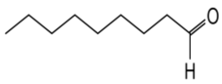
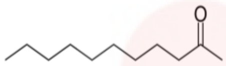
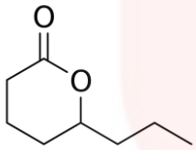


Figure 4.4: the graph 2 of GCMS for oil

Table 4.3 displays the oil GCMS components. Oil GC-MS tests detect the different components in the oil and provide a percentage breakdown of each component's presence. By breaking down the volatile chemicals in the oil into their component parts, GC-MS creates a linear graph that shows each component. GC-MS analysis may assist identify reputable essential oil suppliers and offer useful information about the medicinal uses, purity, quality, and safety of oils. (Figure 1, 2021).

Table 4.3: shows the component of GCMS for oil

Peak	Component	Name	Time, min	Area, %	Height, %
Graf 1					
3		Heptane	1.80	4.22	3.88
6		Heptane, 2,4-dimethyl- (CAS) 2,4-Dimethylhept	2.17	2.98	5.14
8		2-Amino-1,3-propanediol	2.38	2.97	4.85
13		2-Hexanone, 5-methyl-	2.97	2.85	3.59
65		2-UNDECANONE	13.13	1.95	3.05
67		2H-Pyran-2-one, tetrahydro-6-propyl- (CAS)	13.55	6.25	3.11
Graf 2					
10		Hexanal <n->	2.44	1.18	2.10
27		Heptan-2-one	3.17	1.46	2.02

47		Nonanal	7.38	2.73	2.29
77		2-UNDECANONE	13.05	6.37	2.96
79		Octalactone	13.47	17.04	5.31

Powerful separation methods such as gas chromatography (GC) are used in many scientific domains. The partitioning of analytes between the gas mobile phase and the static phase during the transport of volatile and semi-volatile analytes is the main mechanism by which separations in gas chromatography are achieved. Helium or hydrogen is the most frequently used mobile phase, also known as the carrier gas. The mass-to-charge ratio (m/z) of the ion produced by the analyte is measured using mass spectrometry (MS). (Fig.1, 2021) Ionization, dissociation, and detection are the three main processes in MS detection. Mass spectrometers receive analytes through an ionization source. In gas composition (GC) analysis, two types of ionization sources are used: chemical ionization (CI) and electron impact (EI), with ionization sources being more commonly used. (New Direction Aromtics, 2020).

There are many peaks in Graph 1. The heptane component is seen in the third peak in graph 1 which shows the rise. This peak occurs at the 4.22% location and 1.80 minutes. The heptene component, 2,4-dimethyl-(CAS) 2,4-dimethylhept, is present in the sixth highest peak of the graph, the largest among the others, at 2.17 minutes and an area of 2.98%. The height and width of the peaks in the chromatogram reveal the concentration of the corresponding compound. Higher concentrations are often indicated by higher peaks. The peak shape can reveal information about the effectiveness of the separation process and the existence of co-exfoliating materials. A well-resolved asymmetric peak is ideal for accurate identification and measurement. In addition, the components 2-Amino-1,3-propanediol and 2-Hexanone, 5-methyl at peaks 8 and 13 are present in virgin coconut oil. Additionally, peak 65 and peak 67 in Graph 1 are developing. This indicates the presence of 2-UNDECANONE and 2H-Pyran-2-one, tetrahydro-6-propyl (CAS), as constituents in the oil. there is this component between minutes 13.13 and 13.55. This illustrates the various components found in VCO oil.

The 79th peak, which is the highest with the others, is displayed in graph 2. The Octalactone component appears at minute 13.47 Peak 79. Higher concentrations are often indicated by higher peaks. The peak shape can reveal information about the effectiveness of the separation process and the existence of co-exfoliating materials. A well-resolved asymmetric peak is ideal for accurate identification and measurement. There are high peaks in graph 2 at 10, 27, 47, and 77. Hexane \n->, Heptane-2-one, Nonanal, and 2-UNDECANONE are the components found in the oil. This shows that the components used to make the lotion are of high quality. There is nothing odd about this oil that prevents it from being used to make lotions. These tests provide information about the quality, safety, purity, and possible uses of essential oils. This test shows that VCO Oil is safe and free of impurities (Termo, 2015).

In conclusion, GC separation procedures, MS ionization, and mass analysis all contribute to peak formation in GC-MS data. Specific chemicals in a sample can be identified and quantified by analyzing the peaks in the mass spectrum and chromatogram.

4.4 Lotion production from virgin coconut oil.

Table 4.4, shows the ingredients used in lotions and formulations. this material is used in producing VCO lotion. These ingredients will determine whether or not the lotion is suitable for use.

Table 4.4: Ingredients used in lotion and formulation

No	Ingredients	Formulation (%)					
		T1	T2	T3	T4	T5	T6
1	Virgin coconut oil	68	70	68	70	68	68
2	Aloe vera	4	8	8	10	-	-
3	Beeswax	14.5	12.4	11.2	9.2	10.3	10.3
4	Shea butter	9.5	5.6	8.8	6.8	10.8	-
5	Fragrance	4	4	4	4	-	-

Table 4.5, shows the texture of VCO lotion. The texture of Virgin Coconut Oil (VCO) lotion is usually smooth, light, and moisturizing. VCO contains fatty acids that can contribute to the elasticity and elasticity of the skin, making it an effective and safe moisturizer. Homemade coconut oil lotion is described as smooth, light, and non-greasy, with the ability to absorb quickly into the skin. (Leiva, 2020).

Table 4.5: shows the texture of lotion VCO

Sample	
T1 	T4 
T2 	T5 
T3 	T6 

A lotion is a topical application that usually consists of a solid solution in water. It is a composition that can be used with low to medium viscosity. The texture, stability, and effectiveness of lotions can all be improved with the use of additives. The lotion is made from virgin coconut oil (VCO) with added fragrance, beeswax, aloe vera, and shea butter. VCO and beeswax are the main ingredients used in the creation of the lotion. (Barnes, 2021). Additional components, such as aloe vera, these components help in maintaining skin hydration and prevent peeling and dryness. While emulsifiers help in the mixing of water and oil to produce a stable lotion. Agents known as thickening agents help increase the viscosity of the lotion, which increases its application and effectiveness. Other ingredients, such as fragrances, have medicinal properties in addition to emitting a pleasant smell. (Dr. Althea, 2019).

Components are used under the formulation; lotions like T1 consist of a combination of ingredients. The lotion on T1 is a little greasy and clumpy. This is because many viscous components, such as beeswax, are included during the manufacture of the lotion to give it a texture similar to Table 2. This lotion is not suitable for use. At T2, the creation of the lotion seems a little sticky and solid. This is the result of a combination of various chemicals, which explains why the texture in Table 2 looks like that. Also, the production of T3 and T4 lotions looks creamy and smooth thanks to the use of the right components. It is easy to use and has a gel-like appearance. in addition, additives can help in producing lotions that are creamy, smooth, and user-friendly. The production of lotion at T5 exhibits a slight viscosity due to the use of two components namely VCO and beeswax. This shows that even though only two components are needed to make a lotion, the texture is not suitable for use because it is viscous. T6 on the other hand looks quite watery because of the three ingredients it contains such as VCO, beeswax, and shea butter. This is because mixing heated shea butter with lotion will cause it to liquefy. It looks like a watery lotion and is not suitable to use. (Dr. Althea, 2019).

These lotions can also have different textures due to their composition, which can vary depending on the intended use and desired properties. For example, viscous and oily, while lotions are usually thin, moist, and non-greasy. Cream, on the other hand, contains a high oil content and is dense and thick. (Your Glossy, 2017). Additionally, lotions can be formulated with different ingredients, such as natural dye extracts, to provide specific benefits. Finally, the texture of the lotion can affect its effectiveness and user experience, so it is important to choose a product that meets the needs. The viscosity of the lotion can be affected by various factors, including its composition and the presence of thixotropic substances. Lotions are made up of various ingredients such as polymers, oils, waxes, gels, and silicones, which can dramatically change the viscosity of the product. (Leiva, 2020). Additionally, the concentration of ingredients can affect the viscosity of the lotion, with viscosities greater than and less than 30000 cP being classified as creams and lotions, respectively. Therefore, the viscosity of the lotion can vary based on the specific formulation. Therefore, these additives can help in producing this homemade lotion. It can also help improve the effectiveness of the lotion, making it more beneficial for the skin and helping to extend its lifespan. (Rini, 2020)

4.5 Viscosity lotion VCO

Table 4.6, shows the viscosity of the lotion. The viscosity of lotions, including Virgin Coconut Oil (VCO) lotions, can vary depending on the particular formulation. However, lotions containing VCO are generally described as having a smooth, light, and non-greasy texture, allowing for rapid absorption into the skin. (Aladin, 2018).

Table 4.6: shows the viscosity of the lotion

Sample	Viscosity (Pa·s)	Temperature (ºC)
T1	16.6	25.4
T2	16.9	25.9
T3	1.43	26.3
T4	2.91	26.3
T5	L	25.7
T6	1.58	25.1

T1 – T4 = VCO + beeswax + aloe vera + shea butter + fragrance

T5 = VCO + beeswax + shea butter

T6 = VCO + beeswax

The viscosity of any liquid ingredient has a significant effect on the texture, application, and overall effectiveness of the lotion. Different variables can affect a liquid's viscosity, which is a measure of its resistance to flow and can result in variations in lotion consistency. The viscosity of lotions varies for several main reasons, including formulation, temperature, and chemical interactions. (Aladin, 2018)

The viscosity of VCO lotion with additives is shown in Table 5. Because the proportion of ingredients in the lotion varies depending on the formulation, the viscosity of the lotion also varies. At 25 ºC, sample T1 and sample T2 exhibit relatively high viscosities of 16.6 and 16.9.

The sample with the greatest viscosity is T2. Samples T1 and T2 have high viscosity because the thickening material used is more than other materials. Furthermore, at 26.3 ^{O}C, sample T3 exhibits a very low viscosity of 1.43. This T3 sample has a lower viscosity, which increases lotion production. Sample T4 can be used as a lotion even though it has a viscosity of 2.91. this is the result of viscosity being the right amount of liquid and concentrate. It works well for making lotions. (Aladin, 2018). T3 and T4 can be used for lotion production. The T5 and T6 samples then feature a VCO combination plus a few extras. T5 exhibits a viscosity of 25.7 ^{O}C which cannot be measured using a viscosity machine because it contains a combination of VCO, beeswax, and shea butter. This is due to the very thin viscosity of the T5 mixture, which makes it impossible to read. T6, which is a mixture of beeswax and VCO, with a viscosity of 1.58 at 25 ^{O}C. Although the texture is not attractive, this combination can also be used to make a lotion. (Perry44, 2011).

Furthermore, the viscosity of a lotion is largely determined by its formulation. A complex mixture of oils, thickeners, emulsifiers, and different active ingredients make up lotions. The specific arrangement and concentration of these ingredients may affect the overall viscosity of the product. The stability of the oil, for example, is influenced by the type and quantity of emulsifiers used in the formulation, which determine the thickness and consistency of the lotion. Lotions usually contain thickening agents, such as gums or polymers, to help them achieve the correct viscosity. This ingredient makes the lotion more viscous, which makes it thicker and more stable. (Setyawati, 2018). There are significant variations in texture and taste between lotion formulas due to variations in thickener and concentration choices. Furthermore, one important aspect that affects the viscosity of lotions is temperature. The majority of lotions are made to work well and remain stable within a certain temperature range. Temperature changes have the potential to change the viscosity of the lotion, making it thicker or thinner. Certain materials may harden in cold temperatures, while emulsions may break down in heat and become more fluid in texture. As a result, changes in temperature and storage conditions may affect the viscosity of the lotion. (Perry44, 2011)

In addition, the viscosity of the lotion may change due to the interaction of the components. Certain additives may work together to increase the viscosity of the product, while other elements may work against each other to make the consistency thinner. (Aladin, 2018). The overall viscosity profile of a lotion is influenced by the complex interactions and chemical compatibility between oils, emulsifiers, and other additives. Furthermore, viscosity may be affected by the manufacturing process itself. The final texture of the lotion can be affected by the sequence and degree of mixing and blending of the components. Although manufacturers often use certain methods to guarantee a consistent and stable product, variances in the manufacturing process may cause viscosity variations between batches. (Darnes, 2021).

In conclusion, various factors, such as formulation, temperature, interactions between ingredients, manufacturing methods, and user preferences, affect the viscosity of lotions. Samples of T3 and T4 can be used to make lotions. The lotion has several benefits that can be used by the user.

4.6 Fourier Transform Infrared Spectroscopy (FT-IR) for lotion

Figures 4.5 and 4.6, show the FTIR graph for the lotion. The FTIR graph for a lotion will usually show characteristic peaks corresponding to the functional groups present in the formulation. This may include peaks associated with oils, emulsifiers, and other specialized ingredients. FTIR spectra can be used to identify and characterize these components in lotion formulations. (Rohman, 2012).

T1 – T4 = VCO + beeswax + aloe vera + shea butter + fragrance

T5 = VCO + beeswax + shea butter

T6 = VCO + beeswax

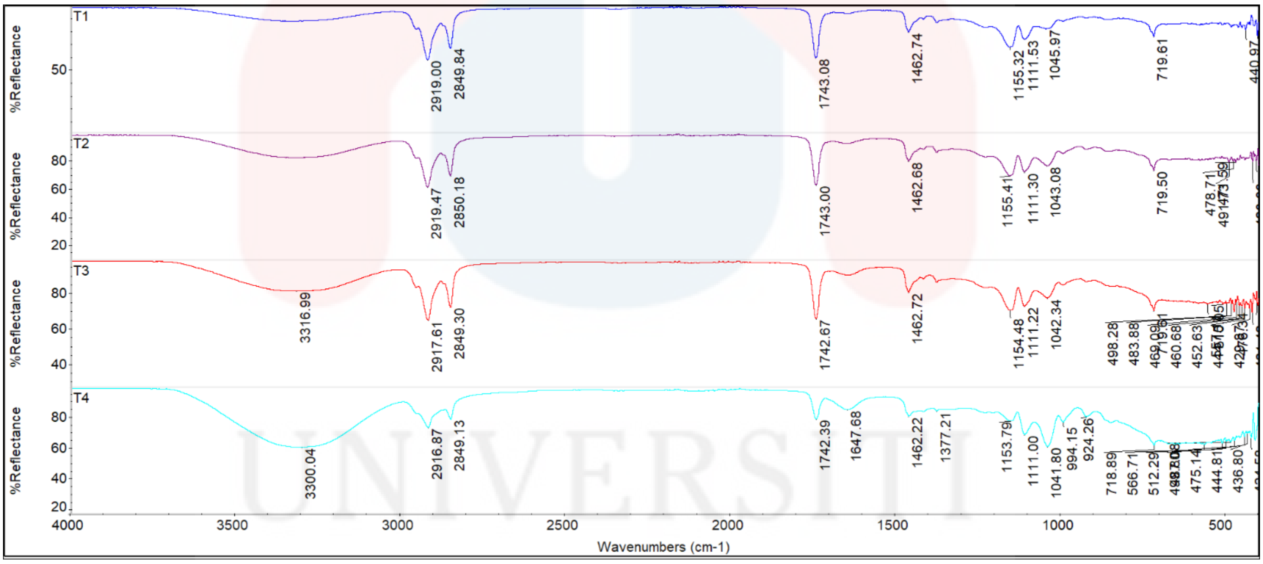


Figure 4.5: the graph of FTIR for lotion

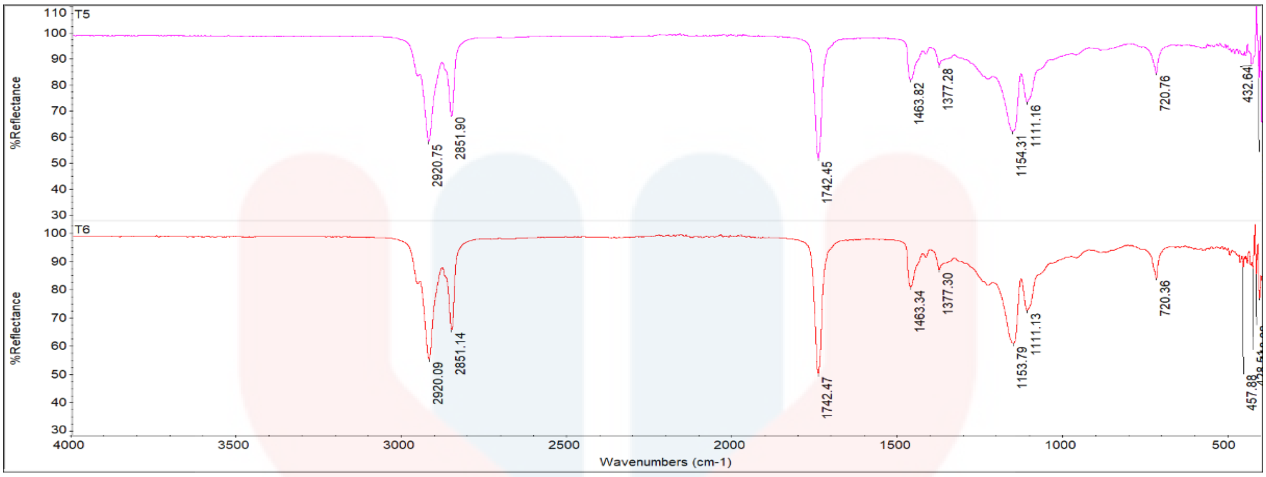


Figure 4.6: the graph of FTIR for lotion

Table 4.7, shows the FTIR functional groups for the lotion. Functional groups commonly found in Fourier transform infrared (FTIR) spectroscopy of lotion formulations include but are not limited to hydroxyl groups. FTIR is a valuable tool for characterizing the chemical composition of lotions, including the identification of specific functional groups present in the formulation. (Rohman, 2012)

Table 4.7: shows the functional group FTIR for lotion

Functional group	Peaks (cm^{-1})	Compound name bond	Bond
Olefins (general)	1688.37 cm^{-1} 3001.66 cm^{-1}	Non-conjugated	CH str.
Aliphatic acetate esters	1042.34 cm^{-1} 1204.33 cm^{-1} 1719.23 cm^{-1}	Unsaturated Butyl acrylates	C=O stretch

Aliphatic hydrocarbons	1387.53 cm^{-1} 1467.14 cm^{-1} 2841.60 cm^{-1}	2-methyl hexane	$-CH_3$ and $-CH_2$
Primary aliphatic alcohols	1073.19 cm^{-1} 3597.55 cm^{-1}	Primary alcohols Phenols	-OH
Inorganic phosphates	1001.84 cm^{-1} 1098.26 cm^{-1} 2602.47 cm^{-1}	Potassium phosphate	CH

For lotions, Fourier transform infrared (FTIR) spectroscopy is used to examine and describe the different ingredients included in the mixture. It is frequently used for the quantitative study of various substances, such as oils, fats, and other components found in cosmetic treatments. (Endang, 2012). Combining FTIR spectroscopy with chemometrics has made it possible to analyze the composition of cosmetics quickly and non-destructively, enabling the identification and measurement of specific components. Table 7 displays the functional groups for VCO lotion. Olefin, a type of hydrocarbon molecule included in lotion, is the first functional group. Lotions containing olefins can be identified using Fourier transform infrared (FTIR) spectroscopy. (Rohman,2012). It is at its highest point 3001.66 cm and 1688.37 cm.

Fourier transform infrared spectroscopy (FTIR) is a useful tool for detecting chemical molecules known as functional groups for alpha-hydrocarbons, which are often found in cosmetic products such as lotions. Based on their molecular structure, various chemicals contained in the sample can be identified using FTIR spectroscopy. Among other substances, methyl parabens, silicates, and aliphatic hydrocarbons have been found in the lotion using FTIR spectroscopy. Lotions and other cosmetic products have been shown to contain aliphatic hydrocarbons in several investigations using FTIR spectroscopy. This method is useful for verifying the safety and quality of the product by checking the contents of the lotion. (Endang, 2012).

Furthermore, chemicals called aliphatic acetate esters, found in oils, are often used in lotions and cosmetics. They are often added because of their various qualities and fragrant smell. These esters can be identified and examined using FTIR (Fourier Transform Infrared) spectroscopy because of their distinctive infrared absorption patterns. When determining and describing the chemical makeup of beauty products including whether or not aliphatic acetate esters are present, FTIR spectroscopy is a useful tool. (Wright. 2015). This technique enables quality assurance and control in the creation of cosmetic formulations by analyzing the molecular structure of the different ingredients present in the lotion. (Morteza Asemani, 2020).

The primary aliphatic alcohol functional group in this lotion has peaked at 1387.53 cm and 3597.55 cm. Using this method, it is possible to determine whether lotions or other cosmetic items include aliphatic alcohols by looking for the distinctive infrared absorption bands associated with these substances. FTIR spectroscopy has been used to identify aliphatic hydrocarbons and other chemical components in cosmetic products. For this reason, the qualitative examination of primary aliphatic alcohols in lotions and other cosmetic compositions may benefit greatly from the use of FTIR spectroscopy. (Azom, 2019). Furthermore, in the context of Fourier transform infrared spectroscopy (FTIR) for lotion formulations, "inorganic phosphate" refers to the existence of phosphate molecules in the lotion that can be examined. A method known as FTIR spectroscopy is used in cosmetic formulations to analyze some ingredients, including phosphates, qualitatively and quantitatively. (Perry44, 2011). Lotions are among the most frequently evaluated and formulated cosmetic products using FTIR analysis, which is useful for identifying and characterizing the presence of inorganic phosphates. This analytical technique aids in the creation and quality control of cosmetic formulations by enabling the identification and measurement of certain chemicals, such as inorganic phosphates. (Wright, 2015)

Analyzing cosmetic lotions, including the detection and quantification of inorganic phosphates, is a well-established technique. FTIR spectroscopy enables the identification and characterization of various components present in cosmetic formulations, contributing to the quality control and development of these products. (Azom, 2019). This technique is widely used for the quantitative analysis of different compounds, including fats, oils, and other substances in cosmetic lotions. The combination of FTIR spectroscopy with chemometrics has been optimized for rapid and non-destructive analysis of cosmetic formulations, allowing the differentiation of various components and the evaluation of their concentrations in lotions. (Endang, 2012).

Chapter 5

5.0 CONCLUSIONS AND RECOMMENDATION

5.1 Conclusions

The results of this study are used to make lotion using virgin coconut oil. Virgin coconut oil provides various advantages and unique qualities. Virgin coconut oil can be used to make lotions with special qualities and possible advantages for the user. Virgin coconut oil has long been recognized for its inherent moisturizing qualities. It can help moisturize the skin and make it feel smooth and supple when used as the main component in lotions. The production of lotion that is suitable for use is T4. This is because the texture of this lotion is not too liquid and not too thick, it is suitable for the user. Coconut oil is a powerful moisturizer due to its emollient qualities, which are a result of the fatty acids it contains. Virgin coconut oil also includes antioxidants, which may provide skin protection. By fighting free radicals, these antioxidants can reduce the appearance of aging and improve the overall health of the skin. The lotion recipe contains virgin coconut oil, which increases the likelihood of this antioxidant action. Specific formulations, thickeners of choice, and manufacturing temperature are just some of the variables that may affect the texture and consistency of lotions made with virgin coconut oil. on T4 the production of lotion that becomes In addition, virgin coconut oil adds a distinct and pleasant scent. Lotions that contain natural aromas can have a pleasant aroma in addition to nourishing the skin. This can have a positive sensory effect. It is important to remember that certain people may be allergic to certain smells, so the concentration used should be taken into account. Virgin coconut oil can be adjusted according to individual taste. Essential oils and other natural extracts are examples of additional components that can be added to lotions to tailor them for specific skin types or to create specific scents. The essential fatty acids, vitamins and minerals found in virgin coconut oil can help nourish the skin. Lotions containing coconut oil can help keep your skin healthy by providing it with nutrients that promote softness and moisture. In conclusion, using virgin coconut oil to make lotion is a healthy and natural way to take care of your skin. While creating a robust emulsion can be difficult, this ingredient has moisturizing, antioxidant and sensory properties that make it a valuable addition to anyone looking for a healthy, customizable skin care product. Lotions that take advantage of the properties of virgin coconut oil and feel wonderful on the skin can be created with careful formulation and consideration for personal preference. This T4 lotion is suitable for users because its properties do not change and the production becomes.

5.2 Recommendations

Considering the rising demand for eco-friendly and natural skincare products. Ethical and environmentally friendly sources of raw materials, such as coconut oil. Products can become more appealing to consumers who care about the environment by emphasizing socially and ecologically responsible production methods. There is a growing trend among consumers to seek products with clear and concise ingredient labels. Make lotions without needless additives or preservatives by using just pure components. To gain the trust of knowledgeable customers, clearly define each ingredient's purpose. Includes functional compounds or adaptogenic herbs with a reputation for improving skin. For instance, components like calendula, green tea extract, or turmeric can enhance the skin's moisturizing properties and provide further advantages. Make an effort to inform consumers about the advantages of VCO and the scientific basis for its development. By offering tools and information on the effects of products on skin health, you can empower consumers to make knowledgeable decisions about their skincare. Consult a dermatologist, esthetician, or other health professional for professional advice and assistance. This can boost the product's legitimacy and offer insightful information to enhance the composition in light of expert advice. The possibility of personalized lotions, enables customers to fit the product to their skin type. A wide range of users can be served by providing versions for various skin types, problems, or personal preferences. Seek professional guidance; this lotion is skin-safe. To address the changing requirements and expectations of consumers, VCO lotions can take a comprehensive strategy that extends beyond skincare benefits and includes sustainability, customization, education, and innovation. Lotion made from virgin coconut oil not only capitalizes on the health advantages but also offers the customer a fun and efficient skincare experience. In addition, provide detailed usage and storage directions if you want to sell or distribute the lotion. Inform customers of the product's inherent features, such as its propensity to crystallize in colder climates. It can inform consumers of this VCO lotion's advantages.

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APPENDIX A

Peak Report TIC

Peak#	R.Time	Area	Area%	Height	Height%	Mark	Name
1	1.521	24036136	1.87	10414068	5.71		Pentanal, 2,3-dimethyl-
2	1.616	31827032	2.48	6388161	3.50	V	Hexanal, 2-ethyl-
3	1.799	54225895	4.22	7083582	3.88	V	Heptane
4	2.014	9744730	0.76	4029216	2.21	V	Oxazolidine, 4,4-dimethyl-
5	2.048	17916699	1.39	3954437	2.17	V	1-Butanol, 3-methyl- (impure) (CAS) 3-Methy
6	2.170	38271690	2.98	9375701	5.14	V	Heptane, 2,4-dimethyl- (CAS) 2,4-Dimethylhe
7	2.240	29950244	2.33	6666751	3.65	V	Hexanal
8	2.377	38155402	2.97	8841412	4.85	V	2-Amino-1,3-propanediol
9	2.469	12158374	0.95	3784131	2.07	V	Hexanal (CAS) n-Hexanal
10	2.546	15369222	1.20	4714035	2.58	V	PROPIONIC ACID
11	2.763	59934268	4.67	4852812	2.66	V	Butyraldehyde, semicarbazone (CAS)
12	2.884	24696310	1.92	5447381	2.99	V	Butanoic acid (CAS) n-Butyric acid
13	2.974	36656519	2.85	6541430	3.59	V	2-Hexanone, 5-methyl-
14	3.141	70374760	5.48	5460801	2.99	V	Heptanoic acid (CAS) Heptoic acid
15	3.438	21446134	1.67	2196832	1.20	V	Nonanal <n->
16	3.628	30376090	2.36	2698559	1.48	V	Pentanoic acid
17	3.858	11831591	0.92	1727241	0.95	V	2-octenoic acid
18	4.028	28389215	2.21	2010976	1.10	V	Hept-(2E)-enal
19	4.348	9402377	0.73	1852033	1.02	V	4-Dodecene, (E)-
20	4.502	33425509	2.60	3393286	1.86	V	2,3,7-TRIMETHYLOCTANAL
21	4.688	8031483	0.63	1721468	0.94	V	2-Octanone
22	4.792	16603165	1.29	3433133	1.88	V	4-Piperidinemethanamine
23	4.973	38701200	3.01	3010857	1.65	V	1-DEUTERIO-TRANS-1,2-DIHYDROXY-C'
24	5.215	22147058	1.72	1712939	0.94	V	OCTANAL
25	5.572	23990545	1.87	1081923	0.59	V	Heptanoic acid <n->
26	6.047	2595081	0.20	524197	0.29	V	1-(5-Ethyl-tetrahydrofuran-2-yl)-3,3-dimethyl-
27	6.128	5775383	0.45	524557	0.29	V	2,2,9,9-D4-NONADECANONE
28	6.350	2433474	0.19	375552	0.21	V	2-[13C]-CYCLOHEXA-2-EN-1-OL
29	6.536	12519606	0.97	1042078	0.57	V	Cyclopropane, octyl-
30	6.815	19278230	1.50	2402348	1.32	V	Heptane, 2,4-dimethyl-
31	6.998	5929317	0.46	1501480	0.82	V	2-Nonanone (CAS) Methyl heptyl ketone
32	7.144	17052456	1.33	1959803	1.07	V	4,6-Dimethylheptan-2-one
33	7.268	10120110	0.79	2176224	1.19	V	Nonanal (CAS) n-Nonanal
34	7.390	6377894	0.50	1688025	0.93	V	Nonanal
35	7.537	24501560	1.91	2049566	1.12	V	NONANAL
36	7.900	13939086	1.09	962546	0.53	V	Nonanal
37	8.168	6740085	0.52	753957	0.41	V	2H-Pyran-2-one, tetrahydro-6-methyl-
38	8.378	1618583	0.13	214019	0.12	V	SILANE, TRIMETHYL-1-PROPENYL-, CIS,
39	8.528	638033	0.05	124774	0.07	V	cis-1,4-Cyclohexanediamine, N,N'-diacetyl
40	8.698	120070	0.01	38871	0.02	V	Oxirane, 2,2'-(1,4-butanediyl)bis-
41	9.188	3597142	0.28	365132	0.20		TRANS-2-TRIDECENAL
42	9.408	2715930	0.21	277903	0.15	V	Heptalactone <gamma->
43	9.646	2872445	0.22	383639	0.21	V	Heptalactone <gamma->
44	9.711	1894148	0.15	379582	0.21	V	4-Undecanone
45	9.910	40819882	3.18	4170894	2.29	V	2-Decanone
46	10.189	9724469	0.76	1028418	0.56	V	Methyl octyl ketone
47	10.376	16982103	1.32	1810435	0.99	V	N-DECANAL
48	10.685	9999771	0.78	784236	0.43	V	Cyclodecanol
49	10.858	2134006	0.17	609325	0.33	V	CYCLOHEXANEACETIC ACID
50	11.098	9363482	0.73	750603	0.41	V	2,4-Dimethylpentan-3-yl isobutyl carbonate
51	11.118	1813479	0.14	763059	0.42	V	9-Octadecenoic acid (Z)- (CAS) Oleic acid
52	11.207	3714769	0.29	806765	0.44	V	2,5-Pyrrolidione, N-[2-(thienyl)acetyloxy]-
53	11.248	1416264	0.11	790517	0.43	V	1-(1-PROPENYLTHIO)PROPANE
54	11.277	3328366	0.26	829793	0.45	V	Cyclohexanone, 4-hydroxy- (CAS) 4-Hydroxy
55	11.368	14219740	1.11	776214	0.43	V	Emylcamate
56	11.748	1984497	0.15	400948	0.22	V	Succinic acid, 2-ethylhexyl hept-1,6-dien-4-yl
57	11.848	1341868	0.10	308685	0.17	V	GERANIAL DIETHYL ACETAL
58	11.948	1005938	0.08	250698	0.14	V	2-Isopropoxyethyl propionate
59	11.988	1603319	0.12	244755	0.13	V	3-((1,1-Dimethylethyl)-thio)-1-propene
60	12.239	5103064	0.40	1051810	0.58	V	2-Decenal, (E)- (CAS) trans-2-Decenal
61	12.350	9222327	0.72	1401344	0.77	V	Dec-(2E)-enal
62	12.448	9748262	0.76	1190857	0.65	V	cis-2-Ethylcyclopentanecarboxaldehyde
63	12.704	8333420	0.65	751991	0.41	V	2(3H)-Furanone, 5-butyldihydro-
64	13.033	17406817	1.36	3205791	1.76	V	2-Undecanone
65	13.126	25085416	1.95	5564252	3.05	V	2-UNDECANONE
66	13.223	28080196	2.19	4645203	2.55	V	2-Undecanone
67	13.546	80246257	6.25	5680597	3.11	SV	2H-Pyran-2-one, tetrahydro-6-propyl- (CAS) .
68	14.407	2469790	0.19	301298	0.17	T	2,4-Decadienal
69	15.602	9043029	0.70	998875	0.55		Undec-(2E)-enal
70	15.858	601422	0.05	148640	0.08	V	Hex-5-enoic acid, ethyl ester
71	16.087	4355903	0.34	400178	0.22	V	Sulfurous acid, hexyl undecyl ester
72	16.294	11428027	0.89	967281	0.53	V	ETHYL CAPRATE
73	16.628	667023	0.05	131358	0.07	V	Azelaic acid
74	16.881	3043299	0.24	301169	0.17	V	Tetradecanal
75	17.128	73340	0.01	37556	0.02	V	3-Heptanol, 3,6-dimethyl-
76	17.500	1192273	0.09	125057	0.07		.delta.-nonalactone
77	17.638	122516	0.01	64646	0.04	V	Butyrate <2-ethyl-, allyl->
78	17.678	341312	0.03	75202	0.04	V	Pentanoic acid, 5-methoxy-, methyl ester
79	19.051	486672	0.04	92018	0.05		1,7-Octadien-3-ol, 2,6-dimethyl-
80	19.202	1237075	0.10	172005	0.09	V	DECANE, 2,3,5,8-TETRAMETHYL-
81	19.449	21888466	1.70	2132123	1.17	SV	2-Tridecanone
82	19.995	2495600	0.19	280640	0.15	V	Tridecanal
83	20.328	6621941	0.52	722444	0.40	V	9-Oxabicyclo[3.3.1]nonan-2-ol, 5-methoxy-, e
84	20.398	4889206	0.38	773093	0.42	V	Dec-(2E)-enoate <ethyl->
85	20.560	10392661	0.81	883712	0.48	V	2H-Pyran-2-one, 6-heptyltetrahydro- (CAS) .I
86	20.668	6096732	0.47	822993	0.45	V	2,2,9,9-D4-NONADECANONE
87	20.828	6425198	0.50	760735	0.42	V	4-Nonanone, 7-ethyl-
88	20.958	8780303	0.68	660639	0.36	V	Ethanone, 1-(2,2-dimethylcyclopentyl)- (CAS)
89	21.208	3922576	0.31	489592	0.27	V	1,4-Dioxaspiro[4.5]decane, 8-methoxy-
90	21.408	1717369	0.13	367035	0.20	V	2H-Pyran-2-one, tetrahydro-6-pentyl-
91	21.506	6793707	0.53	518808	0.28	V	Dodecanoic acid
92	21.808	1565931	0.12	212512	0.12	V	Azacyclodecan-5-ol
93	21.988	950257	0.07	144721	0.08	V	1-(.beta.-d-Arabinofuranosyl)-4-difluorometh y
94	22.108	580263	0.05	107117	0.06	V	2,7-OCTADIENE, 1-METHOXY-
95	22.291	11402672	0.89	1274306	0.70	V	Dodecanoate <ethyl->
96	22.538	1224908	0.10	133037	0.07	V	1,3,5-Triazine-2,4-diamine, 6-chloro-N-ethyl-
97	24.851	570037	0.04	104856	0.06	V	Dibutyl adipate
98	27.002	754878	0.06	111072	0.06		Tetradecanoic acid
99	32.026	648493	0.05	107239	0.06		PALMITIC ACID
100	36.138	683009	0.05	89705	0.05		(E)-9-Octadecenoic acid ethyl ester
		1284523881	100.00	182466270	100.00		

Figure A: shows the result GCMS for oil

APPENDIX B

Figure B: Shows the cooled oil

APPENDIX C

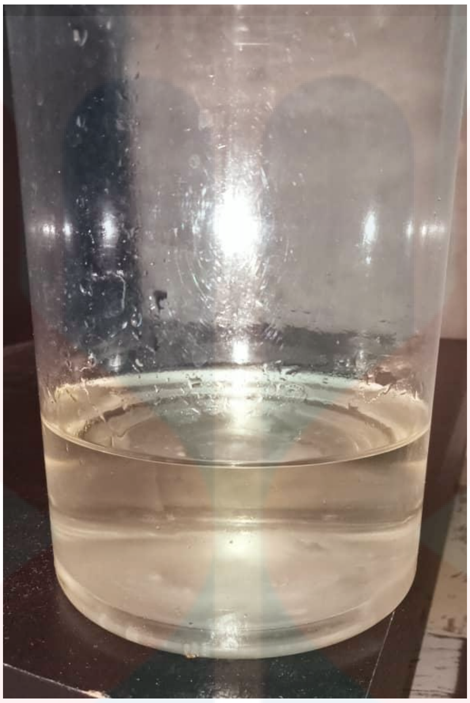

Figure C: Shows the room temperature oil

APPENDIX D

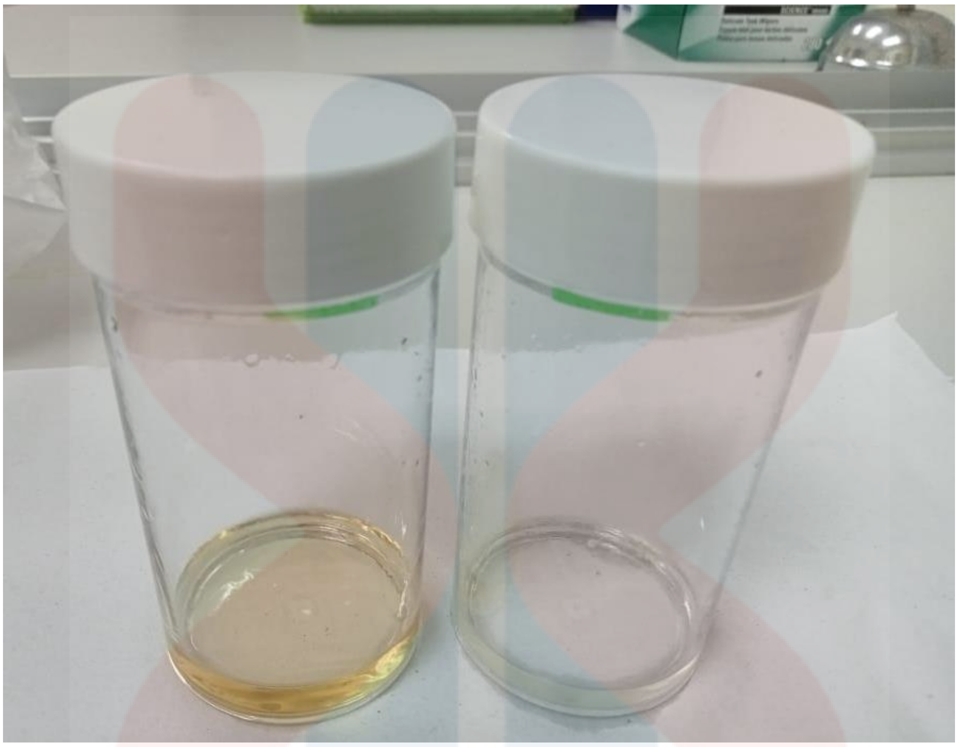

Figure D: the texture oil before and after heated.