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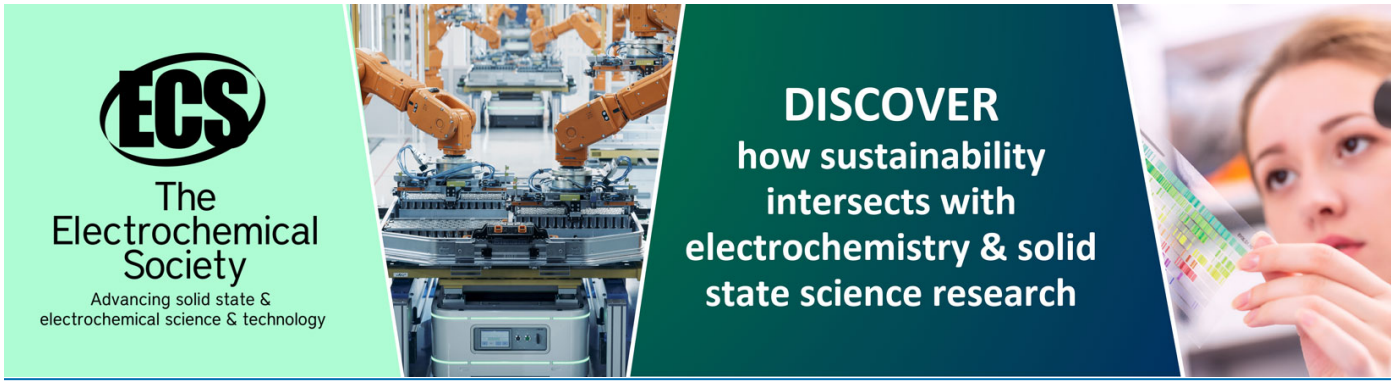

Comparison of Virgin Coconut Oil (VCO) quality with fermentation and centrifugation methods from genjah and hybrid variety of coconut based on Indonesian local environment resources

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Abstract. VCO is one of the processed products made from old coconut which is obtained by extracting the flesh of fruit. VCO has many advantages compared to other oils and many ingredients beneficial for the health of body and coconut always sustainability. This study, the manufacture of VCO using method of fermentation and centrifugation. The material used is fresh old coconut which consists of 2 varieties, from Indonesian local environment resources (namely genjah coconut variey Serdang Bedagai Regency and hybrid variety from Asahan Regency). This study to compare the quality of VCO with fermentation and centrifugation methods of genjah and hybrid varieties of coconut through analysis of water content, free fatty acid peroxide number and iodine number. The results obtained are the manufacture of VCO by centrifugation method has a better quality than fermentation method. Data analysis of VCO quality testing with centrifugation method has met SNI including water content, free fatty acid, peroxide number and iodine number. While the VCO with the fermentation method, in testing the water content and free fatty acids there are those that do not meet SNI but still meet APCC standards. Based on coconut varieties, hybrid VCO varieties have better quality than genjah maturing varieties.

1. Introduction

Coconut (*Cocos nucifera*) is a plant from the *Palmae* family which is often called the tree of life, because all parts of the tree can be used for human needs. According to [1], coconut is a commodity that has potential and plays an important role in the national economy. In addition, Indonesia also has a large coconut plantation area compared to other plantation commodities. One of the processed coconut products that is popular among the public lately is VCO. Virgin Coconut Oil (VCO) is a type of processed product made from old coconut through the extraction process of coconut flesh without heat treatment or chemical purification.

The high content of Medium Chain Fatty Acid (MCFA) which is around 52-68% with lauric acid of 45-55% causes VCO to be superior to other oils. This is because the content of Medium Chain Fatty Acid (MCFA) has a very fast metabolic ability in the body through pancreatic lipase reactions which are hydrolyzed quickly and completely compared to other types of fat [2].

In addition to increasing the body's metabolism, the content of medium-chain fatty acids can reduce cholesterol in the blood and can overcome the problem of overweight or obesity [3]. The dominant fatty acid contained in VCO is lauric acid. The lauric acid content is converted into monolaurin which acts as

an antibacterial, antiviral and antiprotozoal compound [4].

The main components in VCO are about 90% saturated fatty acids and 10% unsaturated fatty acids. Virgin coconut oil has higher phenolic content and antioxidant activity compared to other oils [5]. The content of active compounds and VCO such as flavonoids, saponins and alkaloids can increase antioxidant activity and optimize its health benefits. The content of flavonoid compounds also functions as an antibacterial so that it can be a natural preservative in VCO. The presence of tocopherol/vitamin E as an antioxidant can maintain the distinctive aroma of the oil, prevent rancidity and maintain the stability of the oil. Factors that usually cause rancidity in oil are oxygen, water and the presence of microbial contamination. Virgin coconut oil also has a high antioxidant content, namely a-tocopherol and polyphenols [6].

According to [7], the physical properties of VCO oil are liquid, clear in color, with a characteristic coconut aroma, and insoluble in water but soluble in alcohol. Meanwhile, the chemical characteristics of VCO are specific gravity 0.883 at 20 ^{0}C, pH value below 7, melting point 20-25 ^{0}C, boiling point 225 ^{0}C and vapor density 6.91. In connection with the many benefits of VCO for body health, more and more people are interested in consuming it, especially in this covid-19 pandemic situation. This is because VCO has the potential as a functional food product that has many benefits for the body, including as an antiviral and increasing the immunity of the human body.

The process or method of processing is one of the main factors that determine the quality of the oil so that it still meets SNI [8]. According to [9] also stated that the different methods of making VCO will produce different quality/quality of oil. There are several methods of VCO extraction there are several types, namely fermentation, inducement, cold extraction, heating and centrifugation. One method that is often used is fermentation because it is practical, cost-effective and the processing is simple. This method produces enzymes and acids that cause the coconut milk emulsion protein to coagulate and hydrolysis of fat globules to produce oil [4]. The centrifugation method is a method of making VCO by breaking the bonds between fat and protein contained in coconut milk with a mechanical rotation of the centrifuge machine until separation occurs due to differences in specific gravity [1]. This method is more time efficient and practical but requires a fairly high cost and is usually used by VCO producers for large production.

The coconuts used in this study were genjah varieties of coconut from Serdang Bedagai Regency and hybrid varieties from Asahan Regency. These two areas are coconut producing areas in the province of North Sumatra. The purpose of this study was to compare the quality of VCO with centrifugation and fermentation methods on 2 coconut varieties, namely hybrid and genjah. VCO will be analyzed by testing water content, free fatty acids, peroxide number and iodine number.

2. Materials and methods

The research material is fresh old coconut of the Genjah variety (Serdang Bedagai Regency) and the Hybrid variety (Asahan Regency), North Sumatra. The process of making VCO by mixing grated coconut flesh with water in a ratio of 1: 1.5 and left for 2 hours. After that, 2 layers are formed, namely the skim layer and the coconut cream layer until coconut cream is obtained. The coconut cream layer was divided into two treatments, namely for fermentation and centrifugation methods. The fermentation method was made by adding 0.4% yeast Shaccharomyces cereviceae into coconut cream and fermented for 24 hours [10]. Centrifugation method by inserting coconut cream into a centrifuge tube and setting the speed to 10,000 rpm for 20 minutes [1]. From both methods will form a layer of oil, water and coconut presscake and VCO which we want is on the top layer. VCO is filtered with cotton to obtain a clearer VCO. VCO is then stored in a container (bottle with a tight lid). The VCO was then analyzed for water content [11], free fatty acids, peroxide number and iodine number [12] for 3 replications to minimize experimental error.

2.1 Water Content

The water content test was analyzed using the oven method, where 5 g (a) of the material was weighed into an aluminum dish that had been dried and weighed. The material was put in an oven at 105 ^{0}C for

3 hours, then cooled in a desiccator for 15 minutes. After that, the sample was weighed and this treatment was repeated until the weight was constant (b). Calculation of water content is calculated by the following formula.

$$Water\ content = \frac{a-b}{B} x\ 100\% \quad (1)$$

2.2 Free Fatty Acid

The free fatty acid test was analyzed by weighing 30 grams of material into an erlenmeyer. Add 50 ml of hot neutral alcohol to an Erlenmeyer and 2 ml of phenolphthalein indicator. Next, the sample was titrated with 0.1 N NaOH solution until it turned pink. The end point of the titration is reached when the pink color does not disappear for 30 seconds. Calculation of free fatty acid levels can be calculated by the following formula.

$$Free\ fatty\ acid = \frac{ml\ NaoH\ x\ N\ x\ b}{a\ x\ 1000} x\ 100\% \quad (2)$$

Description:
N = normality of sodium hydroxide solution used
a = weight of the sample (g)
b = lauric acid molecular weight (g)

2.3 Peroxide Number

The peroxide value test was analyzed by weighing 5 g of material into an erlenmeyer. Add 10 ml of chloroform and 20 ml of acetic acid and shake until the material dissolves. After that, 0.5 ml of saturated KI solution was added and allowed to stand for 1 minute (dark room) and added 30 ml of distilled water. Next, the titration was carried out with 0.1 N $Na_2S_2O_3$ until the yellow color almost disappeared. Then 0.5 ml of 0.1% starch solution was added and titrated again until the blue color disappeared. The peroxide value is expressed in milli-equivalents of the peroxide in every 1000 g of the sample. The calculation of the peroxide number test can be calculated by the following formula.

$$Peroxide\ number = \frac{ml\ Na2S2O3\ x\ N}{a\ x\ 1000} x\ 100\% \quad (3)$$

Description:
N = normality of sodium thiosulfate solution used
a = weight of the sample (g)
b= lauric acid molecular weight (g)

2.4 Iodine Number

Determination of the iodine number as much as 1 g of VCO was put into a 500 ml erlenmeyer, added as much as 15 ml of solvent (cyclohexane: acetic acid in a ratio of 1: 1), added 25 ml of wijs solution. After 1-2 hours left in the dark room, added 20% KI solution and 100 ml of distilled water. Starch solution is added as an indicator and 0.1 N $Na_2S_2O_3$ solution is titrated with an indicator in the form of a solution. The calculation of the iodine number test can be calculated by the following formula.

$$Iod\ number = (V1 - V2)\ x\ N\ x\ \frac{12.69}{m} \quad (4)$$

Description:
N = normality of 0.1 N . sodium thiosulfate standard solution
V_1 = volume of 0.1 N thio solution used for blank titration (ml)
V_2 = volume of 0.1 N thio solution used for sample titration (ml)
m = sample weight (g)

3. Results and discussion

Virgin Coconut Oil is one of the processed products from agricultural commodities that are abundant in

Indonesia. Virgin Coconut Oil (VCO) can be used for food, cosmetics and other industrial needs. In addition, there are also processed non-food products from coconut commodities, namely animal feed and biodiesel as an environmentally friendly fuel to replace diesel fuel. The use of VCO for food products such as shortening substitutes and butter in the manufacture of bakery products will ensure sustainability in the future, because coconut raw materials for making VCO are always available, because Indonesian regions grow a lot of coconuts, so it is hoped that raw materials will always be sustainable

Based on research conducted on VCO with fermentation and centrifugation methods on the quality of VCO by testing water content, free fatty acids, peroxide number and iodine number. According to SNI 7381:2008, quality virgin coconut oil must meet the following requirements:

Table 1. VCO quality requirements based on SNI [13].

Test	Requirements
Water content (%)	Max. 0.2
Free fatty acids (%)	Max. 0.2
Peroxide number (meq/kg)	Max. 2
Iodine number (g iodine/100 g)	4.1-11

According to APCC (Asian and Pacific Coconut Community) standards, quality virgin coconut oil must meet the following requirements [7]:

Table 2. VCO quality requirements based on APCC standards.

Test	Requirements
Water content (%)	Max. 0.2
Free fatty acids (%)	Max. 0.2
Peroxide number (meq/kg)	Max. 2
Iodine number (g iodine/100 g)	4.1-11

3.1. Water content

Water content is a very important parameter in determining the quality of fats and oils. The presence of water in the oil can cause a hydrolysis reaction that produces glycerol and free fatty acids, resulting in a decrease in the quality of the oil [14]. Based on the research that has been done, the water content can be seen in Table 3.

Table 3. Analysis of VCO water content.

Varieties	Method	
	Fermentation	Centrifugation
Genjah	0.2105	0.1677
Hybrid	0.2053	0.1585

Based on the table, the water content of the VCO fermentation method with genjah maturing and hybrid varieties was 0.2105% and 0.2053%, while the VCO centrifugation method with genjah maturing and hybrid varieties were 0.1677% and 0.1585%, respectively. Testing the water content of VCO with the centrifugation method is lower than the fermentation method. This is because the separation of oil and water is more effective in the centrifugation method. The centrifugation method uses a mechanical method with centrifugal force to break the bonds of protein and fat so that oil is formed due to differences in the specific gravity of water and oil.

Therefore, the separation between oil and water in this method is more optimal than other methods [1]. While the fermentation method is a traditional method of VCO extraction which requires a long time so that the water content is high and the oil separation is not optimal [10]. Oils with low water content have

a longer shelf life so as to prevent oxidation reactions that cause rancidity [9].
In addition, the results of the study also showed that the VCO from the genjah varieties of coconut with the fermentation method had a water content exceeding 0.2%, namely 0.2105% and 0.2053%, respectively. This indicates that the VCO fermentation method has not met the quality standard of SNI [13] with a maximum water content value of 0.2%. However, the VCO still meets the APCC standard value with the condition that the water content is 0.1-0.15%. Based on the coconut variety, it was found that the water content of the VCO derived from the raw material of the genjah maturing coconut was higher than that of the hybrid variety. Making VCO by centrifugation method, the water content of genjah maturing coconut is 0.1677% and hybrid coconut is 0.1585%.

3.2 Free Fatty Acids

Free fatty acids are an indicator of oil quality which are expressed as unbound acids as triglycerides. Based on the research that has been done, the comparison of free fatty acid levels can be seen in Table 4.

Table 4. Analysis of VCO free fatty acids.

Varieties	Method	
	Fermentation	Centrifugation
Genjah	0.2200	0.1613
Hybrid	0.2079	0.1564

Based on the table, it can be seen that the VCO with the fermentation method has a higher free fatty acid content than the centrifugation method. Free fatty acids from VCO fermentation method with genjah maturing and hybrid varieties were 0.22% and 0.2079%, while VCO from centrifugation method with genjah maturing and hybrid varieties were 0.1613% and 0.1564%, respectively. VCO processing by fermentation method causes lipase enzyme activity and high water content. This triggers a hydrolysis reaction that forms glycerol and free fatty acids and causes the breakdown of triglycerides into free fatty acids and a rancid odor occurs [10]. The rancid odor of the oil also occurs due to exposure to oxygen, light, metal and heat and causes a decrease in the quality of the oil [15].

While the centrifugation method occurs natural oil separation (without heat and fermenter) in the presence of centrifugal force so that it has a lower free fatty acid content. This is in accordance with research [16] which stated that VCO with the centrifugation method had low free fatty acids and was characterized by a clear color and a distinctive coconut aroma (no rancid or sour smell).

The high levels of free fatty acids are caused by the presence of water which triggers a hydrolysis reaction that produces free fatty acids. The more free fatty acids formed, the faster the oxidation of the oil and the resulting rancid odor. In addition, there is an increase in cholesterol levels in the oil which causes clogged blood vessels [8]

The test results also showed that the VCO from the genjah varieties of coconut with the fermentation method had a free fatty acid content of 0.22% so that it did not meet the quality standard of SNI [13]. Based on SNI, the requirement for free fatty acid content in VCO is a maximum of 0.2%. However, the VCO of the two varieties with this fermentation method still met the APCC standard values with the condition that the maximum free fatty acid content was 0.5%. Based on the coconut variety used, it can be concluded from the value of the free fatty acid content of VCO that hybrid varieties are better than genjah maturing varieties. The free fatty acid content of VCO from the genjah maturing variety was higher than that of the hybrid variety.

3.3. Peroxide Number

Peroxide number is a parameter to determine the quality of the oil from the level of lipid oxidation. The high number of peroxides causes an increase in the oxidized lipids to active peroxides. The peroxide contained in the oil is caused by the oxygen binding to the unsaturated fatty acids in the double bonds.

Based on the research that has been done, the peroxide number can be seen in Table 5.

Table 5. Analysis of VCO peroxide number.

Varieties	Method	
	Fermentation	Centrifugation
Genjah	1.8813	1.5097
Hybrid	1.7886	1.4638

Based on the table above, it can be seen that the peroxide value of the VCO fermentation method is higher than the centrifugation method. The peroxide value of VCO using the fermentation method in genjah maturing and hybrid varieties was 1.8813 meq/kg and 1.7886 meq/kg, respectively. Meanwhile, the peroxide value of VCO by centrifugation method for genjah maturing and hybrid varieties was 1.5097 meq/kg and 1.4638 meq/kg, respectively. This is because, VCO with the fermentation method uses the activity of enzymes and microorganisms. The enzyme will produce acid which coagulates the coconut milk emulsion protein so that hydrolysis occurs and will produce oil.

This is in line with research [17] that the oxidation reaction that produces peroxide content is accelerated by light, heat, acid-base and the activity of enzymes and microorganisms. Meanwhile, the centrifugation method only uses centrifugal force to break the fat and protein bonds of coconut cream by spinning.

In addition, the presence of peroxide will form free radicals and cause a rancid odor so that the quality of the oil will decrease. The high number of peroxides will accelerate the oxidation reaction of unsaturated fatty acids by oxygen. The higher the peroxide number, the lower the quality of the oil [18].

The test results also showed that the VCO of genjah maturing and hybrid varieties using the fermentation and centrifugation methods had a peroxide value of 1.4-1.8 meq/kg. From the results of testing the peroxide value, VCO has met the quality standard of SNI [13], namely with a maximum requirement of 2 meq/kg. Based on the coconut varieties used, it can be concluded from the VCO peroxide number that hybrid varieties are better than genjah maturing varieties.

3.4 Iodine Number

The iodine number indicates the degree of unsaturation of an oil or fat and the stability of the oxidation process [16]. Based on the research that has been done, the iodine number can be seen in Table 6.

Table 6. Analysis of VCO iodine number.

Varieties	Method	
	Fermentation	Centrifugation
Genjah	5.5942	6.3876
Hybrid	8.2120	9.4060

Based on the table, it can be seen that the iodine value of the VCO fermentation method is lower than the centrifugation method. The iodine number of VCO using the fermentation method in genjah maturing and hybrid varieties was 5.5942 g iodine/100 g and 6.3876 g iodine/100 g. Meanwhile, the peroxide value of VCO using the centrifugation method for genjah maturing and hybrid varieties was 8.2120 g iodine/100 g. and 9.4060 g iodine/100 g The level of unsaturation of the oil affects the ability of the oil to bind. The higher the iodine number, the higher the level of unsaturation of the oil so that the quality of the oil is getting better [17].

This shows that the quality of the oil by centrifugation method from hybrid coconut varieties is higher because it contains a higher iodine number than other treatments. VCO with fermentation and centrifugation methods on both types of coconut has an iodine number of 5-9 g iodine/100 g so that it meets SNI quality standards with an iodine number of 4.1-11 g iodine/100 g [18]. Based on the coconut

varieties used, it can be concluded from the testing parameters for the Iod number of VCO hybrid varieties are better than genjah maturing varieties.

4. Conclusions and suggestions

Based on the oil quality test parameters that have been tested, it is concluded that the manufacture of oil using the centrifugation method produces VCO with higher quality than the fermentation method. It can be seen from the results of testing the water content, free fatty acids, peroxide number and iodine number of VCO already complied with SNI 7381:2008. While the VCO with the fermentation method, in testing the water content and free fatty acids there are those that do not meet SNI but still meet APCC standards. Based on coconut varieties, VCO hybrid varieties have better quality than genjah maturing varieties.

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