Increasing the quality of virgin coconut oil (vco) using activated carbon adsorbent from candlenut shell (Aleurites mollucana)

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Abstract. Virgin Coconut Oil (VCO) is one of the product from coconuts. VCO has many benefits in health and industry. One method of making the VCO is often used today is the fermentation. Today many domestic industries produce virgin coconut oil (VCO) but in fact, the industry has not been all good in terms of quality. The use of activated carbon from candlenut shells as an adsorbent to increase the quality of VCO has studied. The parameters tested were water content, free fatty acid, and peroxide. The results showed a decline in water levels from 0.1655% to 0.0597%, peroxide number decrease from 0.1991% to 0.0991%, and the free fatty acid content of 0.4186% to 0.366%.

1. Introduction

Virgin Coconut Oil (VCO) is one of the coconuts product. VCO has many benefits in health and industry. That is why the current demand for VCO continues to increase both at home and abroad. Many diseases are derived from viruses, can be resisted by consuming VCO, such as bird flu, HIV / AIDS, hepatitis, and other viral types. In addition, the VCO has also been reported to overcome obesity, skin diseases, until the disease is classified as chronic, such as prostate cancer, heart disease, high blood pressure, and diabetes [1].

One method of making the VCO is often used today is the fermentation. Fermentation includes making an enzymatically VCO because it uses the enzyme directly. VCO with enzymatic manufacture not done by heating. Separation only chemically induced by the enzyme. Fermentation method can be done by adding yeast juice or vinegar to taste. Today many developing home industry producing virgin coconut oil (VCO) but in fact, the industry is not all in the quality of the VCO, this is caused by several factors, including marketing problems, free fatty acid content, water content, easy to experience degradation and packing rudimentary [2].

In the process of manufacture or storage, VCO often suffers damage or loss of quality. This can be seen from the taste and smell of the VCO is changed into rancid. The taste and smell occurred because of the hydrolysis reaction due to high water levels in the VCO. Hydrolyzed fat increases acidity in oil, while fat oxidation increases rancidity of oil. One way to reduce water content and oil peroxide is the use of adsorbents in the screening process [3].

Candlenut shell (Aleurites mollucana) which is a waste from the processing of walnut oil can be developed as an activated charcoal material. Candlenut contains oils that can be processed into biodiesel oil to reduce dependency on fossil fuels. Each of the biodiesel production processes will generate waste in the form of candlenut shell that can pollute the environment. This waste has the potential to be transformed into charcoal and activated charcoal that can then be exploited further [4]. Charcoal is a porous solid containing 85-95% carbon, produced from materials containing carbon by heating at high temperatures. Charcoal is used as fuel in addition, can also be used as an adsorbent. Adsorption is determined by particle surface area and this ability can be higher on the water if done
activation by chemicals or by heating at high temperatures. And then the properties of physics and chemistry charcoal will change [5,6].

Besides the adsorbent synthesis as made by abraham [7], in recent years the source of activated carbon produced from natural materials and abundant agricultural waste such as coffee waste [8], rice hulls [9], pistachio nut shells [10], and cotton stalk [6]. Rustam Effendi in his research stating that the activated charcoal candlenut shell has the potential to be used as an adsorbent for filtering [11].

The purpose of this study was to determine the effect of using adsorbents activated charcoal filtration to the quality of fermented VCO. In this case, the quality of the tested includes water content, free fatty acid, and peroxide.

2. Experiment
2.1. Materials
The materials used in this study include coconut meat, candlenut shells, coconut juice, rice hulls, calcium oxide (CaO), alcohol, sodium hydroxide (NaOH), sodium thiosulfate pentahydrate (Na2S2O5·5H2O), sodium carbonate (Na2CO3), phenolphthalein, potassium iodide (KI), acetic acid (CH3COOH), chloroform (CHCl3), distilled water, hydrochloric acid (HCl), starch, glass wool and filter paper 200 mesh. And the equipment used are plastic containers, grated coconut, mixer, furnace, oven, desiccator, porcelain dish, hot plate, analytical balance, one set of tools chromatographic column, separating funnel and tools in laboratory glassware.

2.2. Preparation of Virgin Coconut Oil (VCO)
Coconut meat that has been shredded weighed as much as 8 Kg was then mixed with 16 L coconut milk, grated coconut knead for ± 10 minutes and squeezed. The results in the form of coconut juice allowed to stand for 2 hours to form two layers, namely cream and skimmed. Once formed two layers, extracted the cream carefully. The cream then mixing for 1 hour. After the cream is inserted into a container for settling for 10 hours to form 3 layers, such as oil, coconut cream, and water. Furthermore, the oil is separated carefully. The separated oil is then filtered with 200 mesh filter paper.

2.3. Preparation of Adsorben
Candlenut shell burned to charcoal and then crushed into small lumps/ granules (± 2-3 mm diameter) and then washed with water and then drained. Then charcoal put into a solution of Ca (OH) 2 until all charcoal is submerged. The mixture is boiled for 60 minutes at a temperature of ± 100 0C. After the charcoal drained and washed with running water. Then charcoal oven-dried at a temperature of ± 125 0C for 75 minutes. Lift charcoal, store in a desiccator. The adsorbent is ready for use.

2.4. Screening Process
80 grams of adsorbent were weighed and then put in a chromatographic column with a length of 45 cm and a diameter of 3 cm, with an adsorbent height of 30 cm. Column previously included glass wool at the bottom of the column. 100 grams of oil entered in the funnel and then poured dropwise into a column, with a flow rate of 1 drop/sec. Oil filtering results stored in the Erlenmeyer flask. Then filtered again using a 200 mesh filter paper, then performed the analysis of water content, free fatty acids and peroxide.

2.5. VCO Quality Test
2.5.1. Water Content Analysis. Determination of the water content of VCO can be done with the oven method. VCO weighed as much as ± 5 grams in a porcelain dish, put in the oven with a temperature of 105 0 C for 3 hours then cooled in a desiccator for 30 minutes, then weighed, then oven and cooled again to constant weight.
Water Content $= \frac{A - B}{A} \times 100\%$  \hspace{1cm} (1)

**Suggestion:**
$A = \text{weight before oven}$
$B = \text{weight before oven}$

2.5.2. **Free Fatty Acids Analysis.** VCO weighed as much as ± 5 grams in a 250-ml Erlenmeyer flask. Into VCO added 50 mL hot ethanol 96% and 2 mL indicators pp, then titrate with 0.05 N NaOH solution standardized until the pink color is achieved and does not disappear. Free fatty acids expressed as % FFA.

$$\% \text{ FFA} = \frac{mL \text{NaOH} \times N \text{NaOH} \times BM \text{ Fatty Acid}}{\text{Weight of Sample} \times 1000} \times 100\%$$  \hspace{1cm} (2)

**Suggestion:**
$N = \text{Normality}$
$BM = \text{Weight}$

2.5.3. **Peroxide Number Analysis.** A total of ± 5 grams VCO included in the 250-ml Erlenmeyer flask with a lid and add 30 mL of acetic acid-chloroform (3: 2). The solution was stirred until all ingredients are dissolved. Added 0.5 mL of saturated KI. Allowed to stand for 1 minute then add 30 mL of distilled water. Dititirasi with 0.01 N Na$_2$SO$_3$ solution until the yellow color had almost disappeared. Added 0.5 mL of 1% starch solution, and the titration is continued until the blue color began to disappear. Peroxide number expressed in milli-equivalent of peroxide in every 1000 g sample.

$$\text{Peroxide Numb.} = \frac{mL \text{Na}_2\text{SO}_3 \times N \text{Na}_2\text{SO}_3 \times 1000}{\text{Weight of Sample}}$$  \hspace{1cm} (3)

3. **Result and Discussion**

3.1. **Quality of Activated Carbon**

The study of activated carbon in a mixture of powder and granules with a chemical activation process using calcium oxide (CaO). From the experiments obtained 0.4955%, this result show that the active carbon quality meets the standards set SNI, the maximum moisture content of grain by 4.4% and for powder 15%. This is due to the fragile nature of the carbon shell cedrela resulting in volatile water when activated at a temperature of 125°C. Low water levels also caused the fewer surface of activated charcoal containing polar functional groups so that the interaction between water vapor is polar too little. Activated charcoal is charcoal activated either chemically[9].

In addition to the water content in the activated carbon was also assayed volatile matter, ash content, and the content of bound carbon. Levels of volatile substance is a material change in the component (shell, wood, etc.) when carbonation at high temperatures. From the results obtained experiment 2.9687%, this value still meets ISO standards that the granules obtained for a maximum of 15% and 25% for the powder. Abu is an inorganic compound that is produced from the combustion of charcoal consisting of calcium, magnesium, potassium, and sodium and metal oxides in charcoal [3]. From the test results obtained ash content is 5.3042% and still exists in SNI standard of 2.5% for grains and 10% for the powder form [12]. Bound carbon content is a bound lagging element in addition to ash and volatile substance in the material time of the carbonation. The carbon content of research got 91.72%
Iodine absorption was also carried out to test the ability of pecan shell carbon to capture or absorb iodine. From the analysis results obtained 750 mg/g that meets the minimum requirements of SNI. This is because the carbon-making process does not use pyrolysis method which serves to open the pores of coal and to reduce the action of oxygen in the combustion process. The higher the iodine adsorption shows that the carbon atoms form hexagonal crystallites more and more so that cracks or pores formed between layers of crystallites are also getting bigger [13].

3.2. Water Content Analysis
The water content in VCO affect the quality of the oil is, therefore Determination of Moisture Content is important. The smaller the water content in VCO the better the quality. The water content obtained after passed to the adsorbent is 0.0597% from 0.1665%. Moisture reduction is caused by the use of alkali hydroxide salts metal carbonate role in the carbon chain termination in the activated carbon [14]. A breakdown of the carbon resulting in the opening of the pores of the activated carbon that can help the process of water absorption. Besides activated carbon is polar because they have functional groups located on the surface so that the water content in VCO can also interact with the functional groups on the surface. These results are also in accordance with the value set APCC [15].

3.3. Peroxide Analysis
Peroxide is a measure of the level of oil damage or as an indicator of oil rancidity. Based on the test it was found that there was a difference between before and after being passed on the adsorbent [3]. The use of activated carbon shell candlenuts lowers peroxide value of 0.1991 meq/kg to 0.0991 meq/kg. It is influenced by the heating process in the manufacturing process. Besides the influence of oxygen in the manufacture also very small for all treatment using sealed containers.

Besides allegedly due to lipid peroxide or hydroperoxide is in the oil are more polar than oil which has not been contaminated with the compound triggers peroxide, therefore the lipid peroxide can be adsorbed in the adsorbent so that after being filtered using adsorbents peroxide from the VCO can be reduced. From the results of the study found that filtering used cooking oil using natural zeolite that has been activated will improve the quality of the oil for free fatty acids and peroxide have been absorbed by natural zeolite [3,13].

3.4. Analysis of Free Fatty Acid.
Free fatty acids are unsaturated fatty acids derived from triglycerides unesterified. Based on the results obtained that the levels of free fatty acids in the VVO being passed to the adsorbent hazelnut shells still meet the standards of the APCC is ≤0.5%. In addition, VCO that has been passed to the adsorbent also decreased the value of free fatty acids from 0.4681% to 0.3666%. This is due to the interaction of polar groups on the surface of the adsorbent with the oil. In addition, it has been helped by a fermentation process that produces the enzyme lipase. Wherein the lipase enzyme helps hydrolyze neutral oils and fats (triglycerides) and will improve the hydrolysis when assisted by heating [16].

4. Conclusion
The use of adsorbent from candlenuts shell can improve the quality VCO with fermented decrease water content, peroxide, and water content. The water content decrease from 0.1655% to 0.0597%, peroxide number from 0.1991 meq/mg to 0.0991 meq/kg and free fatty acid levels from 0.4681% to 0.3666%.

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