Coconut oil purification using two different concentrations of activated charcoal

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Abstract. The coconut oil that is traditionally processed is made by the heating process and normally is not neutralized. To obtain the standardized quality of oil, it is necessary to perform purification to the traditionally processed oil. The specific purpose of this study was to obtain the most effective concentration of charcoal to increase the clarity of coconut oil as well as to remove the particle non-oil like water and free fatty acids. This study using two kinds of different concentration of activated charcoal which was 1% and 1.5%. To test the quality of the oil several measurements was performed which were moisture clarity level, moisture content, and free fatty acids content. The results showed the best amount of active charcoal used in the refining process of coconut oil is at a concentration of 1.5% with a clarity level of 97.83T, moisture content of 0.016%, and free fatty acid 0.006%.

1. Introduction
Indonesia is a country with high production of coconut product including coconut oil [1]. In many areas in Indonesia, coconut oil is produced by small industry with limited technology and expense. The traditionally processed coconut oil is produced by heating process and normally not neutralized. This technique changed the physicochemical properties of oil that further influence its quality, resulting in the unfulfillment of quality standard set by the Indonesian National Standard (SNI) [2].

To obtain the standardized quality of oil, it is necessary to perform purification to crude oil to remove free fatty acids content (FFA) and water, as well as enhancing the clarity of the oil. Several studies have been focusing on edible oil purification [3–6] and studies still continue until now. Removing of FFA has also already been done by Rao et al using a Millipore membrane cell with some chemical like ethanol and methanol and resulted in 95% reduced FFA [7]. However, there is a challenge to find a method in enhancing the quality of crude coconut oil without the application of chemicals like ethanol or methanol. Thus, other methods would be interesting options such as the use of charcoal in purifying the coconut oil as it has absorption capability.

Charcoal absorption capacity has been reported in several studies [8–10]. Charcoal is used for its capabilities in adsorbing undesirable components in a solution. Moreover, charcoal is cheap and easy to obtain, hence making it as a practical and applicable purification method. However, to our knowledge, the best concentration that effective for coconut oil purification in obtaining the best quality oil along with the more applicable way of purification was not known yet.

This paper presented the results of experiment intended to enhance the the quality of coconut oil through purification. This study specifically purposed to obtain the most effective concentration of
charcoal to enhance the clarity of coconut oil as well as to remove the particle non-oil like water and free fatty acids.

2. Methods

2.1. Materials
Unbranded coconut oil (traditional processed) used in this study was obtained from the traditional market. Charcoal, NaOH and Phenolphthalein indicator were obtained from chemical material providers such and chemical store and laboratory.

2.2. Refining process
The sample was purified by putting together the oil, NaOH and activated charcoal with two different concentrations (1% and 1.5%) and mixed it for 30 minutes. Then separation process of the gum by centrifuging it for 30 minutes, followed by filtration in a multi-layer column filter.

2.3. Level of clarity
To measure the clarity (% T), a method set by Indonesian National Standard [11] through spectrophotometry process was applied. The sample was poured inside the cuvette then the spectrophotometry was set at a 395 nm wavelength to measure the Transmittance (T) of sample. The blank of this measurement using deionized water. Formula \( A = 2 - \log T \) was used to measure the absorbance, and further used to define the clarity.

2.4. Moisture content (oven method)
Water content measurement was performed in line with the explained method in Sudarmadji (1989) [12]. Two grams of oil were heated (105°C) and weighed until it reached constant weight. The following formula then used to measure the moisture content.

\[
\text{Moisture content(%) } = \frac{\text{Initial weight} - \text{Final weight}}{\text{Initial weight}} \times 100\% \tag{1}
\]

2.5. Free fatty acid (FFA)
Free fatty acids measured through the titration method [13]. 5 grams of sample that had been stirred previously was poured into an Erlenmeyer. To the Erlenmeyer then was added 50 ml of alcohol that has been neutralized and then heated to 80°C until the solution boiled, after that it is waited until the temperature of the sample decrease to room temperature. Then, 3 drops of the indicator (phenolphthalein) was added to the Erlenmeyer. The sample then titrated with 0.1 N NaOH. Note down the volume of NaOH used. Calculation of ALB levels using the following formula:

\[
\text{Free Fatty Acid} = \frac{V_{\text{NaOH}} \times Mw \text{ of the oil} \times N \text{ NaOH}}{1000 \times \text{Sample weight}} \times 100\% \tag{2}
\]

3. Results and discussion
Coconut oil purification was performed to enhance the appearance of oil as well as to extend the shelf life of oil before consumption [14]. The result of parameters tested as follows;

3.1. Clarity level
The purification process meant to enhance the appearance of sample to meet the coconut oil quality standards set by SNI [15].

The results of the clarity level measurement of all samples tended to increase. The clarity level with the use of 1% activated charcoal obtained a lower value of 96.18% T, compared to the use of 1.5% activated charcoal obtained a value of 97.83T. The level of clarity (T) of initial and purified sample is presented in figure 1.
Figure 1. Clarity level (T) of initial and purified sample of coconut oil in different concentration of activated charcoal

This study finds the level of clarity is higher with the higher concentration of charcoal. The higher amount of the concentration of activated charcoal used, the higher the absorption of activated charcoal to color. The dyes in the oil are absorbed by the surface of activated charcoal. Activated charcoal has a small pore structure and large surface area which increases the adsorption power. At a concentration of 1%, the absorption of activated charcoal to dirt and dyestuffs was limited, whereas using a concentration of 1.5% activated charcoal was able to increase oil clarity to 97.83\% (see figure 1). This explanation is in line with Manocha's [16], that the active group located on the surface of activated charcoal interacts with the adsorbate, causing the adsorbate to be adsorbed into the activated charcoal pore.

3.2. Water content (%)

High water levels can decrease the quality of oil product. Maximum water content of pure coconut oil is 0.2\% [15]. The water content of coconut oil with both applied activated charcoal concentration tended to decrease. Water content with the use of 1.5\% activated charcoal obtained a lower value of 0.016\%, while the water content with the use of 1\% activated charcoal obtained a higher value, which was equal to 0.053\%. The higher the concentration of activated charcoal used, the higher the absorption of activated charcoal to the water content of oil, so that the water content left in oil was lower. The effect of the amount of activated charcoal concentration on the moisture content of samples is presented in figure 2.
Figure 2. Water content (%) of initial and purified sample of coconut oil in different concentration of activated charcoal

Figure 2 shows that the use of 1.5% activated charcoal concentration has a lower water content of 0.016%. This is because activated charcoal has a pore structure and a layer of carbon atoms that can absorb water from the oil. In addition, activated charcoal has hydrophilic properties (like water) so that the higher the concentration of activated charcoal used, the higher the water content in the oil that can be absorbed. The fact that the surface of activated carbon is chemically reactive and has adsorption properties were also stated by Murti [17].

3.3. Free fatty acids (FFA)
During the processing or storage of the oil chemical changes occurs including the forming of free fatty acids due to hydrolysis and oxidation [18]. The fatty acid content affects the quality of coconut oil as it caused rancidity. Maximum free fatty acid in pure coconut oil is 0.2% [15]. Titration method was applied in determination of free fatty acid in this research [13].

The results of FFA levels measurement in coconut oil with the different concentration of activated charcoal tended to decrease. Application of 1.5% of activated charcoal resulted lower free fatty acid content, which was 0.006%, compared to the use of 1% activated charcoal, which resulted 0.046% free fatty acids. The free fatty acid levels (%) of coconut oil in each treatment is presented in figure 3.
The free fatty acid content of coconut oil purified with different concentration of activated charcoal concentration appears to decrease if the amount of active charcoal concentration used increases (see figure 3). This study found out that the higher the concentration of activated charcoal used, the higher the absorption capability of activated charcoal, that further lowered the free fatty acids in oil product. This is because activated charcoal has properties to absorb the FFA in the oil [17].

4. Conclusion
The higher amount of active charcoal used in the refining process of coconut oil resulted in oil with better quality with a level of clarity 97.83T, water content of 0.016%, and FFA content of 0.006%.

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