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Variation of filter media type and thickness combination for coconut oil filtration

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Abstract. Coconut oil is one type of oil that is widely used as cooking oil in Indonesia. There is a lot of oil sold that has not undergone purification, so it still contains a small amount of non-oil components, such as phosphatide sterol (0.06-0.08%), tocopherol (0.003%) and free fatty acids (<5%). This study aimed to find the most effective filter with a combination of the type and thickness of filter media to enhance the quality of coconut oil. The research method was to determine the combination of filter media thickness in the filtration column (fine sand, coarse sand, and zeolite). The results obtained showed that the best combination of filter media thickness namely filter 3 with a combination of column I (3 cm fine sand); column II (3 cm fine sand + zeolite 12.5 cm); column III (3 cm fine sand + zeolite 12.5 cm); column IV (3 cm fine sand) which produces oil with a clarity level of 99.35% T, moisture content of 0.014%, and free fatty acid 0.005%.

1. Introduction

Coconut oil is an oil that contains about 90% saturated fatty acids, 84% triglycerides with three saturated fatty acid molecules, 12% triglycerides with two saturated fatty acids, and 4% triglycerides with one saturated fatty acid [1]. Unrefined coconut oil contains a small amount of non-oil components, such as phosphatida, sterol (0.06-0.08%), tocopherol (0.003%), and free fatty acids (<5%). The processing of coconut oil by heating causes the oil to experience changes in physicochemical properties, such as brownish-yellow color, increase in free fatty acids and peroxide numbers so that the oil produced does not meet the oil quality set by the Indonesian national standard [1,2].

The main purpose of the refining process is to eliminate undesirable flavors and odors, unattractive colors formed due to the heating process, minimize water content, free fatty acid levels, and peroxide levels and extend the shelf life of the oil before consumption. The oil purification can be done chemically or physically. Filtration is the process of separating solids from the fluid (liquid or gas) using a porous medium to remove as much as possible fine suspended solids and colloids [3]. Filtration is needed to improve the purification of coconut oil by reducing water content, free fatty acids, peroxide numbers, color, smell, and taste so that pure oil is obtained that meets the coconut oil quality standards.

In this study, filter media in the form of sand and zeolite were combined where each filter applied different types and thicknesses of this media so that the effectiveness of the combination of types and thickness of filtration media could be determined. In the coconut oil processing industry, the filtration stage is a critical step because it affects the level of clarity. Therefore, it is necessary to know the right combination of type and thickness of filtration media to obtain the best quality oil.



Based on the explanation above, the general objective of this research was to increase the clarity of oil in the filtration process that further will improve the quality of coconut oil. The specific purpose of this study was to obtain the most practical combination of types and thickness of filter media to increase the clarity of coconut oil.

2. Methods

2.1. Refining process

The coconut oil purification process was carried out by bleaching and neutralization. The oil was put in a mixer and stirred for 30 minutes with the addition of NaOH and activated charcoal. Then the gum separation process was carried out by placing the oil in a bottle and centrifuging it for 30 minutes. After that, filtering of the oil was performed by putting oil in a filter that has a multilayer column with a combination of the type and thickness of the filtration medium.

2.2. Determination of the combination of type and thickness of filtration media

Filtration media used in this study were fine sand, coarse sand, zeolite, which was inserted into a filter containing several columns and varied in type and thickness, as can be seen in table 1:

Table 1. The type and thickness of filter media in each column

Filter	Column 1	Column 2	Column 3	Column 4
1	Fine sand 5 cm	Coarse sand 10 cm	Zeolite 25 cm	-
2	Fine sand 5 cm	Fine sand 5 Cm + Zeolite 12.5	Fine sand 5 Cm + Zeolite 12.5 Cm	-
3	Fine sand 3 Cm + Zeolite 12.5 Cm	Fine sand 3 Cm + Zeolite 12.5 Cm	Fine sand 3 Cm + Zeolite 12.5 Cm	Fine sand 3 Cm

2.3. Clarity level

The clarity level (T) measurement was carried out using a spectrophotometer as described by Badan Ndarisasi Nasional (1998) [4]. The oil sample was placed into the cuvette. After that, Transmittance was measured at a wavelength 395 nm by using demineralized water as blank. The absorbance results obtained were calculated in the formula ($A = 2 - \log$ Transmittance) to get the level of clarity.

2.4. Moisture content

Moisture content was measured using oven method in which 2 grams of oil was weighed in the porcelain cup, then heated at a temperature of 105°C until the weight of the oil was constant. The reduction in oil weight was expressed as the weight of the evaporating water.

$$\text{Moisture (\%)} = \frac{\text{Initial weight} - \text{Final weight}}{\text{Initial weight}} \times 100\%$$

2.5. Free fatty acids (FFA)

The measurement of free fatty acids was carried out using the titration method [6], where the sample was stirred and then as much as 5 grams of sample was placed into an Erlenmeyer glass which had been previously weighed. We add 50 ml of neutral alcohol into the Erlenmeyer and then heat it to 80°C until the solution boils after that, three drops of the PP indicator was added into the cold sample. Titration was performed using 0.1 N NaOH which has been standardized until a pink solution was formed and not disappear for 30 seconds. Calculation of FFA levels using the formula:

$$\text{Free fatty Acid} = \frac{V_{\text{NaOH}} \times \text{Mw of the Oil} \times N \text{ NaOH}}{1000 \times \text{Sample weight}} \times 100\%$$

3. Results and discussions

Purification of coconut oil was done to remove unwanted components, unattractive colors, minimize water content, reduce free fatty acids and peroxide levels, and extend the shelf life of oil before consumption [3]. Coconut oil used in this study was traditionally processed coconut oil. Preliminary tests were carried out on coconut oil to determine the quality of the cooking oil. The initial test parameters carried out were clarity level, water content, and free fatty acids.

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Determination of the combination of filter media thickness was done to determine the type and combination of filter media that are effective for absorbing impurities, free fatty acids and other oil degradation results, such as peroxide to produce good quality oil. Determination the effectiveness of the combination of type and thickness of filter media was analyzed by the parameters used in the initial sample, namely the level of clarity, moisture content, and free fatty acids.

3.1. Clarity level

The purification process in coconut oil aims to obtain pure coconut oil with a clearer appearance. Following pure coconut oil quality standards [7] that the color of refined coconut oil is colorless to pale yellow. The clarity level of coconut oil was measured using a spectrophotometer at a wavelength of 395 nm with distilled water as blank. The higher the percentage value of transmittance of coconut oil, the clearer the oil becomes.

The results of the analysis of the level of clarity obtained in coconut oil with different filters showed different values for each treatment, but all sample for each treatment showed a clarity level twice more than the clarity level of the initial sample. The highest value of clarity level was obtained from coconut oil filtered with filter 3 (98.025T). Followed by the clarity level of the filtered oil from filter 1 which obtained a value of 96.84T, while the lowest value of the clarity level was obtained from the filtered oil with filter 2 which was 96.15T. The effect of filter differences used on the clarity level of coconut oil can be seen in Figure 1.

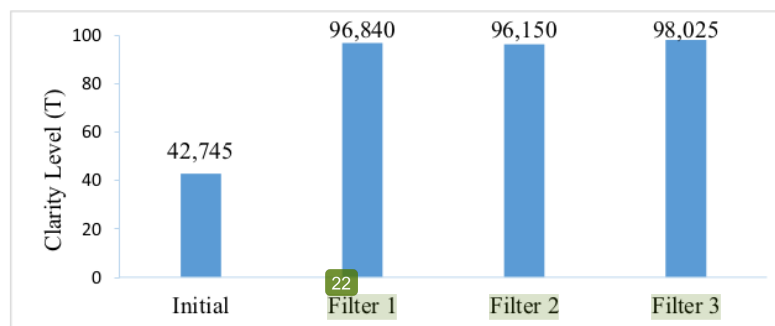


Figure 1. Effect of filter media on clarity level (T) of coconut oil

The clarity level of the oil produced was influenced by the type of adsorbent, the size, and thickness of the filter media. The adsorbent used (in this case zeolite) absorbs the dyes in the oil, adsorbs fatty acids, impurities, and other oil degradation results. The size (diameter) of the grain and the thickness of the filter media also affect the level of clarity of the oil. The smaller the size of the filter media (sand) used, the

lower the porosity between the molecules formed in the filter media [8]. Fine sand used can hold more dirt particles in oil. The thicker the filter media, the higher the absorption of media.

The crude oil filtered with filter 2 obtained the lowest clarity level of 96.15T, while the oil filtered with filter 3 received the highest clarity level of 98.025T. This is influenced by the residence time of oil on zeolite, where zeolite in filter 3 was thicker than zeolite in filter 2. The longer the time of oil stayed, the higher its absorption. High zeolite absorption was caused by the physical and chemical properties of zeolite. Zeolites have a hollow/porous tetrahedral structure with a surface area and porosity so that zeolites can absorb large numbers of molecules smaller in size according to the size of their sockets. Zeolite has a high content of SiO_2 and Al_2O_3 , which causes zeolite to absorb dirt and dyes so that coconut oil will become clearer [9].

3.2. Moisture content

The amount of water content in coconut oil greatly affects the quality of the oil produced. High water levels can accelerate the deterioration of the oil. Pure coconut oil is coconut oil which has a maximum moisture content of 0.2% [7]. Determination of water content in this study applied the oven method. Oil was heated at a temperature of 105°C until the weight of the oil was constant. Reduction in oil weight was expressed as the weight of evaporated water [5].

Before the purification of coconut oil, water content had already met the quality standards set by the Indonesian national standard. The results of the analysis of coconut oil water content after the purification process obtained a varied value in which the water content of the oil purified with all filters were lower than the moisture in initial sample. The coconut oil filtered with filter 2 had the lowest moisture of 0.028%. The effect of the combination of filter media thickness on the moisture content of coconut oil can be seen in figure 2.

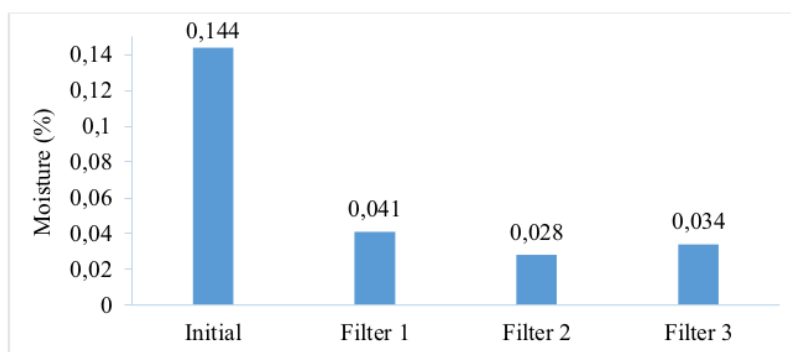


Figure 2. Effect of filter media on coconut oil water content

The water content in the end product was influenced by the size and thickness of the filter media. The filter media used was fine sand, coarse sand, and zeolite. Sand is composed of silica compounds (SiO_2) which can absorb water from the oil. Zeolites have silica (SiO_2) and alumina (Al_2O_3) compounds which contain alkaline cations which are capable of absorbing water from oil. The size and thickness of the filter media had an effect on the water content of the oil. The smaller the diameter of the media and the thicker the height of the filter media, the lower the water content of the oil produced. This is in accordance with Lienda's statement that the depth, size, and type of media affect the quality of filtration results [8].

3.3. Free fatty acids

Free fatty acids and fatty acids that do not bind to glycerol formed during the processing or storage. High and low free fatty acids in the oil will affect the quality of coconut oil produced because this component is one of the causes of rancidity. Free fatty acids can be formed due to hydrolysis and oxidation [10]. Pure coconut oil has a maximum free fatty acid level of 0.2% [7]. Determination of free fatty acid levels in this

study was carried out by the titration method. Coconut oil is titrated with 0.1N NaOH solution which has been standardized to form a pink solution [6].

The results of the analysis of coconut oil free fatty acids after the refining process with all applied filters showed a decrease. The lowest free fatty acid content was obtained from filter 3, which was 0.009%, while the highest free fatty acid content was obtained from filter 1 which was 0.039%. The effect of the combination of filter media thickness on coconut oil free fatty acid levels can be seen in Figure 3.

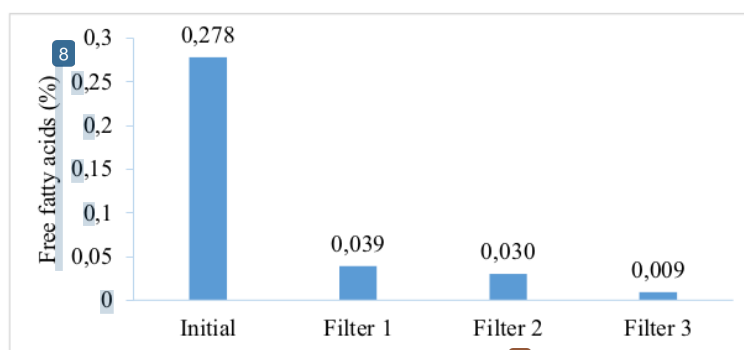


Figure 3. Effect of filter media on coconut oil-free fatty acid levels

Free fatty acid levels after purification with all applied filters are lower than the initial sample and meet the standards set by the Indonesian national standard. As shown in figure 3 that all the fatty acids in oil after filtration in 3 different filters were lower compared to the fatty acids in the initial sample. It also can be seen that although the difference was small the fatty acids in oil filtrated by filter 3 was the lowest. This shows that the filter 3 is the best combination of filtration media.

The free fatty acid content in oil after filtration was influenced by the thickness of zeolite in filter media. The thicker the zeolite layer, the higher the absorption capacity of the filter media against oil-free fatty acids. This result indicated that free fatty acids in the oil were absorbed by the zeolite matrix. The explanation of this is because zeolite has porous that can absorb free component inside the oil including free fatty acids. This is supported by a Rindengan and Novarianto, that zeolite functions as an absorber of free fatty acids that are still present in the oil [11].

4. Conclusion

The most effective combination of filter media thickness to purify coconut oil is in combination filter media 3 with column I (fine sand 3 cm); column II (fine sand 3 cm + zeolite 12.5 cm); column III (fine sand 3 cm + zeolite 12.5 cm); column IV (fine sand 3 cm) with clarity level 99.35% T, moisture content 0.014%, and free fatty acid 0.005%.

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