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UTILIZATION OF ACTIVATED CARBON FROM COCONUT SHELLS IN THE *BLEACHING PROCESS OF CRUDE PALM OIL (CPO)*

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ABSTRACT

CPO (Crude Palm Oil) is the result of processed palm fruit in the form of crude oil so that it needs to be refined so that it can be used by consumers, one of the purification processes of CPO (Crude Palm Oil) is to use the bleaching process. The purpose of this study is to determine the effect of activated carbon size, temperature and bleaching process time on the crude palm oil (CPO) produced. This study used three independent variables, namely the size of activated carbon (120/150, 150/180 and 180/200) mesh and bleaching temperatures of 150^{o}C, 160^{o}C, 170^{o}C and bleaching times of 50 minutes, 60 minutes and 70 minutes. The results showed that the higher the temperature and time in the bleaching process, the lower the level of free fatty acids in CPO both in the size of activated carbon (120/150, 150/180 and 180/200) mesh. In activated carbon, the ash content did not meet the SNI 06-3730-1995 standard while the moisture content met the standard. For CPO (Crude Palm Oil) after the bleaching process, the best results were obtained at a particle size of 120/150 mesh with a temperature of 170^{o}C and a time of 70 minutes.

Keywords: *Crude palm oil (CPO), activated carbon, and bleaching*

1. INTRODUCTION

Indonesia is one of the largest CPO (*Crude Palm Oil*) producing countries in the world in 2019 with a CPO (*Crude Palm Oil) production capacity* of 36.17 million tons (Director General of Plantations, 2020). CPO (*Crude Palm Oil*) is the result of processed palm fruit in the form of crude oil so that it needs to be refined so that it can be used by consumers, one of the purification processes of CPO (*Crude Palm Oil*) is to use the *bleaching process.*

Bleaching is a process of bleaching CPO (*Crude Palm Oil*) which aims to remove the color and residual sap contained in CPO (*Crude Palm Oil*) and to extend the shelf life of cooking oil before consumption, while the *bleaching process* of CPO (*Crude Palm Oil*) is carried out in a commercial way at a temperature of 90-105^{o}C,[1]

Previous research related to the purification of CPO (*Crude Palm Oil*) using the *bleaching process* includes research that has been conducted by [2] with the title of research on the analysis of the use of the amount of BE (*Bleaching Earth*) on the color quality of DBPO (*Degummed Bleached Palm Oil*) in *bleacher* tanks (D202) with a capacity of 2000 tons/day in the refenery unit of PT. Smart TBk Belawan, it can be concluded that the use of *bleaching* as much as 1% has met the standards set by the company based on consumer demand. Based on the research that has been conducted by [3] with the title of research on the purification *of crude gliycerine* through bleaching process using activated carbon, it can be concluded that activated carbon can absorb the coloring substances in *crude gliycerine* best at a size of 150 mesh weighing 1.5 grams in 45 minutes. Based on the research that has been conducted by [4] with the title of research on the determination of bleaching *earth* and *phosporic acid* levels in the *crude palm oil bleaching process*, it can be concluded that the optimal operating conditions for *the bleaching process* are around 110^{o}C with a contact time of 30 minutes.

1.1 Problem Formulation

Based on the above background, the formulation of the problem that will be examined in this study is as follows:

1. How does the size of activated carbon affect *the crude palm oil* (CPO) produced?

2. How does *bleaching* temperature affect the crude *palm oil* (CPO) produced?
3. How does *bleaching* time affect the *crude palm oil* (CPO) produced?

2. RESEARCH METHODS

2.1 Place and Time

This research will be conducted from February 2024 to April 2024 within 3 months from the beginning of the research to completion. The research was carried out at the Water and Waste Treatment Laboratory, Department of Chemical Engineering, Lhokseumawe State Polytechnic.

2.2 Tools and Materials

The tools and materials that will be used in the research to utilize activated carbon from coconut shells in the *bleaching process of crude palm oil* (CPO), as can be seen in Table 1

Table 1 Tools and materials

Tool	Material
1. *Beaker glass*	1. CPO
2. *Magnetic stirrer*	2. Activated carbon
3. *Hotplate*	3. Aquadest
4. Digital scales	4. NaOH
5. Tiration tools	5. H_2SO_4
6. Stirring rod	
7. Separator funnel	
8. Filter Paper	
9. Termometer	
10. Clamps	
11. Static	
12. Erlenmeyer	
13. Cawan Petridish	
14. Desikator/fan	
15. Oven	
16. Ayakan 120 s/d 200 mesh	

2.3Research Variables

2.3.1 Fixed Variables

The fixed variables that will be used in this study are:

1. Volume CPO : 100 grams
2. Rounding of the merger : 250 rpm
3. Stirring time : 120 minutes
4. Activated carbon weight : 4 grams

2.3.2 Independent Variable

The independent variables that will be used in this study are:

1. Activated carbon size: (120/150, 150/180 and 180/200) mesh
2. Temperatur *bleaching* : 150ºC, 160ºC, 170ºC
3. Bleaching time : 50 minutes, 60 minutes and 70 minutes.

2.3.3 Bound Variables

1. Test the moisture content for activated carbon.
2. Test the ash content for activated carbon.
3. Test free fatty acids for CPO.

2.4 Research Procedures

2.4.1 The Process of Making Activated Carbon from Coconut Shells

The steps to make activated carbon from coconut shells for CPO purification using the *bleaching* process are as follows:

1. The coconut shells are cleaned of soil and gravel that are attached.
2. Crack the coconut shell into smaller sizes.
3. The coconut shells that have become small sizes are put into *the furnace* with a temperature of 400ºC for 1 hour to become charcoal.
4. After the carbonization process, the coconut shell charcoal is crushed into powder with (120/150, 150/180 and 180/200) mesh sizes.
5. Then coconut shell charcoal powder with sizes (120/150, 150/180 and 180/200) mesh is activated by soaking in a solution of sulfuric acid (H_2SO_4) with a concentration of 20% as much as 250 ml with 50 grams of charcoal of each size, for 24 hours.
6. After the activation process is completed, the pH of charcoal powder from coconut shells with sizes (120/150, 150/180 and 180/200) mesh is neutralized with aquadest until it reaches pH 7.
7. After the shell charcoal powder with the size (120/150, 150/180 and 180/200) mesh reaches a neutral pH, then the charcoal is dried using an oven at 105ºC until the charcoal is completely dry.

2.4.2 Proses *Bleaching*

The procedure for refining CPO by utilizing activated carbon from coconut shells in the *bleaching* process is as follows:

1. Activated carbon is weighed as much as 4 grams.

2. CPO and activated carbon with variations (120/150, 150/180 and 180/200) mesh are inserted into *the beaker glass.*
3. Stir until homogeneous with temperatures of 150ºC, 160ºC, 170ºC for 120 minutes at 250 percent rotation.
4. Let it sit for 50 minutes, 60 minutes and 70 minutes, then filter using filter paper.

3.5 Testing

3.5.1 Moisture Content Test

The steps for moisture content testing in this study are as follows:

1. Weigh the empty petridish dishes and record the results.
2. Add a sample of 10 grams to a petridish dish and record the results.
3. Dried in the oven for 15 minutes at 105ºC.
4. Refrigerate in a deciker/fan for 10 minutes.
5. Weighed (cups + samples) until they reach a constant weight and record the results.
6. The moisture content is calculated using the formula,

$$\text{Moisture (\%)} = \frac{W1 - W3}{W2} x\ 100\%$$

Information
W1 = Sample weight + petridish cup weight Before Oven
W2 = Sample weight
W3 = Sample weight + weight of petridish dish after oven

3.5.2 Ash Content Test

Ash content testing aims to determine the ash content produced by activated charcoal. The procedure for measuring the ash content of the activated charcoal produced is as follows:

1. Weigh porcelain cups or sample containers with analytical balances.
2. Weigh the weight of each activated charcoal sample.
3. The sample in a porcelain cup is put in an oven at 600ºC for 1 hour.
4. The material is cooled in a desiccant then weighed and the result of the weighing is reduced by the weight of the porcelain cup.
5. Take samples for burning.
6. After the incineration process is complete, calculate the ash content with the following equation:

$$\text{Ash Content} = \times 100\% \frac{M3 - M1}{M2 - M1}$$

Where
M1 : Weight of empty cup + lid (gr).
M2 : Cup weight + lid + sample (gr).
M3 : Cup weight + lid + sample after heating (gr).

3.5.3 Free Fatty Acids Test

The steps for testing free fatty acid levels in this study are as follows:

1. Weighed CPO as 5 grams with a digital analytics scale
2. Put in 250 ml of erlenmeyer.
3. Add 50 ml of alcohol.
4. Added phenolphthalein indicator as many as 2 drops.
5. Titration was carried out with a 0.1 N NaOH solution using a burette until the orange solution turned brick red for 30 seconds.
6. The volume of NaOH solution used is recorded.
7. It is possible to calculate the level of free fatty acids by using the formula,

$$\text{ALB (\%)} = \frac{S\ x\ N\ x\ 25{,}6}{Berat\ sampel}\ x\ 100\%$$

Information
S = Volume NaOH (ml)
N = NaOH Concentration (N)
25,6 = Constant to calculate the content of free fatty acids as palmitic acid

3. RESULTS AND DISCUSSION

3.1 Research Result Data

3.1.1 Activated Carbon Test Result Data

Based on the results of activated carbon testing conducted on July 18, 2024. in the Testing Laboratory of the Department of Chemical Engineering, Lhokseumawe State Polytechnic, water content test data, ash content from activated carbon, can be seen in Table 2

Table 2 Activated carbon test result data

It	Sample name	Specifications	Testing	
			Moisture (%)	Ash (%)
1	Activated carbon	120/150 mesh	6,84	32,11
2		150/180 mesh	14,13	27,36
3		180/200 mesh	14,84	27,25

3.1.2 Free Fatty Acid Test Result Data

Data on the results of free fatty acid testing in *crude palm oil* (CPO) after *bleaching* with temperatures of 150ºC, 160ºC, 170ºC and *bleaching time* of 50 minutes, 60 minutes and 70 minutes, can be seen in Table 3

Table 3 ALB test result data

Size of activated carbon (mesh)	*Bleaching Temp* (^{0}C)	Bleaching time (minutes)	ALB (%) Before Bleaching	ALB(%) After *bleaching*	% ALB Exclusion after *bleaching*
120/150	150	50	7,57	4,09	45,97
		60		4,0	47,15
		70		3,89	48,61
	160	50	7,57	3,69	51,25
		60		3,58	52,70
		70		3,48	54,02
	170	50	7,57	3,28	56,67
		60		3,17	58,12
		70		3,08	59,31
150/180	150	50	7,57	5,22	31,04
		60		5,12	32,36
		70		5,01	33,81
	160	50	7,57	4,92	35,00
		60		4,81	36,45
		70		4,71	37,78
	170	50	7,57	4,61	39,10
		60		4,50	40,55
		70		4,30	43,19
180/200	150	50	7,57	6,55	13,47
		60		6,45	14,79
		70		6,25	17,43
	160	50	7,57	6,14	18,89
		60		5,94	21,53
		70		5,83	22,98
	170	50	7,57	5,73	24,30
		60		5,63	25,62
		70		5,42	28,40

3.2 Discussion

3.2.1 Comparison of Activated Carbon Research Results with SNI 06-3730-1995

Comparison of activated carbon obtained with SNI 06-3730-1995, can be seen in Figure 1

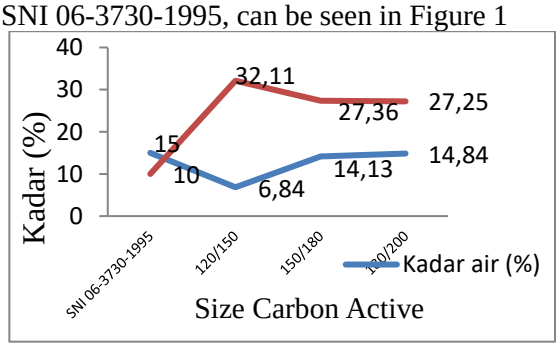

Figure 1 Comparison of activated carbon obtained with SNI 06-3730-1995

Based on Figure 1, it can be seen that the moisture content value in the activated carbon test made by the researcher has met the SNI 06-3730-1995 standard so that it is suitable for use. However, the results of the ash content test have not met SNI 06-3730-1995 because there is incomplete combustion so that the air entering the combustion process causes the oxidation of minerals contained in the biomass. Activated carbon with particle sizes of 150/180 and 180/200 mesh has a lower ash content compared to activated carbon with a particle size of 120/150 mesh, this is influenced by the particle size itself, where the smaller the size of the activated carbon particles, the lower the ash content produced due to the presence of activators that can dissolve metal oxides, this is in line with research that has been conducted by Retno. *et al* (2016), where the results of the study stated that the smaller the size of activated carbon, the smaller the ash content obtained.

4.2.2 Effect of Temperature and Time *Bleaching* Against Free Fatty Acids

Testing of free fatty acids (ALB) in *crude palm oil* (CPO) using activated carbon measuring 120/150 mesh with bleaching temperature variations of 150^{o}C, 160^{o}C, 170^{o}C and *bleaching* time of 50 minutes, 60 minutes and 70 minutes.

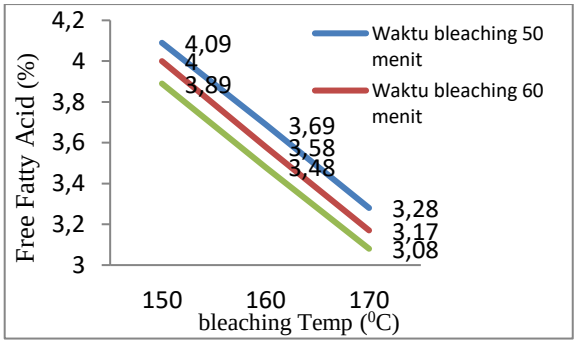

Figure 2 Effect of temperature and *bleaching* time on ALB in CPO for the use of 120/150 mesh activated carbon.

The following is the % allowance of ALB in CPO after *bleaching* on 120/150 mesh activated carbon, can be seen in Figure 3

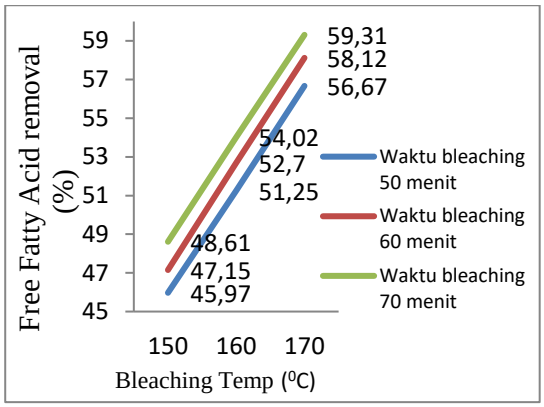

Figure 3% of the ALB allowance in CPO after *bleaching* for 120/150 mesh activated carbon.

From Figure 3, it can be seen that the percentage of ALB allowance in CPO after *bleaching* with 120/150 mesh activated carbon has increased frequently, increasing the bleaching temperature. Thus, it can be said that the higher the bleaching temperature, the more ALB is absorbed by the 120/150 mesh activated carbon.

For the effect of temperature and *bleaching* time on ALB in CPO produced from 150/180 mesh activated carbon, it can be seen in Figure 4.

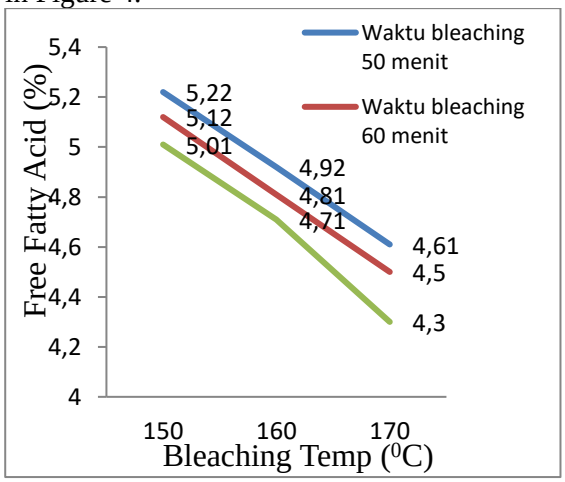

Figure 4 Effect of temperature and *bleaching* time on ALB in CPO for the use of 150/180 mesh activated carbon.

The following is the % of ALB allowance in CPO after *bleaching* on 150/180 mesh activated carbon, which can be seen in Figure 5

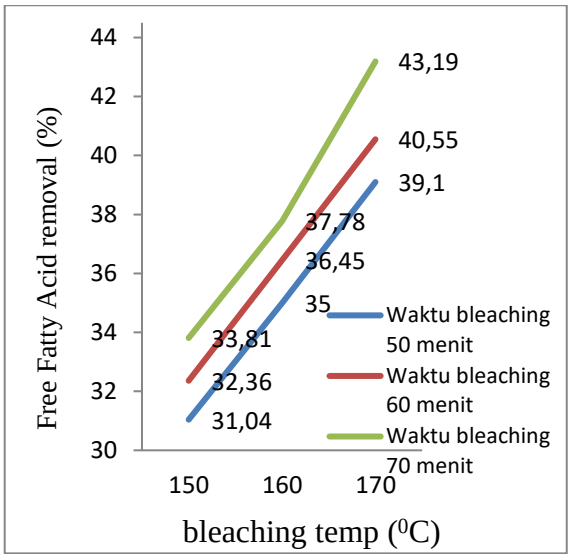

Figure 5% allowance of ALB in CPO after *bleaching* for 150/180 mesh activated carbon.

From Figure 5, it can be seen that the percentage of ALB allowance in CPO after *bleaching* with 150/180 mesh activated carbon has increased along with the increase in time and temperature in the *bleaching* process. So, temperature and time greatly affect the absorption of ALB in CPO where the higher the temperature and the longer the time in the ALB bleaching process that is absorbed by 150/180 mesh activated carbon, the more it is.

As for the effect of temperature and *bleaching* time on ALB in CPO produced from 180/200 mesh activated carbon, it can be seen in Figure 6

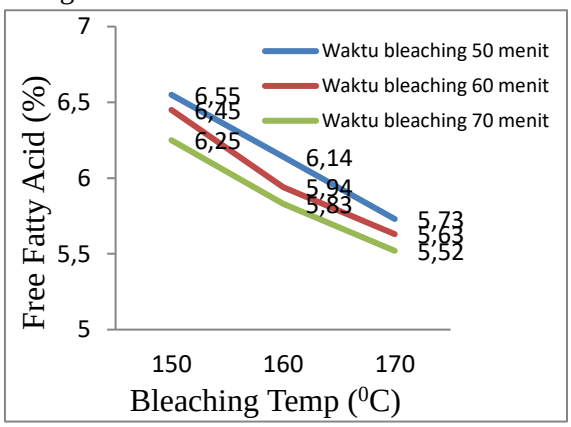

Figure 6 Effect of temperature and *bleaching* time on ALB in CPO for the use of 180/200 mesh activated carbon.

The following is the % allowance of ALB in CPO after *bleaching* on 180/200 mesh activated carbon, can be seen in Figure 7

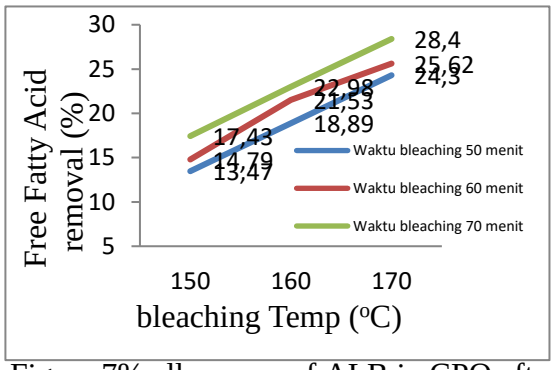

Figure 7% allowance of ALB in CPO after *bleaching* for 180/200 mesh activated carbon.

From Figure 7, it can be seen that the absorption of free fatty acids in CPO is directly proportional to the temperature and bleaching time, where at 170°C with a time of 70 minutes the absorption of ALB is higher while the lowest is at a temperature of 150°C with a time of 50 minutes.

Thus, the absorption of ALB in CPO after *the bleaching* process can be seen in Figures 2, 4 and 6 where free fatty acids decrease along with the increase of *bleaching* temperature and *bleaching time*, if the high level of free fatty acids will cause a decrease in the quality *of crude palm oil* (CPO) so that it can cause rancidity in the *crude palm oil* (CPO).

In this study, the ash content value in activated charcoal did not meet the SNI 06-3730-1995 standard, but from the results of *crude palm oil* (CPO) testing after the *bleaching process* , the content of free fatty acids decreased, where in activated charcoal with sizes of 120/150 mesh, 150/180 mesh and 180/200 mesh continued to decrease along with the increase in temperature and bleaching time for *crude palm oil* (CPO) for each size of activated charcoal particles. If you look at the results of the activated charcoal test, the ash content value is very high, then the pores in the activated charcoal will be closed by the ash, but in fact the ash content has no effect on the *bleaching* process where the results obtained continue to decrease, this is because it has a wider adsorbent surface area so that the adsorption process runs better in absorbing free fatty acids even though the content of activated charcoal ash does not meet SNI 06-3730-1995 standards.

4. CONCLUSION

1 The higher the temperature and time in the *bleaching* process , the lower the level of free fatty acids in CPO.
2 The larger the size of activated carbon used, the more free fatty acids can be absorbed.
3 From the test results, it was found that the activated carbon did not meet the SNI 06-3730-1995 standard for ash content where in the size of activated carbon particles (120/150, 150/180 and 180/200) the mesh had ash content values of 32.11%, 27.36% and 27.25% respectively while the required 10%, for the moisture content has met the standard because the size of activated carbon particles (120/150, 150/180 and 180/200) the mesh has a water content of 6.84% respectively, 14.13% and 14.84%, all of which are below the required 15%

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