RESEARCH ARTICLE

Advanced Science Letters
Vol. 23, 12239–12242, 2017

The Effect of Heating Temperature at the Bleaching Process of Palm Oil to the Color's Absorption of Activated-Based Trass Rock

Laurentius Urip Widodo*, Sukirmiyadi, and Kindriari Nurma Wahyusi

Department of Chemical Engineering, Universitas Pembangunan Nasional "Veteran" Jawa Timur Raya Rungkut Madya Gunung Anyar Surabaya 60294, East Java, Indonesia

In general palm oil becomes the raw material of frying oil, therefore palm oil needs to be processed at first before being consumed. However, this process has to pass through several stages, such as degumming, neutralization and bleaching. In degumming phosphate acid of 85% as much as 0.15% from the weight of palm oil then it was stirred for 15 minutes at the temperature of 80 °C. After that, to neutralize it we added some solution of NaOH 11,1% (16°Be) as much as 6% from the oil volume, then it was stirred for 25 minutes at the temperature of 60 °C. Meanwhile the novelty of this research could be seen from the bleaching process, the activated trass rock of HCl of 4% from the weight of oil was required as a bleaching material. This process was undertaken by varying its heating temperature of 140, 160, 180, 200, 220 and 240 °C. Furthermore, the bleaching times required were 15, 25, 35, 45 and 55 minutes and the most appropriate condition of heating temperature was 240 °C. Among those time variations, the bleaching time of 15 minutes was obtained the intensity of red color was 15 and the yellow was 38,9, free fatty acids was 1,44% and peroxide value was 7,30 meq O_2/kg.

Keywords: Trass Rock, Bleaching, Color's Absorption, Palm Oil.

1. INTRODUCTION

Frying oil is required and consumed by almost all of the Indonesian people. Therefore the need for it is getting more and more increasing from time to time. In oil making process, bentonite is usually used as a bleaching material. However, there is the other alternative used as a bleaching material, that is trass rock instead of bentonite. The original material required as a bleaching material in oil making process is taken from the trass rock.

This kind of rock is used to process the palm oil into frying oil. As vegetable oil, palm oil is rich for its minor component having a good nutrition because it contains of some variations of carotene around 500–700 ppm. The highest carotene, especially that belongs to α- and β contained in the palm oil is around ~90% from the total amount of carotene. Therefore, β-carotene is becoming the most important factor to obtain vitamin e A. Besides, carotene also takes an important role to prevent cancer disease, cataract, and degenerative disease like heart.[13]

Furthermore, palm oil is produced from the fat or oil of fruit flesh with its specific color, orange–red. This is due to the high content of carotenoide. Besides some pigment of some dirt like free fatty acids.[2]

In general, the original color of palm oil is dark red before being processed. Therefore before being used and consumed as frying oil, it needs bleaching process to clear up the red color (pigment) and another compound in the palm oil. Those pigment and compounds do not smell and taste nice. In bleaching process, some certain particles of unwanted smell and taste might be absorbed.[12]

Meanwhile, the main parameter of the controller at the bleaching process is the particle's size of its bleaching material. Furthermore, the oil's proportion, the dosage of its bleaching material, temperature and contact time between bleaching clay and oil are also important to consider.[9] The performance of bleaching material was taken from the activated clay and dealing with reducing its color, the bleaching material had to be capable of absorbing the palm oil.[4] During the bleaching process, the dye material, peroxide and any other dirt are released from the raw material of palm oil. After bleaching process has finished, the oil's color performance is getting clearer and clearer. This might increase the stability of its product.[5] Furthermore, bleaching earth can also omit some other particles like chlorophyll, carotenoids, phosphorlipids, metals and oxidation product of oil. However, so far, the only one system usually used to omit/clear up those particles is adsorption.[7] Some kind of crude oil, color, the content of free fatty acids, taste, physical and other chemical

*Author to whom correspondence should be addressed.

characteristics are becoming the other parameter Jenis which is also essential to be concerned with in efforts to obtain the good quality of final product.[4] However, to achieve the performance of optimal bleaching with the most economical cost in bleaching process several aspects to consider such as the kind and quality of oil, degumming and purification/refinement or neutralization, the characteristics of oil being processed, processing condition and site plan of processing tools being used.[11] Before bleaching process, some treatments of palm oil such as degumming and neutralization process have to be conducted at first. Degumming process is meant to eliminate some latex available in the palm oil without reducing the fatty acid in the oil and to precipitate some phosphatides which is not soluble in the water. Meanwhile, neutralization process is aimed at reducing or eliminating the free fatty acids available in the palm oil. The addition of NaOH solution during neutralization process has to be seen its concentration or volume of NaOH solution added so that the oil will not lose too much. The low value of water content in the raw palm oil might also cause the low content of free fatty acid. The water content might influence the percentage of free fatty acid in the oil and it must be diminished until reaching up 0,15% to 0,25% to avoid the increase of free fatty acid through autocatalytic reaction.[10] If the reaction between water and oil (triglis-eryde) happens in the palm oil, this reaction will be obtained glycerol and free fatty acid. Therefore, if the water content in the oil is quite high, this might cause the content of free fatty acids in the palm oil will be high also. It was suggested that the raw material of palm oil used as frying oil be oil having much content of unsaturated fatty acid. This is considered to be the healthy choice rather than that of containing saturated fatty acid. In general, frying oil has much unsaturated fatty acid so that oxidation will happen easily. Therefore, in using frying oil, it is suggested not to use it to fry many times. The more often the frying oil is used, the less amount of unsaturated fatty acid will be and the higher the saturated fatty acid of the frying oil. This might cause the value of peroxide in the frying oil increase due to the repeated heating. This could happen because the frying oil sustains oxidation process.[6]

This research was aimed at obtaining the operation condition of palm oil bleaching process using the bleaching material from activated trass rock of HCL as its absorption material. Therefore, it needs to vary several heating temperatures and the duration of bleaching time of palm oil. This process would be obtained the right condition where the red color contained in the palm oil would be absorbed as much as possible by the bleaching material of activated trass rock.

2. METHODOLOGY

Some materials required in this research were activated trass rock of HCl, NaOH, phosphate acid of 85%, aquadest and crude palm oil (CPO). Several equipments required were such as stove/heater, tank/baker glass, mixer, filter paper, funnel and thermometer. This research was conducted in two process stages, preparation of crude palm oil and bleaching process of palm oil. At first, the raw material of oil that would be used was analyzed dealing with the content/level of free fatty acid (FFA) and its peroxide value to know the former quality of palm oil. For preparation process, the raw material of palm oil required was as much as 21 liters. This was meant that later when the bleaching process was conducted, the condition of palm oil would be the same as what it was in preparation process. Then, those 21 liters of palm oil were done degumming by heating it up to 80 °C. After that, it was added with phosphate acid of 85% as much as 0.15% of the weight of palm oil and stirred for 15 minutes. The next, neutralization process was conducted by lowering/reducing its heating temperature of oil until 60 °C and added with NaOH solution with concentration of 11,1% (16°Be) as much as 6% of the oil volume and stirred for 25 minutes. After it had finished, the oil was cooled. The next, it was centrifuged or filtered to separate oil and suds/soap. Oil, as the result of neutralization process was then analyzed its content of FFA and peroxide value by using titrimetri method. While for its color's intensity of oil, with lovibond method we used test equipment of tintometer series E. After preparation process of palm oil material had finished, the next process was bleaching process. In this process we weighed palm oil as much as 300 grams added with activated trass rock of HCL of 4% from the oil's weight (12 grams of activated trass rock). This activated trass rock was obtained by activating the trass rock with 5 N of HCL solution with its comparison of 1:10 for 4 hours at its activation temperature of 105 °C. In this research, the bleaching process was conducted by varying its heating temperature, they were: 140, 160, 180, 200, 220 and 240 °C with its duration of 15, 25, 35, 45 and 55 minutes. After being weight, palm oil was put into a baker glass of 500 ml and heated until its temperature reached up as it had been determined. After that, the activated trass rock was put and mixed in the palm oil being heated and then stirred until the temperature reached up to the time limit already determined. After the bleaching process finished, the oil was filtered to isolate oil from its bleaching earth, that was activated trass rock. Having been filtered, the oil resulted in bleaching was then analyzed for its color's intensity using lovibond method with the test equipment of tintometer series E, the content of FFA and its peroxide value with titrimetri method.

3. EXPERIMENTAL RESULT

Having been analyzed, it was known that the quality of the former raw material of palm oil before being neutralized was as it was shown in Table I. The analysis result of palm oil after being neutralized might be seen in Table II. The analysis result of palm oil in a good condition after bleaching process can be seen in Table III.

Neutralization process of palm oil added with solution volume of NaOH 6% from the oil volume with its solution concentration of NaOH 11,1% of the oil's weight was capable of reducing the free fatty acid and peroxide value contained in palm oil might be seen in Tables I and II. It was shown that peroxide value was formerly 12,28 meq O_2/kg and decreased into 7,70 meq O_2/kg. Meanwhile, before the oil had been neutralized, the free fatty acid was 5,70%, and after being neutralized it decreased into 1,98%. The reduction of free fatty acid was due to the reaction between the free fatty acid and NaOH solution when neutralization process turned to soap and glycerol.

Table I. Data analysis of former palm oil.

Material	FFA (%)	Peroxide value (Meq O_2/Kg)
Former palm oil	5.70	12,28

Table II. The data of analysis result of palm oil after being neutralized.

Palm oil after being neutralized			
Intensity of oil's color			
Red	Yellow	FFA (%)	Peroxide value (Meq O_2/Kg)
59	30	1,98	7,70

The most important thing in bleaching process of palm oil was how the red color contained in the palm oil was like what it was said by Egbuna,[2] could be reduced or absorbed the whole bleaching material or the activated trass rock so that the oil's color turned to clear yellow as the frying oil in general. However bleaching process could also reduce some other unwanted materials such as free fatty acid and peroxide value contained in the palm oil could be seen in Table III, it is the same as that expressed by Falaras.[5] In line with the explanation above, in this research, the researcher wanted to see the operational condition of bleaching process by taking care of the effect of several variations of heating and bleaching time especially for bleaching material from activated trass rock. Based on the experiment, heating temperature and bleaching time took an important role to the oil result obtained either it was seen from its color's absorption or the absorption aspects of the other elements. Furthermore, the effect of employing several kinds of heating temperature to the absorption of red color of oil might be seen in Figure 1 (one) below.

As it was performed in Figure 1 below that the effect of temperature to bleaching process had an important role to the absorption of red color from palm oil. It could be concluded that the higher the heating temperature in bleaching process, the lower the intensity of red color to the palm oil would be Usman.[12] Furthermore, he said that the increase of bleaching efficiency would be followed by the temperature's increase to all adsorbens being used. These could be explained as follows, while the palm oil was being heated, it was expanding and this could reduce the oil's viscosity so that it could cause a better dispersion of oil's particle rather than what it was stated by Ejikeme.[3] The expansion of palm oil could be seen from the existence of oil volume in the vessel or container. The higher the heating temperature in bleaching process, the greater the oil's expansion would be and the oil's viscosity would be getting smaller. This oil's expansion might cause the color's bond contained in the oil would be getting thinner and oil's color would become light red. Therefore, the red color contained in the palm oil would be getting easier to be absorbed by the activated trass rock as the bleaching material. Besides, it might also be caused by the oil's viscosity was getting smaller so that oil would become thinner and clearer.

Table III. Data analysis of palm oil after bleaching process.

Bleaching time (minute)	Bleaching temperature (°C)	Intensity of oil's color		FFA (%)	Peroxide value (meq O_2/kg)
		Red	Yellow		
15	140	46,1	31	1,62	7,72
	160	41	31	1,21	6,90
	180	33	29	1,42	4,44
	200	23,3	35	1,51	5,25
	220	15,4	39,8	1,19	7,45
	240	15	38,9	1,44	7,30

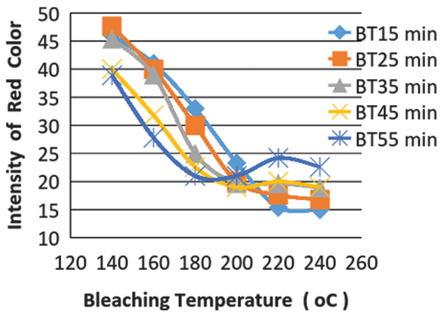

Fig. 1. The relationship between bleaching temperature and its intensity of red color.

This condition might cause the oil would become more easily to penetrate the pores of its bleaching material and make the oil's color easier to be absorbed. The good result of red color's absorption was when the heating temperature reaching up to 240 °C with its bleaching time of 15 minutes. This condition could be capable of reducing the intensity of red color from 59 to 15 as it could be performed in Tables II and III. Based on the explanation above, it could be concluded that the two aspects which could make the red color in palm oil be easier to be well absorbed were high temperature and the surface broadness of activated trass rock. The high temperature might make the loosening ties of oil's color and the surface broadness of activated trass rock could make the red color contained in the palm oil be well absorbed. There was about 74,6% of the red color of palm oil absorbed. However, we had to be cautious, otherwise the heating temperature of 240 °C during the bleaching time taking longer than it had to be was known that there was an intensity increase of red color. This could be seen in Figure 1 (one). It was shown that starting from the bleaching time of 25, 35, 45 and 55 minutes, the intensity of red color of the oil was getting increased again. This increase was due to the quite high temperature during heating process. This condition could make the oxidation reaction causing the oil's color turned darker. If the bleaching time took longer than it had to be, oil would keep on oxidizing. If this happened continually and the red color would keep on forming/establishing meanwhile its absorption power of bleaching material (the activated trass rock) was getting decreased and decreased. Therefore, the red color contained in the oil's performance was not any longer the red color from carotenoids from the oil of the former's palm oil but the red color caused by the change of oxidized oil. This condition might cause the oil as the result of bleaching process turn its color into dark yellow. Meanwhile, the oil as the result of bleaching process within 15 minutes, its color looked clear yellow. This might be due to the bleaching time of 15 minutes with its heating temperature of 240 °C had already been in balance with its bleaching process. Therefore, if the bleaching time was longer than 15 minutes, the red color from its pigment that had already been absorbed, it would be released again and it would enter the oil. The balance achieved by each oil material was different from one and another.[1] Furthermore, his experiment result was said that corn oil could achieve its balance after 2 hours at 45 °C, and after 30 minutes at 85 °C. On the other hand, oil from the sun flower's seed was much faster. It was said that at 45 °C the balance would be achieved after 40 minutes and the heating temperature of 85 °C would be achieved after 15 minutes. This condition might be assumed that the bleaching

process taking a long time would not provide the good result as what we had expected. In other words, the bleaching process had to be conducted at an exact heating temperature and exact bleaching time.[8]

4. CONCLUSIONS

Based on the experiment, the research result could be concluded that in bleaching process, heating temperature took an important role in the color's absorption of palm oil. However, the longer time of bleaching would not provide a good result. Therefore, we had to take care of the balance of color's absorption from the bleaching material being used. In this research, the best quality of oil product was obtained from the heating temperature of 240 °C and bleaching time of 15 minutes. In this condition, the intensity of red color could be decreased from 59 to 15 and the intensity of yellow color could be increased from 30 to 38,9. Besides, it could be capable of absorbing the content of free fatty acid (FFA) from 1,98% to 1,44%, as well as reducing its peroxide value from 7,70 meq O_2/kg to 7,30 meq O_2/kg.

References and Notes

1. G. E. Christidis and S. Kosiari, *Clays and Clay Minerals* 51, 327 **(2003)**.
2. S. O. Egbuna and M. Omotioma, *International Journal of Engineering Science Invention* 2, 21 **(2013)**.
3. E. M. Ejikeme, S. O. Egbuna, and P. C. N. Ejikeme, *International Journal of Engineering and Innovative Technology (IJEIT)* 3, 13 **(2013)**.
4. S. O. Egbuna, A. J. Ujam, and P. C. N. Ejikeme, *International Journal of Engineering and Applied Sciences* 4, 28 **(2013)**.
5. P. Falaras, F. Lezou, G. Seiragakis, and P. Dimitrios, *Clays and Clay Minerals* 48, 549 **(2000)**.
6. X. F. Leong, J. Salimon, M. R. Mustafa, and K. Jaarin, *Malays J. Med. Sci.* 19, 20 **(2012)**.
7. B. Makhoukhi, M. A. Didi, D. Villeminb, and A. Azzouzc, *Grasas Y Aceites* 60, 343 **(2009)**.
8. J. T. Nwabanne and F. C. Ekwu, *International Journal of Applied Science and Technology* 3, 69 **(2013)**.
9. J. T. Nwabanne and F. C. Ekwu, *International Journal of Multidisciplinary Sciences and Engineering* 4, 20 **(2013)**.
10. J. C. Okolo and B. A. Adejumo, *IOSR Journal of Engineering (IOSRJEN)* 4, 25 **(2014)**.
11. T. O. Salawudeen, A. O. Arinkoola, M. O. Jimoh, and B. A. Akinwande, *Journal of Minerals and Materials Characterization and Engineering* 2, 586 **(2014)**.
12. M. A. Usman, O. Oribayo, and A. A. Adebayo, *Chemical and Process Engineering Research* 10, 1 **(2013)**.
13. P. C. Wei, Y. M. Choo, N. Maah, and C. H. Chuah, *Journal of Oil Palm Research* 16, 57 **(2004)**.

Received: 29 August 2016. Accepted: 7 May 2017.