e-ISSN 2581-0405

Asian Journal of Applied Research for Community Development and Empowerment

Journal home page: http://ajarcde-safe-network.org ISSN 2581-0405

The Effect of Addition and Soaking Duration of Jackfruit Skin Bioadsorbent On The Purification of Used Cooking Oil

Raka Adi[1], Ulya Sarofa[1], Rosida[1].

[1]Department of Food Technology, Faculty of Engineering and Science, Universitas Pembangunan Nasional Veteran Jawa Timur, Indonesia.60294.

ARTICLE INFO

Article History:
Received: 12 May 2025
Final Revision: 08 June 2025
Accepted: 09 June 2025
Online Publication: 10 June 2025

KEYWORDS

Purification, Used cooking oil (UCO), Skin Jackfruit

CORRESPONDING AUTHOR

*E-mail: ulyasarofa@tp.upnjatim.ac.id

A B S T R A C T

Used cooking oil that has undergone repeated frying cycles experiences a significant decline in quality due to various degradation processes. The deterioration of fats during frying is primarily caused by the interaction of oil with air (oxidation), prolonged exposure to high temperatures, interaction with food materials, and burnt residues. Indicators of oil degradation include changes in color, increased Viscosity, elevated levels of free fatty acids and peroxides, and a decreased iodine number. Purifying used cooking oil removes harmful degradation by-products such as water, peroxides, free fatty acids, aldehydes, and ketones. One effective and sustainable method to improve the quality of used cooking oil is adsorption using natural adsorbents. The adsorption process involves mixing the oil with an adsorbent material capable of binding and removing impurities, followed by stirring and filtration. This study aimed to evaluate the effect of adsorbent concentration and soaking time using jackfruit peel—an agricultural waste product—as a low-cost and eco-friendly adsorbent, on the physicochemical properties of used cooking oil. The research utilized a Completely Randomized Design (CRD) with two factors: the concentration of jackfruit peel adsorbent (10%, 20%, 30%) and soaking time (30, 60, and 90 minutes). Data were analyzed using ANOVA, followed by a 5% Duncan Multiple Range Test (DMRT) and the Zeleny method to identify the best treatment combination. The optimal treatment was found to be a 30% adsorbent concentration with a 90-minute soaking time, which significantly improved the quality of the used cooking oil. The results were as follows: color score of 3.75, aroma score of 3.85, clarity score of 4.00, water content of 0.39%, free fatty acid (FFA) level of 0.23%, peroxide value of 7.18 meqO_2/kg, iodine value of 66.10 I_2/100g, Viscosity of 70.33 cP, and a smoke point of 179.20°C.

Contribution to the Sustainable Development Goals (SDGs):
SDG 12: Responsible Consumption and Production
SDG 3: Good Health and Well-being
SDG 13: Climate Action
SDG 9: Industry, Innovation and Infrastructure.

1. INTRODUCTION

1.1. Research Background

Cooking oil that has been used repeatedly will experience a decrease in quality. Fat damage during the frying process is caused by contact of oil with air, excessive heating, contact of oil with food ingredients, and burnt cooking ingredients during the frying process. Oil damage due to heating can be seen from color changes, increased viscosity, free fatty acid content, peroxide, and decreased iodine number [1].

Purifying used cooking oil separates degradation reaction products in water, peroxide, free fatty acids, aldehydes, and ketones from oil. One way that can be done to improve the quality of used cooking oil is by adsorption using adsorbents so that the quality of cooking oil can be maintained [2]. The adsorption process uses a material called an adsorbent that can adsorb dirt in oil. The cooking oil adsorption process can be done by adding adsorbent mixed with oil, followed by stirring and filtering [3].

According to Ref. [4], sufficient interaction time is needed by activated carbon to adsorb adsorbates optimally. The longer the interaction time, the more adsorbates are adsorbed because there are more opportunities for activated carbon particles to come into contact with the adsorbate. This causes more adsorbates to be bound in the pores of the activated carbon. This ability can be higher if the activated carbon is chemically activated or by heating at high temperatures [5]. The particle size and contact time of activated carbon affect the absorption capacity of activated carbon if used in the cooking oil refining process.

This study used jackfruit skin waste because jackfruit skin flour, according to Ref. [6], the largest components are cellulose (35-50%), hemicellulose (20-35%), and lignin (10-25%). Cellulose is a polysaccharide that functions as a structural element in the cell walls of higher plants. Cellulose has the potential to be used as an adsorbent.

Cellulose has quite a large potential to be used as an adsorbent because the -OH group bound to cellulose, when heated at high temperatures, will lose hydrogen and oxygen atoms so that only carbon atoms are bound to form a hexagon with carbon atoms located at each corner.

Charcoal or carbon is a porous solid material resulting from combustion through the carbonization process. Its components consist of fixed carbon, ash, water, nitrogen, and sulfur. Activated charcoal (activated carbon) is amorphous carbon from flat plates composed of C atoms that are covalently bonded in a flat hexagonal lattice with one C atom at each corner.

Previous research, according to Ref. [7], the contact time of activated carbon significantly affects the water content, peroxide value, free fatty acids, concentration weight, color sensory test, and Aroma of used cooking oil. The interaction between these two factors significantly affects the water content, peroxide value, free fatty acids, concentration weight, and color and aroma sensory tests of used cooking oil. The best treatment in this study was A2B3 (particle size 100 mesh with a contact time of 6 hours) with a water content of 0.19%, peroxide value 0.59 meq/kg, free fatty acids 1.64%, and concentration weight 0.88.

1.2. *Cooking Oil*

The quality of cooking oil is determined by the components of its fatty acids, namely, saturated or unsaturated fatty acids. Unsaturated fatty acids contain double bonds. In contrast, saturated fatty acids do not have double bonds. Fatty acids with more double bonds will be more reactive to oxygen, so they tend to be easily oxidized [8].

1.2.1. Used Cooking Oil (UCO)

In its use, cooking oil undergoes chemical changes due to oxidation and hydrolysis, which can cause damage to the cooking oil. Some triglycerides will break down into other compounds: Free Fatty Acid (FFA) or free fatty acids [9]. The formation of free fatty acids in used cooking oil or waste cooking oil is caused by hydrolysis during the frying process, which is usually carried out at a temperature of 160-200°C [9].

1.2.2. Jackfruit Skin

Jackfruit skin has a fairly complete nutrient content, including protein, fat, carbohydrates, fiber, calcium, phosphorus, iron, sodium, potassium, carotene, vitamin B1 (thiamine), vitamin B2 (riboflavin), niacin, and vitamin C (ascorbic acid). detailed that in addition to water, the components of jackfruit that are quite large are vitamin C (14.21%), carbohydrates (9.85%), protein (1.91%), fat (1.86%), and sugar (1.39%). The data shows that the carbon content of jackfruit is quite high. The percentage of this carbon content will be even greater on the skin of the fruit and its straw, which are dominated by cellulose and lignin. Thus, jackfruit skin waste is suitable for exploiting as a source for making activated carbon. This is also supported by opportunities for its application to the general public with simple technology, such as reducing dyes from textile industry wastewater and other liquid wastes. In jackfruit skin waste, the water content is 3.23%, ash content is 0.19%, volatile matter is 0.81%, fixed carbon is 95.74%, and the calorific value is 3863.54 cal/gram [10]

Figure 1. Jackfruit Skin

1.2.3. Sensory Profile of oil

a. Color

The color of oil or fat can be determined by comparing the color of the sample with the standard color. Changes in the color of cooking oil to a dark color can occur during the processing and storage process, which is caused by several factors: The heating temperature is too high when pressing by hydraulics or expeller, so that some of the oil is oxidized. In addition, the oil contained in a material, when hot, will extract the coloring substances contained in the material. Pressing materials containing oil with higher pressure and temperature will produce oil with a darker color [9].

b. Aroma

Fat is easy to absorb odors. If the packaging material can absorb fat, then the absorbed fat will be oxidized by the air so that it is damaged and smells. The smell of the damaged part of the fat will be absorbed by the fat in the package which causes all the fat to be damaged [11].

c. Purity

The more concentration of activated carbon used causes the activated carbon left in the oil to increase and the possibility of activated carbon dissolving in the oil because the size of the activated carbon particles is very small, therefore the level of clarity decreases. This is also supported by the statement which

https://doi.org/10.29165/ajarcde.v9i2.689

states that the adsorption process that is too long causes the separation process to take longer, and the filtration results become imperfect, as a result, the clarity becomes even less [12].

1.2.4. Free Fatty Acid (FFA)

Free fatty acids are obtained from hydrolysis, which is the decomposition of fat or triglycerides with water molecules that produce glycerol and free fatty acids. Damage to oil or fat can also be caused by the oxidation process, which is the contact between oxygen and oil or fat, usually beginning with the formation of peroxides and hydroperoxides. Then the free fatty acids will break down, accompanied by hydroperoxides into aldehydes, ketones, and fatty acids. Determination of fatty acids can be used to determine the quality of oil or fat, this is because the acid number can be used to measure and determine the amount of free fatty acids in a material or sample. The higher the acid number, the higher the free fatty acid content in the sample; the amount of free fatty acids contained in the sample can be caused by hydrolysis or poor processing [9].

1.2.5. Value of Peroxide

Oxidation of fat by oxygen occurs spontaneously if fatty materials are left in contact with air, while the rate of oxidation depends on the type of fat and storage conditions. Exposure to oxygen, light, and high temperatures are some of the factors that affect oxidation. The use of high temperatures during frying stimulates oil oxidation. The rate of fat oxidation will increase with increasing temperature and decrease at low temperatures. Cooking oil with peroxide content that exceeds the standard has a relatively thick, cloudy, foamy sediment, making the cooking oil thicker than cooking oil with peroxide content that still meets the standard [13].

1.2.6. Water Content

Water content is the amount of water contained in cooking oil that determines the level of purity of the oil and is related to the strength of the storage capacity of the fried shoulder, properties and taste. During the frying process, the water contained in the food ingredients will come out and come into contact with the oil, some of the water will evaporate, and some will mix with the oil to encourage a hydrolysis reaction, especially if the fried ingredients have a high water content. So the lower the water content, the better the quality of the cooking oil and the higher the water content, the lower the quality of the oil. This is because the presence of water in the oil can trigger a hydrolysis reaction, which causes a decrease in the quality of the oil. When heating, cooking oil with a high water content will cause oil splashes when frying [9].

1.2.7. Viscocity

The quality of cooking oil is inversely proportional to the Viscosity and refractive index values, so if the value of these parameters increases, the quality of the oil decreases. The greater the frequency of repeated use of cooking oil, the higher the oil's Viscosity and refractive index values and the lower its quality. The increase in the Viscosity and refractive index values of the cooking oil sample after use can be caused by complex reactions that occur during the frying process such as dissolving fat from food ingredients [14].

1.2.8. Value of iodine

The iodine number reflects the unsaturation of fatty acids that make up oil and fat. Unsaturated fatty acids can bind iodine and form saturated compounds. The amount of iodine bound indicates the number of double bonds. The iodine number is expressed as the number of grams of iodine bound by 100 grams of oil or fat. The more iodine numbers are measured, the more unsaturated fatty acid content in the oil, which indicates the better quality of the oil [15].

1.2.9. Smoke Point

The smoke point is the temperature at which oil or fat produces thin, bluish smoke when heated [9].

The limit of oil damage or oil that is not suitable for reuse can be determined from its smoke point. A smoke point of 170ºC is the minimum standard used to state that the oil has reached the damage limit [16].

The presence of a smoke point indicates that the cooking oil has experienced physical damage. Likewise with the statement Tobing [17]. that the smoke point of cooking oil increases in line with the decreasing levels of free fatty acids [17].

1.2.10. Activated Carbon

Activated carbon is obtained through combustion (carbonization) and activation processes. Carbonization or charring is a heating process at a certain temperature of organic materials in a very limited amount of oxygen, usually carried out in a Maffle Furnace. According to Nafi'ah [4] , the combustion temperature for charcoal formation ranges from 350–500 °C. The carbonization stage will produce charcoal that has weak absorption because the surface of the charcoal is still covered with hydrocarbon compounds. Therefore, charcoal still requires improving its pore structure through activation. The activation process aims to enlarge the pores by breaking hydrocarbon bonds or oxidizing the molecules that cover the surface of the charcoal so that the charcoal experiences changes in properties, both physical and chemical, and its surface area increases and affects the absorption capacity [4].

Activated charcoal has differences from ordinary charcoal. This is because the carbon in the pores of activated charcoal has been activated, so its adsorption capacity is greater. The activated charcoal obtained has a role as an adsorbent for oil bleaching, absorbing odors produced from colloidal suspensions and degrading oil to reduce the amount of peroxide number. Contact time can also affect activated carbon's performance and absorption capacity, which will affect the effectiveness of an adsorbent. According to Nafi'ah [4], sufficient interaction time is needed by activated carbon in order to adsorb the adsorbate optimally. The longer the interaction time, the more adsorbate is adsorbed because there are more opportunities for activated charcoal particles to come into contact with the adsorbate. This causes more adsorbate to be bound in the pores of activated charcoal. This ability can be higher if the activated carbon is chemically activated or by heating at high temperatures [5]. The particle size and contact time of activated carbon affect the absorption capacity of activated carbon when used in the used cooking oil purification process.

1.2.11. Process of purity used cooking oil

The process of regenerating used cooking oil can be done by: a sample of 100ml of used cooking oil is heated on a hot plate at a temperature of 70-100°C, then an adsorbent with a concentration of 1-10% is added while stirring using a magnetic stirrer for 30 minutes. Furthermore, the mixture is left for ±5 hours and filtered with filter paper to separate the adsorbent from the oil using filter paper [18].

Purification is the first stage of using used cooking oil, either for reuse or as a raw product material. One method considered simple, economical, and easy to improve the quality of used cooking oil is adsorption.

In this case, activated charcoal is the adsorbent, while the peroxide number and dye are adsorbates. The adsorption power of activated charcoal is because activated charcoal has a large number of pores, and adsorption will occur due to the difference in potential energy between the surface of the charcoal and the substance being absorbed. Activated charcoal can absorb 95-97% of the total dye contained in the oil. Activated charcoal can also absorb some of the unwanted odors contained in the oil and reduce the peroxide number so that it can improve the quality of the oil. Adsorbents have cellulose, which can adsorb fatty acids and dyes in oil. Cellulose contains hydroxyl groups or -OH groups, while free fatty acids contain compounds that can bind to the -OH groups of the adsorbent. The cellulose content in rice husks and the activation of rice husk charcoal can reduce the peroxide and iodine content in used cooking oil [18].

1.3. Research Objective

This study aims to determine the effect of the addition of treatment and soaking time of jackfruit skin adsorbent on the physicochemical properties of used cooking oil, and to find out the best treatment between the adsorbent treatment and soaking time of jackfruit skin adsorbent on the physicochemical properties of used cooking oil.

2. MATERIALS AND METHODS

The purification of used cooking oil begins with an initial analysis, then the used cooking oil is heated at a temperature of 70 degrees Celsius, and activated carbon is inserted into the used cooking oil according to the mass, adsorbent size, and adsorption time specified. Then the FFA content, acid number, water content, and peroxide number were tested. This study consisted of two stages, namely the manufacture of activated carbon (including activation) and the purification of used cooking oil. The materials needed in this study include jackfruit waste, which will later be dried and made into powder, used cooking oil or used frying oil, 10% KOH activation solution. The tools used in this study include: Measuring flask, beaker glass, Erlenmeyer, Buchner filter, measuring cup, dropper pipette, volume pipette, funnel, digital scale, magnetic stirrer, burette, thermometer, pH meter, oven, magnetic stirrer, stopwatch, fine sieve (100 mesh), hot plate, blender, filter paper, universal pH paper, centrifuge, funnel and desiccator

2.1. Methodology

This study consists of two stages: manufacturing activated carbon (including activation) and using cooking oil purification. Experimental variations were carried out on the mass of activated carbon, namely 10; 20; 30 grams, adsorbent size 100 mesh and adsorption time 30; 60; 90 minutes. The manufacture of activated carbon was carried out by dividing jackfruit skin into smaller parts and burning it in a furnace at a temperature of 400C for 2 hours, the carbon was ground and sieved using a 100 mesh sieve, then chemically activated with 10% KOH and rinsed with distilled water until the pH was neutral.

Description :
A1B1 = 10 g of jackfruit skin adsorbent added with a soaking time of 30 minutes
A1B2 = 10 g of jackfruit skin adsorbent addition with a soaking time of 60 minutes
A1B3 = 10 g of jackfruit skin adsorbent added with a soaking time of 90 minutes
A2B1 = 20 g of jackfruit skin adsorbent added with a soaking time of 30 minutes
A2B2 = 20 g of jackfruit skin adsorbent added with a soaking time of 60 minutes
A2B3 = 20 g of jackfruit skin adsorbent added with a soaking time of 90 minutes
A3B1 = 30 g of jackfruit skin adsorbent added with a soaking time of 30 minutes
A3B2 = 30 g of jackfruit skin adsorbent added with a soaking time of 60 minutes
A3B3 = 30 g of jackfruit skin adsorbent added with a soaking time of 90 minutes

This study used the Completely Randomized Design (CRD) method. Factor 1 was the concentration of adsorbent addition (10%, 20%, 30%), and factor 2 was the soaking time (30 minutes, 60 minutes, 90 minutes). The data were analyzed using the ANOVA method, 5% DMRT further test, and the best treatment test was carried out using the Zeleny method.

2.2. Research Analysis

2.2.1. Physicochemical properties of used cooking oil and used cooking oil after regeneration

The parameters analyzed were Water content, Free fatty acid content, Peroxide number, Smoke point, and Iodine number.

2.2.2. Physicochemical properties of the carbon active of jackfruit skin

The parameters analyzed were Water content and ash content.

2.2.3. Sensory evaluation of used cooking oil and used cooking oil after regeneration

Sensory characteristics were selected to evaluate the quality of cooking oil used after regeneration, as well as its appearance, colour, Aroma, and purity. A total of 20 panelists were assigned to rate the acceptability of the product using a 5-point scale.

https://doi.org/10.29165/ajarcde.v9i2.689

3. RESULT AND DISCUSSION

3.1. Analysis of Raw Material

3.1.1. Used Cooking Oil Analysis

The results of the physicochemical and organoleptic analysis of used cooking oil raw materials can be seen in Table 1.

Table 1. Results of physicochemical and organoleptic analysis of used cooking oil raw materials.

Parameter	Result Analysis	Literature
Value of water (%)	1.52 ± 0,215	Maks 0,15[a]
Free Fatty Acid (%)	0.69 ± 0,026	Maks 0,3[a]
Value of Peroxide (mEq/Kg)	22,07 ± 0,790	Maks 10[a]
Value Of Iodine (gr I_2/100 gr)	55,33 ± 0,577	50,0[b]
Viscosity (cP)	82,67 ± 0,577	85[c]
Smoke Point (^{0}C)	140,33 ± 0,577	180[d]
Organoleptic		
- Aroma	Rancid	-
- Color	Brown	-
- Purity	Cloudy	-

The analysis of used cooking oil does not comply with SNI 01-3741-2019 because, according to Ref. [3], cooking oil undergoes chemical changes due to oxidation and hydrolysis, which can cause damage to the cooking oil. Through these processes, some triglycerides will break down into other compounds, one of which is Free Fatty Acid (FFA), so that the level of free fatty acids in the oil will increase.

3.1.2. Carbon Active of Jackfruit Skin Analysis

The results of the analysis in Table 2 show that the raw material of jackfruit skin activated charcoal has a water content of 9.57% and an ash content of 8.80%, which refers to the SNI 01-6235-2000 regulation for the biobriquette standard, the test parameters are a maximum water content of 8%, a maximum ash content of 8%, so it can be concluded that jackfruit skin activated charcoal has not met the SNI 01-6235-2000 standard that has been set so that it is not optimal to become a adsorbent.

Table 2. Moisture and Ash Content Analysis of Carbon Active from Jackfruit Skin

Parameter	Analysis Result	Literatur
Moisture Content	9.57 ± 0.260	Max. 8%
Ash Content	8.80 ± 0.724	Max. 8%

3.2. Regenerated Oil Analysis Results

3.2.1. Water Content

The average water content of regenerated oil ranges from 1.24% at the highest, with the addition of 10% adsorbent and a soaking time of 30 minutes, and the lowest is 0.39% with the addition of 30% adsorbent and a soaking time of 90 minutes (Table 3).

.

Table 3. The average water content of regenerated oil

Treatment		Value of Water (%)	Notation
Addition of Adsorbent	Soaking Time (Minutes)		
10% Adsorbent	30	1.24 ± 0.007	a
	60	0.86 ± 0.018	d
	90	0.57 ± 0.027	g
20% Adsorbent	30	1.18 ± 0.013	b
	60	0.77 ± 0.023	e
	90	0.45 ± 0.015	h
30% Adsorbent	30	1.12 ± 0.007	c
	60	0.66 ± 0.020	f
	90	0.39 ± 0.028	i

The graph of the relationship between the treatment of adsorbent concentration and adsorption time to the water content of regenerated oil can be seen in Figure 2.

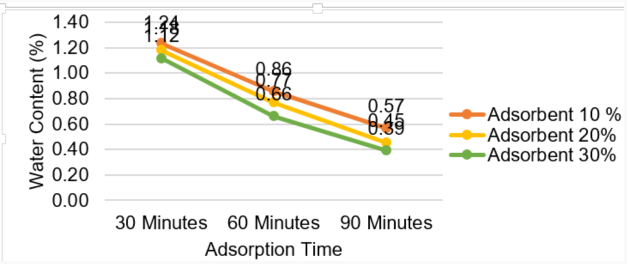

Figure 2. The relationship between the treatment of adsorbent concentration and adsorption time to the water content of regenerated oil.

In Figure 2, the lowest water content was obtained with a result of 0.39, 30% adsorbent, and a soaking time of 90 minutes. And the highest water content was obtained with a result of 1.24 with 10% adsorbent and a soaking time of 30 minutes. This is due to the absorption of the adsorbent into the used cooking oil, which can reduce the water content in the used cooking oil. The greater the effect of adding adsorbent, the lower the cooking oil's water content. Contact time can also affect the performance and absorption of activated carbon, so it will affect the effectiveness of an adsorbent. Therefore, the longer the adsorbent is soaked in used cooking oil, the lower the water content, where the contact time between the adsorbent also affects the water content of used cooking oil. According to [4], sufficient interaction time is needed by activated carbon to adsorb the adsorbate optimally. The longer the interaction time, the more adsorbate is adsorbed because there are more opportunities for activated carbon particles to come into contact with the adsorbate. This causes more adsorbate to be bound in the pores of the activated carbon.

3.2.2. Free Fatty Acid

Based on Table 4, the average free fatty acid content of regenerated oil ranges from 0.6356%, the highest with the addition of 10% adsorbent and a soaking time of 30 minutes, and 0.2340%, the lowest with the addition of 30% adsorbent and a soaking time of 90 minutes. The graph of the relationship between the treatment of adsorbent concentration and adsorption time on free fatty acids of regenerated oil can be seen in Figure 3

.

Table 4. The average free fatty acid content of regenerated oil

Treatment			
Addition of Adsorbent	Soaking Time (Minutes)	Free Fatty Acid (%)	Notation
10% adsorbent	30	0.6356 ± 0.013	a
	60	0.5064 ± 0.010	d
	90	0.3612 ± 0.022	g
20% Adsorbent	30	0.6017 ± 0.008	b
	60	0.4553 ± 0.006	e
	90	0.2765 ± 0.007	h
30% Adsorbent	30	0.5593 ± 0.007	c
	60	0.3970 ± 0.007	f
	90	0.2340 ± 0.011	i

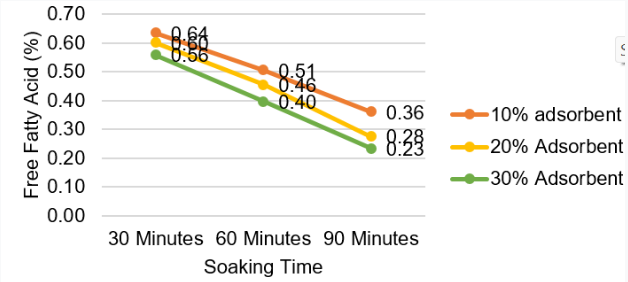

Figure 3. The relationship between the treatment of adsorbent concentration and adsorption time to the FFA content of regenerated oil.

Based on the Figure 3, the greater the addition of adsorbent, the lower the free fatty acid content of the regenerated oil because the more adsorbent, the more adsorbent can adsorb the adsorbate so that it can reduce the free fatty acid content, the relationship between the treatment of adding adsorbent and the duration of adsorption of free fatty acids in regenerated used cooking oil, the higher the free fatty acid number, the lower the quality of the oil. Free fatty acids are obtained from hydrolysis, namely the decomposition of fat or triglycerides with water molecules that produce glycerol and free fatty acids. According to [9], damage to oil or fat can also be caused by the oxidation process, namely the contact between a number of oxygen and oil or fat which usually begins with the formation of peroxides and hydroperoxides. Then the free fatty acids will break down accompanied by hydroperoxides into aldehydes, ketones, and fatty acids. It can be seen that the free fatty acids or FFA content from the used cooking oil purification process is not yet optimal and meets the specified standards, namely a maximum of 0.3%.

3.2.3. Value of Peroxide

Table 5. The average score of the Peroxide Value of regenerated oil

Treatment			
Addition Adsorbent	Soaking Time (Minutes)	Value of Peroxide (mek O2/kg)	Notation
10% Adsorbent	30	19.48 ± 0.110	a
	60	15.62 ± 0.580	d
	90	9.94 ± 0.034	g
20% Adsorbent	30	18.35 ± 0.296	b
	60	13.32 ± 0.557	e
	90	8.34 ± 0.313	h
30% Adsorbent	30	17.37 ± 0.400	c
	60	11.95 ± 0.010	f
	90	7.17 ± 0.018	i

The average peroxide number of regenerated used cooking oil ranges from 19.48 ± 0.110, the largest with a concentration of 10% and a soaking time of 30 minutes, and 7.17 ± 0.018, the lowest with a concentration of 30% and a soaking time of 90 minutes. The graph of the relationship between the treatment of adding adsorbents and the soaking time on the peroxide number of regenerated oil can be seen in the Figure 4.

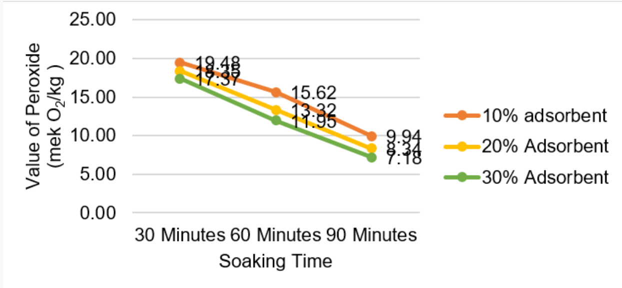

Figure 4. The relationship between the treatment of adsorbent concentration and adsorption time to the Peroxide Value of regenerated oil.

Figure 4 shows that the greater the addition of adsorbent, the lower the peroxide number because the more adsorbent, the adsorbent will adsorb the more and also the longer the interaction time, the more adsorbent interacts to reduce the peroxide number. Sufficient interaction time is needed by activated carbon in order to adsorb the adsorbate optimally. The longer the interaction time, the more adsorbate is adsorbed because there are more opportunities for activated carbon particles to come into contact with the adsorbate. So if the longer the soaking, the longer, the contact time, which can decrease the peroxide number. This is following the statement [4], sufficient interaction time is needed by activated carbon in order to optimally adsorb the adsorbate. The longer the interaction time, the more adsorbate is adsorbed because there are more opportunities for activated carbon particles to come into contact with the adsorbate.

3.2.4. Value of Iodine

The average iodine number of regenerated used cooking oil ranges from 57.40 (g I2/100g) the lowest with the treatment of adding 10% adsorbent concentration and soaking time for 30 minutes, and the highest result is 66.10 (g I2/100g) with the treatment of adding 30% adsorbent concentration and soaking time for 90 minutes. The graph of the relationship between the treatment of adsorbent concentration and adsorption time to the iodine number of regenerated oil can be seen in Figure 5.

Table 6. The Iodine Value of regenerated oil

Treatment		Value of Iodine (gr I2/ 100 gr) Average	Notation
Addition Adsorbent	Soaking Time (Minutes)		
10% Adsorbent	30	57.40 ± 0.173	H
	60	59.80 ± 0.361	e
	90	63.37 ± 0.473	c
20% Adsorbent	30	58.07 ± 0.208	g
	60	61.07 ± 0.208	d
	90	64.17 ± 0.289	b
30% Adsorbent	30	58.93 ± 0.306	g
	60	62.87 ± 0.153	c
	90	66.10 ± 0.173	a

 https://doi.org/10.29165/ajarcde.v9i2.689

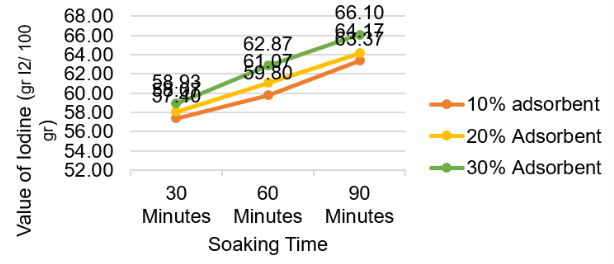

Figure 5. The relationship between the treatment of adsorbent concentration and adsorption time to the Iodine Value of regenerated oil.

Figure 5 shows that the greater the addition of adsorbent, the iodine number increases after being treated with the addition of adsorbent so that it is adsorbed with jackfruit skin activated carbon. This is due to the absorption process of saturated fatty acids in used cooking oil, which increases the iodine number. The longer the interaction time, the more adsorbents interact to reduce the peroxide number. Sufficient interaction time is needed by activated carbon to optimally adsorb the adsorbate. The longer the interaction time, the more adsorbate is adsorbed because there are more opportunities for activated carbon particles to come into contact with the adsorbate. This is following the statement [15] the iodine number is used to determine the unsaturation of oil or indicate the number of double bonds owned by fatty acids. The more fatty acids with double bonds, the higher the iodine number and the liquid form.

3.2.5. *Viscocity*

The average Viscosity of the regenerated oil ranges from 80.33 (Cp) with an adsorbent concentration of 10% and a soaking time of 30 minutes, producing the highest Viscosity (Table 7) and the lowest Viscosity of 70.33 (Cp) is produced from the treatment of 30% adsorbent concentration with a soaking time of 90 minutes. The graph of the relationship between the treatment of adsorbent concentration and adsorption time on the Viscosity of the regenerated oil can be seen in Figure 6.

Table 7. The average score of Viscosity of regenerated oil

Treatment			Notation
Addition Adsorbent	Soaking Time (Minutes)	Viscocity (Cp)	
10% Adsorben	30	80.33 ± 0.577	a
	60	75.00 ± 0.000	d
	90	73.00 ± 0.000	f
20% Adsorben	30	78.00 ± 0.000	b
	60	74.67 ± 0.577	d
	90	72.00 ± 1.000	g
30% Adsorben	30	76.33 ± 0.577	c
	60	74.00 ± 1.000	e
	90	70.33 ± 0.577	h

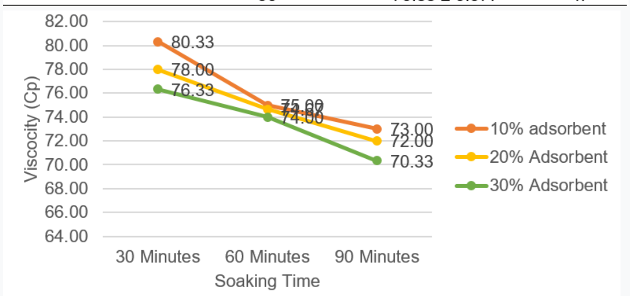

Figure 6. The relationship between the treatment of adsorbent concentration and adsorption time to the Viscosity of regenerated oil.

it can be seen in the picture that the treatment with a concentration of 10% adsorbent and a soaking time of 30 minutes is less effective in reducing oil viscosity because the contact time and soaking time are less effective so that they are unable to absorb chemical compounds in used cooking oil which causes an increase in oil viscosity, because heating or repeated use of oil can increase Viscosity due to the formation of polymers and crumbs from the fried ingredients. This is following the statement [14] the greater the frequency of repeated use of cooking oil, the higher the Viscosity and refractive index of the oil and the lower its quality. The increase in the Viscosity and refractive index of the cooking oil sample after use can be caused by complex reactions during the frying process, such as dissolving fat from food ingredients.

3.2.6. *Smoke Point*

The average smoke point of regenerated oil ranges from 150.83 ± 0.764°C with a concentration of 10% and a soaking time of 30 minutes as the lowest and 179.20 ± 0.721°C with a concentration of 30% and a soaking time of 90 minutes as the highest.)Table 8). The graph of the relationship between the treatment of adsorbent concentration and adsorption time on the smoke point of regenerated oil can be seen in Figure 7.

Table 8. The average score of the Smoke Point of regenerated oil

Treatment			Notation
Addition Adsorbent	Soaking Time (Minutes)	Smoke Point (C°)	
10% Adsorbent	30	150.83 ± 0.764	i
	60	164.13 ± 0.808	f
	90	172.00 ± 0.600	c
20% Adsorbent	30	153.27 ± 0.252	h
	60	167.57 ± 0.603	e
	90	174.63 ± 0.945	b
30% Adsorbent	30	155.57 ± 0.603	g
	60	169.77 ± 0.802	d
	90	179.20 ± 0.721	a

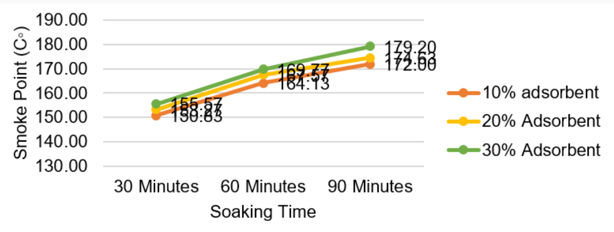

Figure 7. the relationship between the treatment of adsorbent concentration and adsorption time to the smoke point of regenerated oil.

Figure 7 shows that the greater the addition of adsorbent and the longer the soaking, the higher the smoke point of the regenerated oil. This is because the more adsorbent and the longer the soaking, the adsorbent will adsorb the regenerated oil to the maximum because if the interaction time is sufficient, the adsorbent can reduce free fatty acids which will increase the smoke point of the regenerated oil. After all, free fatty acids decrease, in line with the increase in the smoke point of cooking oil. This is also following the statement of Ref. [17]. This decrease in the smoke point is caused by the oil being oxidized due to contact with air, heat at high temperatures, and long frying times, which causes oil molecules to decompose.

3.2.7. Color

Table 9 shows that the average color scoring value of regenerated used cooking oil ranges from 2.15 with the lowest score given a 30-minute soaking treatment showing that the oil color is brown and the adsorbent concentration is 10% and gets the highest score with 3.75 with a 90-minute soaking treatment and an adsorbent concentration of 30% which shows that the color results tend to approach golden yellow. Based on the table above, shows that the soaking treatment for 30 minutes with an adsorbent concentration of 10% shows brown oil which is caused by the use of oil periodically, continuously, causing the oxidation process in the oil which causes the color and rancidity of the cooking oil. This is following the statement [9], that the oil contained in a material, in a hot state, will extract the coloring substances contained in the material. pressing materials containing oil with higher pressure and temperature will produce oil with a darker color.

Table 9. The average score of color

Treatment		Color	BNJ 5%	Notation
Addition Adsorbent	Soaking Time (Minutes)			
10% adsorbent	30	2.15 ± 0.875	0.176	g
	60	2.70 ± 0.801		f
	90	3.35 ± 1.089		c
20% Adsorbent	30	2.35 ± 0.587		g
	60	2.95 ± 0.826		e
	90	3.60 ± 0.940		b
30% Adsorbent	30	2.50 ± 0.513		f
	60	3.10 ± 0.718		d
	90	3.75 ± 0.716		a

3.2.8. Aroma

Table 10 shows that the average value of the aroma scoring of regenerated used cooking oil ranges from 1.80 to 3.85. It can be seen that the lowest scoring value is the treatment with an adsorbent concentration of 10% with a soaking time of 30 minutes which produces a scoring test of 1.80 which means a rancid aroma, while in the treatment with an adsorbent concentration of 30% with a soaking time of 90 minutes the highest scoring test result is 3.85 which still has a distinctive aroma of oil. that the higher the scoring test number, the better the aroma quality of the regenerated oil.

Table 10. The average score of Aroma of regenerated oil

Treatment		Aroma	BNJ 5%	Notation
Addition Adsorben	Soaking Time (Minutes)			
10% Adsorben	30	1.80 ± 0.768	0.177	h
	60	2.35 ± 0.813		f
	90	3.30 ± 0.923		c
20% Adsorben	30	2.00 ± 0.795		g
	60	2.65 ± 0.875		e
	90	3.55 ± 0.826		b
30% Adsorben	30	2.20 ± 0.696		f
	60	2.90 ± 0.788		d
	90	3.85 ± 0.745		a

The aroma parameter obtained the best results, namely having a distinctive aroma of palm cooking oil (3.85) because the adsorbent can absorb the chemical components in used cooking oil so that the regenerated oil can produce a distinctive aroma of palm cooking oil, and also the longer the interaction time between the adsorbent and the adsorbate can produce maximum Aroma, this is following the statement of [4], sufficient interaction time is needed by activated carbon to optimally adsorb the adsorbate. The longer the interaction time, the more adsorbate is adsorbed because there are more opportunities for activated carbon particles to come into contact with the adsorbate.

3.2.9. Purity

Table 11 shows that the average score of the clarity of regenerated used cooking oil ranges from 2.25 to 4.00. It can be seen from the scoring test value that the lowest result is 2.25 (cloudy), which is treated with a concentration of 10% adsorbent and a soaking time of 30 minutes. The highest result in the scoring test is 4.00 (clear), which is treated with a concentration of 30% adsorbent and a soaking time of 90 minutes. In the aroma parameter, the best results were obtained in the treatment of adding 30% adsorbent and a soaking time of 90 minutes. This is because there is sufficient contact time between the adsorbent and the sample (used cooking oil), where the adsorbent can absorb chemical compounds in the oil so that clear results are obtained.

Table 11. The average score of the Purity of regenerated oil

Treatment		Purity	BNJ 5%	Notation
Addition Adsorbent	Soaking Time (Minutes)			
10% adsorbent	30	2.25 ± 0.967	0.203	g
	60	2.70 ± 0.923		e
	90	3.40 ± 0.995		c
20% Adsorbent	30	2.50 ± 0.889		f
	60	2.90 ± 0.968		d
	90	3.75 ± 0.967		b
30% Adsorbent	30	2.60 ± 0.754		f
	60	3.55 ± 0.945		c
	90	4.00 ± 0.918		a

The adsorbent concentration also affects the process of clarifying the cooking oil used. This is supported by the statement [4], which states that Sufficient interaction time is needed by activated carbon to adsorb the adsorbate optimally. The longer the interaction time, the more adsorbate is adsorbed because there are more opportunities for activated carbon particles to come into contact with the adsorbate. This causes more adsorbate to be bound in the pores of activated carbon. This ability can be higher if the activated carbon has been activated chemically or by heating at high temperatures.

3.2.10. Analysis Decision

The selection of the best treatment of regenerated used cooking oil is based on analysis using the Multiple Attribute Method. The assessment procedure for selecting the best treatment is done by determining the ideal value for each parameter and calculating the degree of density (dk) and the density distance (Lp). The best treatment selected from the treatment has a minimum value of L1, L2, and L. This method is determined based on the parameters analyzed. These parameters include: Water Content, Free Fatty Acid (FFA), Peroxide Number, Iodine Number, Viscosity, Smoke Point, and organoleptic scoring (including color, Aroma, clarity). The analysis table for determining the best treatment for the sensory characteristics of used cooking oil can be seen in the Table 12.

Based on Table 12. the treatment of 30% concentration and 90 minutes of soaking time has the lowest total value of L1, L2, and L Max in organoleptic parameters. This shows that this treatment is the best treatment for organoleptic properties, in the color, Aroma, and clarity tests, showing a decrease in value, which indicates that the regenerated used cooking oil has increased in quality. This shows that the longer the adsorption

https://doi.org/10.29165/ajarcde.v9i2.689

time used, the better the results obtained, this is in line with [4] The longer the interaction time, the more adsorbate is adsorbed, because the more opportunities for activated carbon particles to come into contact with the adsorbate. The adsorbent type also affects the cooking oil's organoleptic value. This is due to differences in components and the ability of the adsorbent to absorb components in used cooking oil.

Table. 12. The Best Sensory Characteristics of Regenerated Oil

Treatment		L1	L2	Best Treatment
Addition Adsorbent	Soaking Time (Minutes)			
10% adsorbent	30	0.4655	0.0019	0.6449
	60	0.3315	0.0005	0.4619
	90	0.1332	0.0000	0.1832
20% Adsorbent	30	0.4096	0.0011	0.5709
	60	0.2667	0.0002	0.3708
	90	0.0601	0.0000	0.0861
30% Adsorbent	30	0.3706	0.0008	0.5142
	60	0.1775	0.0001	0.2598
	90	0.0000	0.0000	0.0000*

The best treatment of the physicochemical characteristics of used cooking oil is also important and closely related to the quality of used cooking oil. The analysis table for determining the best treatment of the physicochemical characteristics of used cooking oil can be seen in the Table 13.

Table 13. The Best Physicochemical Characteristics of Regenerated Oil

Treatment		L1	L2	Best Treatment
Addition Adsorbent	Soaking Time (Minutes)			
10% adsorbent	30	0.3947	0.0004	0.5094
	60	0.3129	0.0002	0.4046
	90	0.1792	0.0000	0.2394
20% Adsorbent	30	0.3770	0.0004	0.4890
	60	0.2754	0.0001	0.3589
	90	0.0881	0.0000	0.1179
30% Adsorbent	30	0.3578	0.0003	0.4667
	60	0.2306	0.0001	0.3015
	90	0.0000	0.0000	0.0000*

Based on Table 13, the best treatment of the physicochemical properties of used cooking oil with the Multiple Attribute method shows that the treatment of 30% activated charcoal concentration and 90 minutes soaking time has the smallest total value. The results of testing the physicochemical properties of the parameters of Water Content, Free Fatty Acid (FFA), Peroxide Number, and Viscosity showed a decrease in value, which indicates that the regenerated used cooking oil has increased in quality. Based on the analysis of determining the best treatment for organoleptic and physicochemical characteristics, the best treatment was obtained, namely used cooking oil with a concentration of 30% activated charcoal and a soaking time of 90 minutes having color characteristics of 3.75, Aroma of 3.85, clarity of 4.00, Water Content of 0.39%, Free Fatty Acid (FFA) of 0.23%, Peroxide Number of 7.18 MekO2/Kg, iodine number of 66.10 I2/100, Viscosity of 70.33 cP, and Smoke Point of 179.20 C.

4. CONCLUSION

Based on the analysis of determining the best treatment for organoleptic and physicochemical characteristics, the best treatment was obtained, namely used cooking oil with a concentration of 30% activated charcoal and a soaking time of 90 minutes having color characteristics of 3.75, Aroma of 3.85, clarity of 4.00, Water Content of 0.39%, Free Fatty Acid (FFA) of 0.23%, Peroxide Number of 7.18 MekO$_2$/Kg, iodine number of 66.10 I$_2$/100, Viscosity of 70.33 cP, and Smoke Point of 179.20°C. Of all the treatments on the test parameters, the best results were obtained from the combination of adding 30% adsorbent and a soaking time of 90 minutes.

REFERENCE

[1] F. C. Hidayati and I. Yulianti, 2016. Pemurnian Minyak Goreng Bekas Pakai (Jelantah) dengan Menggunakan Arang Bonggol Jagung, J. Ilmu Pendidik. Fis., vol. 1, no. 2, pp. 67–70.

[2] Wijayanti. H., Nora, H & Amelia, R. (2012). Pemanfaatan Arang Aktif dari Serbuk Gergaji Kayu Ulin untuk Meningkatkan Kualitas Minyak Goreng Bekas. Konversi. Vol. 1 No.1

[3] Ketaren, S. 2008. Pengantar Teknologi Minyak Dan Lemak Pangan. Jakarta, Universitas Indonesia (UI-Press).

[4] Nafi'ah, R. 2016. Kinetika Adsorpsi Pb (II) dengan Adsorben Arang Aktif dari Sabut Siwalan. Jurnal Farmasi Sains dan Praktis. Vol:1(2) 28-36

[5] Maulinda, L., Nasrul, Z.A., Sari, D.S. 2015. Pemanfaatan kulit singkong sebagai bahan baku karbon aktif. Jurnal Teknik Kimia. Vol:4(2) 11-19.

[6] Saha, B.C. 2006. Hemicellulose Bioconversion. J. Ind. Microbiol. Biotechnol. 30: 279-291

[7] Zunifer, A., & Ayu, D. F. (2020). Ukuran Partikel dan Waktu Kontak Karbon Aktif dari Kulit Singkong Terhadap Mutu Minyak Jelantah. SAGU Journal: Agricultural Science and Technology, 19(2), 27–38

[8] Subiyantoro. Kajian pemucatan minyak goreng bekas dengan metode adsorbsi dan pengkelatannya. Tugas Akhir, Fakultas Teknologi Pangan IPB;2003

[9] Ketaren, S., 2012, Pengantar Teknologi Minyak dan Lemak Pangan, UI Press, Jakarta

[10] Ramli, R.A., 2009, Physicochemical Characteristics of Calcium-Treated Jackfruit (ArtocarpusHeterophyllus) Pulps During Chilled Storage,Thesis submitted in fulfillment of the requirements for the Degree of Doctor of Philosophy UKM

[11] Winarno, F. G. 2014. Kimia Pangan dan Gizi, Jakarta, Gramedia Pustaka Utama

[12] Sulistiyowati, R., dan Aajilaini, S. Al. 2017. Pengaruh penambahan arang aktif cangkang keluwek terhadap penurunan bilangan peroksida dalam minyak jelantah. Jurnal Kesehatan Pena Medika, 7(2), 92– 105.

[13] Oktaviani. (2018). Hubungan Lamanya Pemanasan Dengan Kerusakan Minyak Goreng Curah Ditinjau Dari Bilangan Oksidasi. Jurnal Biomedika, 1(1): 31-35.

[14] Zhou, W. (2019). Optical Properties of Crude Oil with Different Temperatures. International Journal for Light and Electron Optics, 12-17

[15] Hutapea, P.H,Penfield, K. H. 2021. Uji Kualitas Minyak Goreng Curah yang dijual di Pasar Tradisional Surakarta dengan Penentuan Kadar Air, Bilangan Asam dan Bilangan Peroksida. Program Studi Kimia Industri Politeknik Santo Paulus Surakarta. Jurnal Kimia Sains dan Terapan Volume 3, Nomor 1.

[16] Berger, K.G. 2005. The Use of Palm Oil in Frying. Malaysian Palm Oil Promotion Council

[17] Tobing, L.M.L. 2014 Analisis Kualitas Minyak Goreng pada Penggorengan Berulang Ikan Nila (Oreochromis Niloticus) berdasarkan Parameter ALB, Titik asap, Indeks Bias, dan Viskositas. Skripsi.Jurusan Terknologi Pertanian Universitas Bengkulu.Bengkulu.

[18] Nasrun, D., Samangun, T., Iskandar, T., dan Mas'um, Z. 2017. Pemurnian Minyak Jelantah menggunakan Arang Aktif dari Sekam Padi. Jurnal Penelitian Teknik Sipil Dan Teknik Kimia, 1(2), 1–7.