Volume 02, Number 02, December 2022, Page 45 - 52
e-ISSN: 2776-4508; p-ISSN: 2776-1711
Publisher : Universitas Pakuan

COMPARISON OF RICE AND AKING RICE AS ADSORBENT FOR WASTE COOKING OIL

Nila Tanyela B[a*)], Ana Lailatul Farida[a)], Sayyidah Afifa[a)], Mazaya Aurora R.S. [a)], Brikita Eusebes S. T. [a)], Salsa Safitri Putri E[a)].

[a)] *Department of Chemistry, Faculty of Science and Computer, Universitas Pertamina, Jl. Teuku Nyak Arief-Simprug, Kebayoran Lama, Jakarta Selatan, 12220, Indonesia.*

[*)] *Corresponding Author: nila.tanyela@universitaspertamina.ac.id*

***Article history:** received:13-10-2022; revised:14-11-2022; accepted: 30-12-2022; published: 31-12-2022*

ABSTRACT.

The regular use of waste cooking oil, which has a high level of free fatty acids and carbonyl and peroxide compounds, is the background of this study, which is harmful to one's health. Using it indefinitely will harm health, including cancer, heart disease, and possibly death. We, therefore, performed research on the purification and analysis of waste cooking oil using white rice and aking rice with the batch method to detect the free fatty acid levels before and after purification and to establish the effectiveness of white rice and aking rice. Determine the utilized cooking oil's quality following filtration using adsorbent. The findings demonstrated that white rice was more effective than aking rice at reducing fatty acid levels, as shown by the acquisition of FFA levels using white rice of 0.3141% in the merchant oil sample and 0.2410% in the home oil sample. In comparison, purification with the aking rice adsorbent is 0.3474% in the merchant oil sample and 0.1374% in the home oil sample.

Keywords: aking rice, free fatty acids (FFA), waste cooking oil.

1. INTRODUCTION

Cooking oil is one of the basic human needs that is used as a basic ingredient in the frying process with the main function as a medium for conducting heat, adding savory taste, increasing nutritional value, and heating food ingredients. The use of cooking oil more than two or three times is referred to as used cooking oil. It is categorized as waste because it can damage the environment and even provide dangerous side effects if used continuously [1]. Waste Cooking Oil (WCO) or used cooking oil contains carcinogenic compounds. Based on the existing analysis, used cooking oil contains peroxide. The more it is used, the higher the peroxide value [2].

Repeated use of WCO with a high enough frying temperature can cause damage to the cooking oil, such as making the oil smoke or foam faster. In addition, the increase in the brown color of the oil causes the aroma or taste of the fried food ingredients to be inappropriate, other damage caused by used cooking oil is the decrease in the nutritional value and quality of the food ingredients fried using the WCO [3]. Using used cooking oil can cause the oxidation of unsaturated fatty acids which form a group, namely peroxide groups, and cyclic monomers, which can adversely impact the health of those who consume it, one of which is causing poisoning in the body. A study says that the peroxide group can be present in the body in large quantities and can cause colon cancer.

In one year, as much as 4.1 kg of WCO is produced per person so, considering the human population in the world today is 7.1 billion, it is estimated that WCO produced per year is around

Volume 02, Number 02, December 2022, Page 45 - 52
e-ISSN: 2776-4508; p-ISSN: 2776-1711
Publisher : Universitas Pakuan

29 million tons. Many rumors are circulating that used cooking oil can no longer be used, unfortunately not many are aware of it. Along with the development of technology, there is an alternative to reusing used cooking oil, which can be an effort to reduce environmental pollution caused by the used cooking oil waste [2]. In this case, used cooking oil needs to be purified. Benefits can save resources but also bring economic benefits and reduce environmental pressures.

The research carried out was a purification of WCO using a batch method that utilized rice as an adsorbent for used cooking oil, the rice used varied, namely white rice which of course still contains water and aking rice [4]. Previously, the characterization was carried out so that it was known the content of each adsorbent, namely white rice and aking rice as well as the levels of free fatty acids or Free Fatty Acids (FFA) in WCO. It is hoped that after refining it can help reduce FFA levels so that used cooking oil which is usually discarded or even used but still has a high and dangerous free fatty acid content becomes oil that is ready to use and safe for health [6]. The objectives to be achieved in this research are determining the levels of FFA in Waste Cooking Oil (WCO) before and after purification using the batch method, determining the effectiveness of white rice and aking rice as adsorbents in the purification of WCO using the batch method, determining the quality of the purified Waste Cooking Oil (WCO) using the batch method that refers to the Indonesian National Standard (SNI) [7].

2. METHODS

2.1. Chemical and reagents

The chemicals used are used cooking oil (merchant), Cooking Oil (Homemade), Phenolphthalein (p.a), Oxalic Acid (p.a), NaOH (p.a), Ethanol (p.a), White rice, and Aking rice.

2.2. Preparation of Aking Rice Adsorbent Sample

Aking rice needs to be prepared beforehand so that it can be used as an adsorbent. The preparation of aking rice is done by crushing the aking rice until it is like sugar particles. Then the crushed aking rice was sieved using a 40-mesh sieve. Aking rice that does not pass through the sieve is used as an adsorbent in the purification of WCO.

2.3. Adsorbent Performance Test in Waste Cooking Oil (WCO)

The adsorbent performance test in WCO was carried out using the batch method. The WCO samples used were obtained from merchants and homes. Each WCO sample was weighed as much as 1.8 grams and heated to a temperature of 70ºC. Then, 2 grams of white rice were added and stirred using a magnetic stirrer for 1 hour at a speed of 500 rpm. Furthermore, WCO is filtered to be separated from white rice. The WCO-purified filtrate was then tested for FFA levels. The same procedure was carried out for the aking rice adsorbent**.**

2.4. Determination of FFA Levels in WCO Samples

In determining the FFA levels of WCO samples from both fried and home merchants using the acid-base titration method. Before being used in the titration, the NaOH solution was standardized with 0.1 M oxalic acid solution. 10 mL of oxalic acid solution was pipetted and put into a 50 mL Erlenmeyer flask. Then, 3 drops of phenolphthalein (PP) indicator was added. Next, the titration was carried out with 0.1 M NaOH solution. The titration was carried out 2 times (Duplo).

The standardized NaOH solution was then used to determine the FFA levels in the WCO samples before purification. In addition to the WCO sample, new cooking oil with the brand Sania was also used to determine the FFA content of the new oil. 2.25 mL of each sample was taken

Volume 02, Number 02, December 2022, Page 45 - 52
e-ISSN: 2776-4508; p-ISSN: 2776-1711
Publisher : Universitas Pakuan

and put into a 250 mL Erlenmeyer flask. Then each sample was added 3.6 mL of ethanol and heated for 1 minute. After heating, each sample was added with 1 drop of PP indicator. Titrate with 0.1 M NaOH solution until it turns pink which does not disappear when shaken for 30 minutes. Titration for each sample was carried out 2 times (Duplo). After purification, the same titration was carried out for WCO samples from fried and home merchants.

2.5. Characterization

2.5.1. Functional Group Analysis

Functional group analysis using an FTIR spectrophotometer was carried out for the adsorbent of white rice and aking rice both before use in purification and after use. The adsorbent sample is first pulverized (has a small structure), and then placed in the FTIR Spectrophotometer holder. Furthermore, the functional groups on each adsorbent were analyzed.

2.5.1. Surface Area Analysis

Analysis of the surface area on aking rice as an adsorbent in WCO purification was carried out using the BET method (SSA Messo 122). Aking rice weighed as much as 0.4 grams. Then degassing was carried out at a temperature of 300ºC for 3 hours to remove the trapped gases on the surface of the sample. Then analyzed using nitrogen gas (N_2).

3. RESULTS AND DISCUSSION

3.1. Adsorption of WCO Samples by Batch Method

In this study, the batch method was used in the purification process of Waste Cooking Oil (WCO). This adsorption process used samples of initially packaged cooking oil with the brand Sania and samples of WCO from fried food vendors and homemade products with the same brand. According to the Indonesian National Standard (SNI), the best cooking oil to use is cooking oil which has a maximum FFA content of 0.3% [11]. The result of the initial FFA analysis of new cooking oil (Sania) was 0.304%. This shows that the newly packaged cooking oil with the Sania brand contains FFA, which is following the established SNI.

Furthermore, the FFA test was carried out for WCO samples from both the merchant oil sample and home oil to know how much damage the cooking oil was seen from the increase in %FFA before adsorption using the batch method. In the following, the %FFA data on WCO samples before absorption is presented in Table 1.

Table 1. FFA levels in WCO samples

WCO Sampel	FFA Level (%)
The merchant oil	0.63
Home oil	0.42

The results of %FFA on WCO samples from the merchant oil and home oil showed that there was damage to cooking oil as seen from the increase in %FFA compared to %FFA in new oil (Sania). This happens because of the hydrolysis process which causes the fatty acid bonds in the cooking oil to break and produce free fatty acids or Free Fatty Acids (FFA) and glycerol. The FFA level of the WCO sample from the merchant oil has a greater value than the WCO sample from home oil, the cooking oil trader may use it repeatedly

FFA levels in oil with a value exceeding SNI will be harmful to health and the environment if disposed of carelessly because of the peroxide content of WCO, the more times cooking oil is used, the higher the peroxide value will be [1]. A study states that large amounts of peroxide in the body can cause colon cancer [2].

Volume 02, Number 02, December 2022, Page 45 - 52
e-ISSN: 2776-4508; p-ISSN: 2776-1711
Publisher : Universitas Pakuan

WCO samples from the merchant oil and home oil that had been tested for FFA content were adsorbed using the batch method. The principle of the adsorption process in a batch system is when the adsorbent is mixed with a fixed amount of solution, and the change in quality is observed in a certain time interval [14]. In this adsorption process, 2 adsorbents were used, namely white rice and aking rice. For aking rice adsorbent used in the adsorption process is that which does not pass the 40-mesh sieve. The mass of the WCO sample used was 1.8 grams with a mass of 2 grams of adsorbent and stirring using a magnetic stirrer for 60 minutes with a stirring speed of 500 rpm. The results of FFA analysis using the batch method on 2 WCO samples with 2 adsorbents before and after adsorption can be seen in Table 2.

Table 2. Comparison of %FFA results on WCO samples before and after adsorption

WCO Sampel	%FFA Before Adsorption	%FFA After Adsorption		% Decrease in FFA	
		White Rice	Aking Rice	White Rice	Aking Rice
The Merchant Oil	0.63	0.3159	0.2826	0.3141	0.3474
Home Oil	0.42	0.1790	0.2826	0.2410	0.1374
% FFA In Standard Nasional Indonesia (SNI) No. 01-2901-2006 Is 0.3% [11]					

Table 2 shows that the adsorbent of aking rice can adsorb better than the adsorbent of white rice for the WCO samples of the merchant oil. On the other hand, in the home WCO sample, white rice adsorbent was better in adsorption. Data analysis of %FFA in both samples showed a decrease after the adsorbent performance test using the batch method and indicated that the WCO samples could still be consumed except the WCO samples from fried food vendors with white rice adsorbents. This is because the results of the %FFA analysis test for the merchant oil' WCO samples with white rice adsorbents still exceed the maximum threshold of %FFA levels permitted by SNI, namely 0.3% [10, 11]. The difference in %FFA levels between the two WCO samples can also be caused by the number and type of fried foods [6]. WCO samples from the merchant oil have higher %FFA levels both before adsorption and after adsorption compared to home WCO samples. This is possible because fried food merchant use cooking oil repeatedly with the amount and variety of food ingredients.

3.2. Adsorbent Characterization

Analysis using the FTIR spectrophotometer was used to determine the functional groups contained in the aking and white rice biomass. FTIR analysis was carried out for the adsorbent before being used in purification, after being used in purification both in the WCO samples from the merchant and home. Figure 1 shows the FTIR spectrum of aking rice biomass.

Volume 02, Number 02, December 2022, Page 45 - 52
e-ISSN: 2776-4508; p-ISSN: 2776-1711
Publisher : Universitas Pakuan

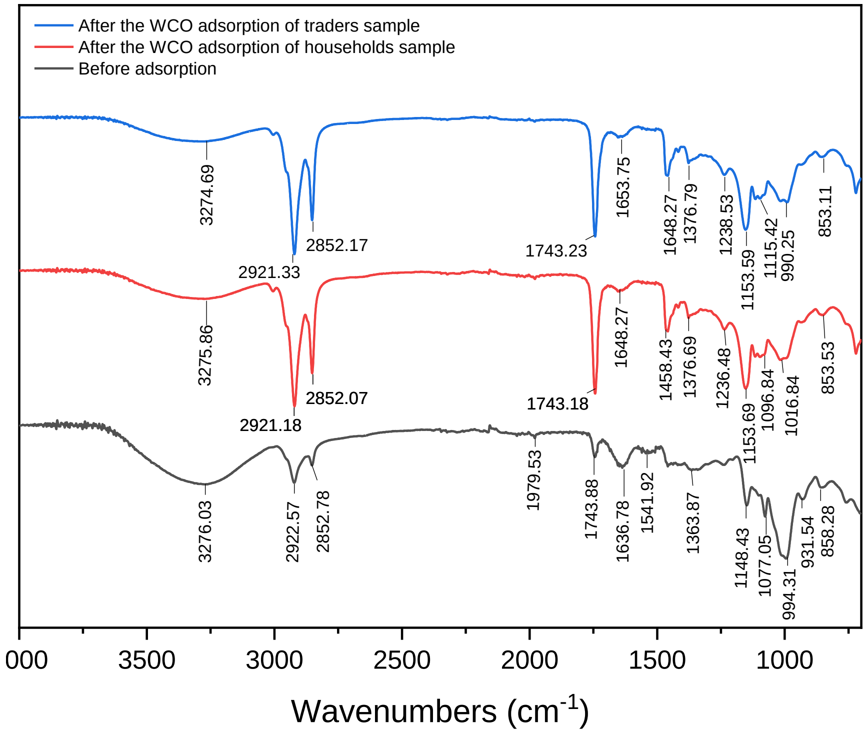

Fig. 1 FTIR spectra for aking rice biomass

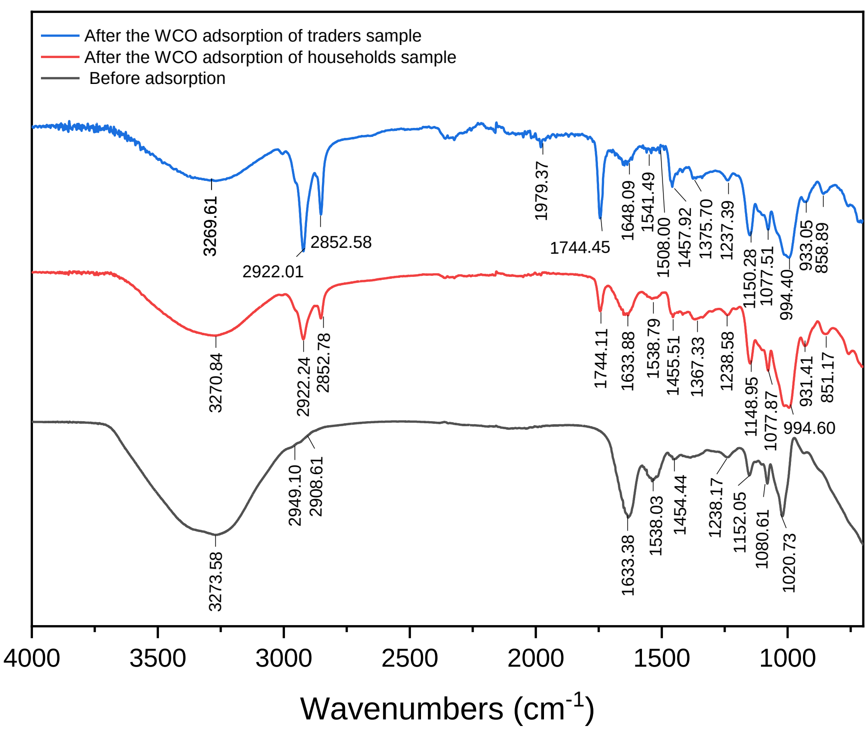

Fig. 2 FTIR spectra for white rice biomass

Volume 02, Number 02, December 2022, Page 45 - 52
e-ISSN: 2776-4508; p-ISSN: 2776-1711
Publisher : Universitas Pakuan

The results of the FTIR can be seen that the aking rice biomass before adsorption has active groups, namely the -O-H group with board absorption (width) in 3276.03 cm^{-1} area, which indicates the presence of cellulose compounds in the aking rice biomass content. The -C-H sp^3 group with absorption in 2922.27 cm^{-1} and 2852.78 cm^{-1} area. There is a C=O group with absorption in 1743.88 cm^{-1} area which indicates the presence of glucose compounds in the biomass content of aking rice. There is also a C-O group with absorption in 1148.43 cm^{-1} area.

The FTIR results for aking rice after adsorption for the home sample a widening of the O-H functional group bond peak at a wave number of 3275.86 cm^{-1} because it was influenced by the strong vibration intensity of the C-H sp^3 bond. This is also a characteristic of the O-H bond which can be easily analyzed directly if it is in acid or it can be concluded that the aking rice biomass has succeeded in binding free fatty acids from home WCO samples [8, 9]. Then at a wave number of 1743.18 cm^{-1} which is the peak of the C=O functional group, it appears to have a sharper peak intensity after the adsorption process of biomass is carried out, this indicates that the bonding of the C=O functional group belongs to the carboxylic acid of the free fatty acid structure. In addition, the difference can also be seen at the peak which becomes sharper at wave number 1458.43 cm^{-1} which is a typical area of the -CH_2 bending functional group belonging to the structure of biomass and free fatty acids [6].

The FTIR results for the aking rice adsorbent for merchant sample have an O-H group which has an adsorption shift of 3276.03 cm^{-1} to 3275.86 cm^{-1} this is due to heating during the adsorption process, but the presence of O-H groups proves that the adsorbent can bind free fatty acids from the sample oil merchant [8]. Then found the C=O functional group at the peak of 1743.23 cm^{-1} with a sharper peak intensity, it is known that the C=O functional group is a carboxylic acid-forming structure, this indicates that the adsorbent can bind free fatty acids in the merchant oil sample [7]. There are also differences with the finding of the CH_2 functional group which has a sharper peak of 1648.27 cm^{-1}, it is known that the CH_2 functional group is also a constituent of free fatty acids, so it can be concluded that the adsorbent can absorb the merchant' WCO samples. Figure 2 shows the FTIR spectrum of white rice biomass. FTIR results on white rice biomass before adsorption have a wide absorption with fairly high intensity at a wavelength of 3273.58 cm^{-1} which indicates the presence of O-H groups. The O-H group in white rice biomass indicates the cellulose content. The absorption peaks at wavelengths of 2949.10 cm^{-1} (strong C-H bonds) and 2908.61 cm^{-1} (C-H bonds) show a spectrum with very small intensity, so it is not very visible in the resulting FTIR spectra. At a wavelength of 1633.38 cm^{-1} there is an absorption peak that indicates the C=C group. And the absorption at wave number 1080.61 cm^{-1} indicates the C-O functional group. The presence of this C-O group indicates that white rice contains glucose compounds.

The results of FTIR on white rice biomass after adsorption for the home sample have O-H group absorption at a peak of 3270.89 cm^{-1} which has a lower intensity than the spectrum before adsorption. The O-H group may have undergone evaporation during the heating process. Then the C-H group was also found at the peak of 2922.24 cm^{-1} and peak of 2852.78 cm^{-1}. At this peak, it has a sharper intensity than before adsorption, this proves that the white rice adsorbent has adsorbed the compounds resulting from the polymerization reaction that causes the dark color of the home WCO samples. A C=O group was also found at the absorption peak of 1744.11 cm^{-1}, this group was only found in the spectrum after the adsorption process, which indicated that the white rice adsorbent had absorbed aldehyde compounds that cause rancid odor in the home WCO samples.

The FTIR results for the aking rice adsorbent for merchant sample have O-H group absorption at a peak of 3269.61 cm^{-1} which has a smaller intensity than the spectrum before absorption. This is possible when the O-H group undergoes evaporation during the heating process. Then the C-H functional group at the peak of 2922.01 cm^{-1} and 2852.58 cm^{-1} with the highest intensity compared to other spectra, this proves that the white rice adsorbent has absorbed more compounds resulting from the polymerization reaction that causes dark color in the merchant' WCO samples. At the peak of 1979.37 cm^{-1} there is a C=O functional group, at the peak of 1744.45 cm^{-1} there is an aldehyde group, at the peak of 1648.09 cm^{-1} there is a C=C functional group

Volume 02, Number 02, December 2022, Page 45 - 52
e-ISSN: 2776-4508; p-ISSN: 2776-1711
Publisher : Universitas Pakuan

or alkene, there is a C-O group at the peak of 1541.49 cm^{-1}. These peaks have a higher intensity than other FTIR spectra. This is because the %FFA of the merchant's WCO sample is higher than that of the home WCO sample so that the white rice adsorbent absorbs more of the clusters causing the quality of the cooking oil to decrease.

The BET test was carried out to determine the surface area of the adsorbent and to find out how much the adsorbent might absorb impurities. Surface area is one of the important factors and affects the adsorption quality. The results of the BET analysis revealed that the surface area of the biomass of aking rice and white rice with a size that did not pass 40 mesh was 7.810 m^2/g. In previous studies, the results of the BET test on aking rice biomass with a size of more than 40 mesh had a surface area of 3.283 m^2/g [6]. Compared with the current research, the adsorbent surface area of aking rice and white rice in the previous study was smaller. This can occur due to differences in particle size at the time of separation using a mesh sieve. The adsorbent in the previous study had less fine particle size, so the surface area was smaller. The smoother the adsorbent, the greater the surface area, this can be seen in the surface area results obtained in this study [6]. In terms of the effectiveness of aking rice and white rice, they have something in common, namely the surface area has the same magnitude so that only one BET test is carried out to determine the surface area.

4. CONCLUSION

Based on the Standard Nasional Indonesia (SNI) 7709-2012 regarding the quality requirements of coconut cooking oil that is safe for public consumption, the percentage of free fatty acids (%FFA) allowed is a maximum of 0.3%. Therefore, the aking rice adsorption process using the batch method was considered successful in making the fried oil and home cooking oil samples into cooking oil that's safe for consumption, because the %FFA obtained was 0.2826% for the merchant oil sample and 0.2826% for the home oil samples. The same thing was also shown in the white rice adsorption process using the batch method for the home oil samples because the percentage of %FFA obtained was 0.1790% which was the largest decrease in %FFA. However, the %FFA obtained from the white rice adsorption process using the batch method for merchant oil samples did not meet the quality requirements of palm cooking oil, because the results obtained were 0.3159%. Although the FFA levels decreased but did not meet the quality standards, it is estimated that this was due to too high levels of FFA contained in the oil.

REFERENCES

[1] A. Rafati, K. Tahvildari, and M. Nozari, “Production of biodiesel by electrolysis method from waste cooking oil using heterogeneous MgO-NaOH nano catalyst,” *Energy Sources, Part A Recover. Util. Environ. Eff.*, vol. 41, no. 9, 2019., pp. 1062–1074. doi: 10.1080/15567036.2018.1539139.

[2] M. Alamsyah, R. Kalla, and L. I. La Ifa, “Pemurnian Minyak Jelantah Dengan Proses Adsorbsi,” *J. Chem. Process Eng.*, 2017., vol. 2, no. 2, p. 22., doi: 10.33536/jcpe.v2i2.162

[3] Z. Wu, H. Li, and D. Tu, “Application of Fourier Transform Infrared (FT-IR) Spectroscopy Combined with Chemometrics for Analysis of Rapeseed Oil Adulterated with Refining and Purificating Waste Cooking Oil,” *Food Anal. Methods*, 2015., vol. 8, no. 10, pp. 2581–2587. doi: 10.1007/s12161-015-0149-z.

[4] Kemendag, “Profil Komoditas Minyak Goreng.,” *Jakarta*, 2016., p. 84. [Online]. Available: https://ews.kemendag.go.id/sp2kp-landing/assets/pdf/120116_ANK_PKM_DSK_Minyak.pdf.

[5] D. A. Kusumawardhani, “Pemanfaatan Limbah Nasi Aking sebagai Adsorben untuk Menurunkan Kadar Asam Lemak Bebas pada Minyak Jelantah,” 2016. pp. 14–15,

[6] A. S. Suroso, “Kualitas Minyak Goreng Habis Pakai Ditinjau dari Bilangan Peroksida,Bilangan Asam dan Kadar Air,” *J. Kefarmasian Indones.*, 2013., Vol 3, no. 2, pp. 77–88.

[7] L. M. Widhyasari, N. L. N. D. D. Putri, and P. A. Parwati, “Determination Carbohydrate Level of White Rice in the Rice Cooker Heating Process With Time Variation,” *Bali Med. J.*, 2017, vol. 4, no. 2, pp. 115–125. doi: 10.36376/bmj.v4i2.9.

Volume 02, Number 02, December 2022, Page 45 - 52
e-ISSN: 2776-4508; p-ISSN: 2776-1711
Publisher : Universitas Pakuan

[8] M. Novianti, V. M. A. Tiwow, and K. Mustapa, "Analysis of Glucose Levels in Rice and Corn Using Spectronic 20," *Gizi*, 2017., vol. 6, no. May, pp. 107–112.

[9] H. Tiernan, B. Byrne, and S. G. Kazarian, "ATR-FTIR spectroscopy and spectroscopic imaging for the analysis of biopharmaceuticals," *Spectrochim. Acta - Part A Mol. Biomol. Spectrosc.*, 2020., vol. 241, p. 118636. doi: 10.1016/j.saa.2020.118636.

[10] Badan Standardisasi Nasional, "SNI 7709:2012 tentang Minyak Goreng Sawit," 2012.

[11] F. C. Hidayati, "Pemurnian Minyak Goreng Bekas Pakai (Jelantah) dengan Menggunakan Arang Bonggol Jagung," *JIPF (Jurnal Ilmu Pendidik. Fis.*, 2016., vol. 1, no. 2,p. 67. doi: 10.26737/jipf.v1i2.67.

[12] C. A. Saputri, "Kapasitas adsorpsi serbuk nata de coco (bacterialsellulose) terhadap ion Pb^{2+} menggunakan metode batch," *J. Kim.*, 2020., vol. 14, no. 1, p. 71. doi: 10.24843/jchem.2020.v14.i01.p12.

[13] Candra Irawan, "The effect of adsorbate concentrationon the effectiveness of decreasing fe using fly ash as adsorben," 2018., pp. 4–6,

[14] S. A. Putri, A. Asnawati, and D. Indarti, "Optimalisasi Adsorpsi Zat Warna RhodaminB Pada Hemiselulosa Dalam Sistem Dinamis," *Berk. Sainstek.*, 2019, vol. 7, no. 1, p. 1. doi: 10.19184/bst.v7i1.9681.