THE EFFECT OF ACTIVE CARBON ADDITION FROM WASTE OF AMBON LUMUT BANANA PEEL (Musa acuminata Colla) ON DECREASING PEROXIDE IN USED COOKING OIL

PENGARUH PENAMBAHAN KARBON AKTIF DARI LIMBAH KULIT PISANG AMBON LUMUT (*Musa acuminata* Colla) TERHADAP PENURUNAN PEROKSIDA PADA MINYAK BEKAS

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ABSTRACT

High temperature, repeated, and oxidized heating process will experience used cooking oil damage. Peroxide number is the most important value to determine the degree of damage the oil. The purpose of this study was to see the effect of soaking with activated carbon from Ambon Lumut banana peels with different activators on decreasing the peroxide value in used cooking oil, determining the analysis was carried out using the iodometric method. The results were obtained after soaking banana peel activated carbon with HCl activator in used cooking oil samples from frying chicken, fried snacks, and 2 times the use of each % decreased peroxide number by 82.26%; 30.90% and 68.88%, while the $ZnCl_2$ activator in these samples decreased by 85.22%; 51.82% and 92.77%. The use of $ZnCl_2$ activator gives the best results in reducing the peroxide value in used cooking oil.

***Keywords**: Activated carbon, banana peel, using cooking oil, Iodometry.*

ABSTRAK

Minyak yang telah mengalami proses pemanasan dengan suhu tinggi, berulang, dan teroksidasi akan mengalami kerusakan. Bilangan peroksida adalah nilai terpenting untuk menentukan derajat kerusakan pada minyak atau lemak. Tujuan penelitian ini adalah untuk melihat pengaruh perendaman dengan karbon aktif dari kulit pisang ambon lumut dengan perbedaan 2 jenis aktivator terhadap penurunan bilangan peroksida pada minyak goreng bekas, penentuan analisis dilakukan dengan menggunakan metode iodometri. Hasil didapatkan setelah perendaman karbon aktif kulit pisang dengan aktivator HCl pada sampel minyak goreng jelantah dari menggoreng ayam, cemilan gorengan, dan 2 kali pemakaian masing-masing % penurunan bilangan peroksida sebesar 82,26%; 30,90% dan 68,88% sedangkan dengan aktivator $ZnCl_2$ pada sampel tersebut masing-masing % penurunannya sebesar 85,22%; 51,82% dan 92,77%. Penggunaan aktivator $ZnCl_2$ memberikan hasil terbaik dalam menurunkan bilangan peroksida pada minyak bekas.

Kata Kunci: Karbon aktif, minyak bekas, Iodometri.

INTRODUCTION

There are several reasons for using used cooking oil, among others is generally to saving on the use of cooking oil, when there is a scarcity of cooking oil, causing the price of cooking oil to be high on the market. In the fact, using cooking oil have a high peroxide value. One of the methods to reduce the peroxide value in used oil is to add activated carbon.

Activated carbon is one of the organic materials, generally used large and small industries. Activated carbon is usually used as a catalyst, odor removal, color absorption, purification substances (Pujiarti and Sutapa, 2005). Activated carbon is an amorphous compound that is produced from materials containing carbon or charcoal that are specially treated to obtain high adsorption power. Activated carbon can adsorb gases and certain chemical compounds or selective adsorption, depending on the size or volume of pores and surface area. The absorption of activated carbon is very large, range is 25-100% of the weight of activated carbon (Prabarini and Okaydana, 2013).

Activated carbon can be made from coconut shells, candle, bagasse, wood powder,

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and banana peel. One of the raw materials that can be developed for making activated carbon in this study is banana peel. The banana peel will undergo a process of carbonization and activation to form it into activated carbon (Rahmansyah et al., 2005). Banana peel can be used as an adsorbent because it has a high lignocellulose content. The composition of raw banana peel based on cell wall analysis (% dry weight) was 37.52% hemicellulose, 12.06% cellulose, and 7.04% lignin (Simangunsong, Rohanah and Shady, 2017). Adsorbent banana peel can be made, because high level the substance of pectin contained in old banana peel (Buanarinda et al., 2014).

Used cooking oil is oil using have been used repeatedly, from its chemical composition, used cooking oil contains compounds that are carcinogenic, which occur during the frying process, in long term can cause cancer (Ketaren, 2005). One of the quality parameters of cooking oil is peroxide number. Peroxide is the most important value for determining the degree of damage to oil or fat. Unsaturated fatty acids can bind oxygen to their double bonds to form peroxide. Materials that contain fat with high peroxide numbers will accelerate rancidity (Ketaren, 2005).

Base on that case, this research want to prove the addition effect of actived carbon from ambon lumut banana peel on decreasing peroxide value in used cooking oil, by the absorption mechanism.

METHOD

Tools

The tools used in this study were a set of titration devices (burette *(Pyrex®)*, statif, clamp and Erlenmeyer *(Pyrex®)*, kiln, oven *(Kirin)*, crucible cup *(Pyrex®)*, porcelain cup *(Pyrex®)*, thermometer, desiccator, filter paper, mesh 100, 100 mL measuring cup *(iwaki)*, 10 mL volume pipette *(Pyrex®)*, and 250 mL *glass beaker (Pyrex®)*.

Materials

The materials used on this research were used cooking oil, Ambon Lumut banana peel from fried banana seller, $Na_2S_2O_3.5H_2O$ 0,1N (pa), KIO_3 0,1N solution, KI saturated solution (Smart Lab), KI 10 % solvent, starch 1% (pa), H_2SO_4, (Merck) acid acetate-chloroform (3:2), (Merck) and aquadest (pa).

Procedures

1. Preparation of Sample

Banana peel will be wet shorted to remove dirt. Washed with running water and drained, then cut into piece. The peel of the banana will be processed for processing activated carbon through three stages, namely the process of dehydration, carbonization, and activation. Prepared the sample into 3 parts. The first sample was used cooking oil from frying chicken, fried snacks, and twice frying. All sample will be soaking treatment with and without adding activated carbon, with activator HCl and $ZnCl_2$.

2. Preparation of Active Carbon Simulation

The step procedure making active carbon was dehydration process by drying in the sun or heating it in the oven until a constant weight was obtained. The second process is carbonization or drying using an oven at 600°C for 90 minutes and the third one was the chemical activation process which was soaking with chemicals such as HCl and $ZnCl_2$ for 24 hours then filtered and rinsed with distilled water until the pH was the same as the aquadest pH then drained and heated at 105-110°C for 1-2 hours until a constant weight was obtained.

3. Active Carbon Characterization

3.1 Determination of ash content

Weighed 1 gram of activated charcoal from Ambon Lumut banana peel was weighed and put into the weighed crucible cup (W1). Then the crucible containing the sample was put into the furnace which has reached a temperature of 800°C and left for 3 hours. After the activated charcoal was ash cooled in the desiccator and weighed until a constant weight (W2) is achieved (Jubilate et al., 2016).

3.2 Determination of Moisture Content

The active charcoal of Ambon Lumut banana peel was weighed as much as 1 gram each, after that it is put into a porcelain dish that has been dried in the oven and its fixed weight was known. The porcelain cup which was filled with the sample was then dried into an oven at 105°C for 3 hours and then cooled. Then stored in a desiccator and weighed to determine the water content (Jubilate et al., 2016).

3.3 Determination of Iodine Absorption

Determination of iodine number was done by weighing 0.5 grams of activated carbon ambon lumut banana peel then transferred into a dark and closed container. Then put 50 mL of 0.1 N iodine solution into the container and then the shakered at 150 rpm for 15 minutes and filtered. The filtrate was taken as much as 10 mL and stored in Erlenmeyer then titrated with 0.1 sodium thiosulfate solution. If the solution's yellow color was almost gone, 1% starch indicator was added. Titration was continued until the blue color disappears and the solution becomes clear. The volume of sodium thiosulfate solution used for titration was recorded. Repeated the above procedure 3 times (triplo) (Jubilate et al., 2016).

3.4 Determination of Evaporating Substance

The active charcoal of ambon lumut banana peel was weighed as much as 1 gram each and then heated into the furnace at 950°C for 6 minutes and cooled into the desiccator then weighed (Jamilatun&Martomo, 2014).

3.5 Determination of Bonded Carbon Levels

The procedure for determining the bound carbon content refers to the Indonesian National Standard (SNI) 06-3730-1995, concerning quality requirements and testing of activated charcoal. Bonded carbon is the fraction of carbon bound in space in addition to the fraction of water, evaporating substances, and ash (Jamilatun&Martomo, 2014).

4. Making Reagent Solutions

4.1 Manufacture of $Na_2 S_2 O_3 .5H_2O$ 0.1 N Solution

Weighed 24.8 grams of sodium thiosulfate pentahydrate crystals were dissolved in 1 liter of water that has been boiled and cooled. Then 0.2 grams of sodium carbonate was added as a preservative and stored in a clean bottle.

4.2 Making Solution KI 10%

Potassium Iodide (KI) of 10 grams was weighed and dissolved with distilled water in a volumetric flask up to 100 mL.

4.3 Making saturated KI solutions

KI was added in 1.5 mL of aquadest while stirring until KI did not dissolve again.

4.4 Making 1% Amylum Indicator

The starch was weighed as much as 0.2 grams and then put into a glass beaker and added aquadest to 20 mL and heated it to clear.

5. Standardization of $Na_2S_2O_3$with KIO_3

Weighed 0.05 grams of KIO_3 and put it in an Erlenmeyer flask, added aquadest 5 mL, then added 10 mL of KI 10%. Titrated with a standard solution of sodium thiosulfate ($Na_2S_2O_3$) until it is yellow, added 1 mL of the starch indicator solution until it appears blue, then continue the titration until the blue color disappears.

$$\text{Standardization of } Na_2S_2O_3 = \frac{W\, KIO_3}{BE \times V\, Titration} \quad .... (1)$$

6. Determination Value Peroxide by Iodometry Method

Used cooking oil soaked with activated carbon each taken as much as 5 grams and put into a closed Erlenmeyer then added 30 mL of acetic acid-chloroform solution (3:2). Shaked until all ingredients were dissolved, then 0.5 mL of saturated KI solution was added. Leave for 1 minute while shaking, after that 30 mL aquadest is added. The mixture was titrated with 0.1 $Na_2S_2O_3 5H_2O$ until the yellow color was almost disappear adding 0.5 mL of 1% starch indicator and titrated again until the blue color disappears. Titration was replicated 3 times (Wardoyo, 2018).

7. Determination of Peroxide Numbers with Active Carbon from Ambon Banana Peel on Varian Samples

Used cooking oil soaked with activated carbon each taken as much as 5 grams and put into closed Erlenmeyer then added 30 mL of acetic-chloroform acid solution (3:2). Shaken until all ingredients were dissolved, then added 0.5 mL of saturated KI solution. Let stand for 1 minute while being shaken, after that 30 mL of aquadest was added. The mixture was titrated with 0.1 $Na_2S_2O_3 .5H_2O$ until the yellow was almost gone, added 0.5 mL of the 1% starch indicator and titrated again until the blue color disappears. Titration was replicated 3 times (Tarigan & Simatupang, 2019).

RESULT AND DISCUSSION

The selection of Ambon Lumut banana peels as activated carbon because the content of old banana peels contains a lot of pectin which can be used as bio adsorbent. The ability of the adsorbent on this banana peel will be used in determining the decrease in the number of peroxides from used cooking oil.

Making activated carbon from ambon lumut banana peel waste through three processes, namely the process of dehydration, carbonization, and activation. The dehydration process aims to evaporate the water content or reduce the moisture of the raw material. The carbonization process is the process of forming material by increasing the carbon content of organic material from incomplete combustion by producing C, CO, and H_2O. At this stage the organic material contained will be degraded to carbon and non-organic compounds will be converted into tar compounds. The reactions that occur during the carbonization process are:

$$C_6H_{12}O_6 + O_2 \rightarrow 4C_{(s)} + 2CO_{(g)} + 6H_2O_{(g)} \quad ....(2)$$

The last process is an activation process that aims to remove impurities that cover the pore surface of carbon after the carbonization process.

The activation process carried out in this study was chemical activation with activator HCl and $ZnCl_2$. This activation will cause the number of pores to be formed more and during activation, the activator will bind impurities in the form of tar compounds left over from the carbonization process and wasted during washing (Jubilate et al, 2016).

After the production of activated carbon is complete, the activated carbon must be characterized which aims to determine the quality of activated carbon so that it can be used as an adsorbent in decreasing peroxide numbers in used cooking oil. The quality of activated carbon can be determined by determining the parameters of water content, ash content, volatile substances, bound substances and absorption of iodine. The results of the characteristics of activated carbon can be seen in Table 1.

Determination of water content aims to determine the nature of hygroscopic activated carbon. In Table 1 it can be seen that the water content of activated carbon with HCl and $ZnCl_2$ activators is 5% and 3% respectively, which when compared with the activated carbon quality requirements in SNI 06-3730-1995 which is 15% which means carbon water content actively meeting activated carbon quality standards. The water content of activated carbon is influenced by the hygroscopic nature of the charcoal due to the activation process after the washing process. Overall, the water content of the activated carbon is relatively small, this indicates that the water content of the carbonized raw material comes out before being activated. The higher the water content of activated carbon can affect the closure of the pores.

Determination of ash content aims to determine the content of metal oxide in activated carbon. In Table 1 it can be seen that the ash content of activated carbon with HCl and $ZnCl_2$ activators is 1% and 7%, respectively. According to SNI 06-3730-1995 stated that the quality requirements for activated carbon ash content is a maximum of 10% which means that the ash content of activated carbon from Ambon lumut banana peel have the quality standards of activated carbon. The low ash content of the resulting HCl activator may be due to the use of a non-concentrated solution because dilution of the HCl solution activator. The higher the ash content of activated carbon can reduce the adsorption capacity of activated carbon, because the pores of activated carbon are filled with metal minerals such as magnesium, calcium, and potassium.

Determination of the evaporating substance content aims to determine the content of compounds that have not evaporated at the time of carbonization and activation contained in act if carbon at a temperature of 950°C. In Table 1 the levels of evaporating substances for HCl and $ZnCl_2$ activators were 18.47% and 19.2% respectively, which stated that the level of evaporating substances fulfilled the activated carbon quality standard according to SNI 06-3730-1995 which means activated carbon Ambon Lumut banana peel has experienced decomposition of non-carbon compounds such as CO_2 and CO.

Determination of carbon content bound to activated charcoal aims to determine the carbon content after the carbonization process. In Table 1 the bounded carbon content for HCl and $ZnCl_2$ activators is 75.53% and 70.8% respectively, which states that the bound carbon content has met the activated carbon quality standards (SNI 06-3730-1995). The high carbon content bound is caused by the low water content, ash content, and evaporated carbon content produced. The results of the study prove that the lower the water content, ash content, and the level of evaporated substances produced, will produce a high carbon content bound.

Determination of absorption of activated carbon against iodine aims to determine the ability of activated carbon to absorb colored solutions with molecular sizes of less than 10 Å or 1 nm. In Table 1 the absorptive power obtained from the activated carbon of Ambon Lumut banana peel with HCl and $ZnCl_2$ activators is 3045.85 mg/gram and 1776.74 mg/g respectively, which indicates that iodine absorption meets the activated carbon quality standard (SNI 06-3730-1995) which is a minimum of 750 mg/g. The higher absorption capacity of iodine, the greater the ability to adsorb adsorbent or solutes.

Table 1. Characteristics of Ambon Lumut Banana Peel Activated Carbon

Activator	Water Content (%)	Ash Content (%)	Evaporated Carbon Content (%)	Bonded Carbon Content (%)	Iodine Adsorption (mg/g)
HCl	5	1	18,47	75,53	3045,85
$ZnCl_2$	3	7	19,2	70,8	1776,74
SNI 06-3730-1995	Maks.15	Maks.10	< 25%	> 65%	Min 750 mg/g

In this study, the determination of the decrease in peroxide number in three samples of used cooking oil from fried chicken, fried snacks, and used cooking oil from twice usage will be treated with immersion from banana peel activated carbon Ambon Lumut for 4 hours using different activators. Each sample weighed as much as 5 grams was put into Erlenmeyer, then added a fat solvent consisting of chloroform and glacial acetic acid (3:2) as much as 30 mL.

Addition of glacial acetic acid and chloroform to dissolve oil because alkali iodide will react perfectly in acidic solutions. 0.5 mL of saturated KI was added to free iodine which was indicated by the formation of yellow in the sample (Fanani & Ningsih, 2019). Let it stand in a dark place for 1 minute so that the reaction takes place perfectly. After that 30 mL aquadest was added and titrated with $Na_2S_2O_3$ 0.16 N until the light yellow almost disappeared and immediately added 1% starch indicator which aims to clarify the end point of titration and titrate with $Na_2S_2O_3$ 0.16 N until blue disappears. Record the volume of the titration and do it three times.

The results obtained for decreasing peroxide number can be seen in Table 2 results of decreasing peroxide numbers in samples with immersion of activated carbon from Ambon Lumut banana peel. Based on the results in Table 2, it states that the activated carbon from ambon banana peel can reduce peroxide number in used cooking oil, either using activators from HCl or from activators from $ZnCl_2$

In used cooking oil from frying chicken with activator HCl and $ZnCl_2$, the initial peroxide number is 0.09216 mgO_2/gram and 0.0768 mgO_2/gram and has decreased peroxide number by 0.42752 mgO_2/gram and 0.44288 mgO_2/gram, so that the percent decrease in peroxide number from soaking activated carbon with activator HCl and $ZnCl_2$ is 82.26% and 85.22%.

Then in used cooking oil from fried snacks with activator HCl and $ZnCl_2$, the initial peroxide number was 0.19456 mgO_2/gram and 0.13568 mgO_2/gram and peroxide number decreased after immersion of activated carbon is 0.08704 mgO_2/gram and 0.14592 mgO_2/gram, so that the percent decrease in peroxide number from

Table 2. Results of Reducing Peroxide Numbers in Samples by Immersion Activated Carbon from Ambon Lumut Banana Peel

No.	Sample	Peroxide Value (mgO_2/gram)	Decreasing Peroxide Value (mgO_2/gram)	Percentage Decreasing Peroxide Value (%)
1.	Used cooking oil after frying chicken	0,51968	-	-
2.	Used cooking oil after frying snack	0,2816	-	-
3.	Used cooking oil after twice frying	0,4608	-	-
4.	Used cooking oil after frying chicken, soaking active carbon with HCl activator	0,09216	0,42752	82,26
5.	Used cooking oil after frying snack, soaking active carbon with HCl activator	0,19456	0,08704	30,90
6.	Used cooking oil after twice frying, soaking active carbon with HCl activator	0,14336	0,31744	68,88
7.	Used cooking oil after frying chicken, soaking active carbon with $ZnCl_2$ activator	0,0768	0,44288	85,22
8.	Used cooking oil after frying snack, soaking active carbon with $ZnCl_2$ activator	0,13568	0,14592	51,82
9.	Used cooking oil after twice frying, soaking active carbon with $ZnCl_2$ activator	0,03328	0,42752	92,77

soaking activated carbon with activator HCl and $ZnCl_2$ is 30.90% and 51.82%.

In used cooking oil from twice using the use of HCl and $ZnCl_2$ activator the initial peroxide number was 0.14336 mgO_2/gram and 0.03328 mgO_2/gram and decreased peroxide number 0.31744 mgO_2/gram respectively and 0.42752 mgO_2/gram, so that the percent decrease in peroxide number from soaking activated carbon with activator HCl and $ZnCl_2$ is 68.88% and 92.77%.

CONCLUSION

Activated carbon from Ambon Lumut banana peel can be used to reduce peroxide value in used cooking oil, with activator HCl and $ZnCl_2$. The best activator $ZnCl_2$ is can reduce peroxide numbers successively in cooking oil from frying chicken percentage decreasing 85.22%, on cooking oil from fried snacks 51.82%, and cooking oil used for twice usage decreased 92.77%.

REFERENCES

Buanarinda, T., Rahmawati, N., Ainun, I., & Hidayah, R. (2014). *Proceedings of the National Chemistry Seminar. Making Biosorbent Made from Kepok Banana Peel (Musa acuminate) Waste Packaged Like Tea Bags*. 61–63.

Fanani, N., & Ningsih, E. (2019). Analisis Kualitas Minyak Goreng Habis Pakai yang Digunakan oleh Pedagang Penyetan di Daerah Rungkut Surabaya Ditinjau dari Kadar Air dan Kadar Asam Lemak Bebas (ALB). *Jurnal IPTEK*, *22*(2), 59–66.

Jamilatun, S., & Martomo, S. (2014). *Making Active Charcoal from Coconut Shell and Its Application for Liquid Smoke Purification. Ind. Spectrum*. *12*, 73–83.

Jubilate, F., Zaharah, T., & Syahbanu, I. (2016). Effect of Activation of Charcoal from Kepok Banana Peel Waste as Iron (II) Adsorbent in Groundwater. *JJK*, *5*, 14–21.

Ketaren. (2005). *Introduction to Food Oil and Fat Technology*. 131–132.

N, P., & D, O. (2013). Elimination of Iron (Fe) Metal in Well Water with Activated Carbon from Candlenut Shells. 2013; 33 – 41 (5). *Journal of Environmental Technology Science*, *5*, 33–41.

R, P., & Sutapa, J. P. G. (2005). Quality of Active Charcoal from Waste Mahogany (Swietenia macrophylla King) as Water Purifier. 33 – 38 (3). *Journal of Tropical Wood Science and Technology*, *3*, 33–38.

Rahmansyah, A., Larashima, Ismuyanto, B., & N.H Dwi Septiati, A. (2005). *Manufacturing of Active Carbon Based on Banana Skins with Variation in Carbonization Temperature. 1*.

Simangunsong, D., Rohanah, A., & Shady, A. (2017). Making Active Charcoal from Raja Banana Peel Waste (Musa Textilia) to Improve Physical Quality of Water. *Journal of Food and Agriculture Engineering*, *5*, 639–644.

Tarigan, J., & Simatupang, D. F. (2019). Uji Kualitas Minyak Goreng Bekas Pakai Dengan Penentuan Bilangan Asam, Bilangan Peroksida Dan Kadar Air. *Ready Star - 2*, *2*(1), 6–10.

Wardoyo, F. A. (2018). Penurunan Bilangan Peroksida pada minyak Jelantah Menggunakan Serbuk Daun Pepaya. *Jurnal Pangan Dan Gizi*, *8*(2), 82–90.