Effect of Addition of Sugarcane Bagasse Activated Charcoal (Saccharum officinarum L) on Reducing Peroxide Numbers in Cooking Oil

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Abstract:
A research has been conducted entitled "The Effect of Addition of Sugarcane Bagasse Activated Charcoal (Saccharum Officinarum L) on Reducing Peroxide Numbers in Cooking Oil". The basis of this research, cooking oil that is used repeatedly and undergoes an excessive heating process causes a decrease in the quality of cooking oil, which is indicated by an increase in the peroxide value of the oil. Improving the quality of cooking oil can be done by adding activated charcoal made from bagasse. This study aims to determine the effect of adding sugarcane bagasse activated charcoal to decrease the peroxide number. This research was carried out at the Chemical Laboratory of the Aceh Government Health Analyst Academy using the experimental method, the population in this study was cooking oil. After doing research using the Iodometry method, the results obtained for the addition of 1% bagasse activated charcoal to reduce the peroxide value by 3,597 meq O_2/100 gr (40%), the addition of 2% bagasse activated charcoal resulted in a decrease of 1,417 meq O_2/100 gr (76.36%), and the addition of 3% bagasse activated charcoal resulted in a decrease of 1.253 meq O_2/100 gr (79.09%). Thus it can be concluded that the addition of bagasse activated charcoal can reduce the level of peroxide value in cooking oil.

Keywords:
Sugarcane Bagasse Activated Charcoal, Peroxide Number, Cooking Oil

JEL: I10, I18, I19

INTRODUCTION

Cooking oil is oil derived from purified plant or animal fats. Cooking oil is one of the nine staple ingredients consumed by all levels of society. Cooking oil can be produced from various types of plants, including coconut, seeds, nuts, corn, soybeans, and canola. Cooking oil is a food ingredient that is composed of various types of triglyceride compounds and is obtained from the final stage of the oil refining process (Kusnandar, 2010).

Cooking oil is a food ingredient that is liquid at room temperature, which is useful as a savory taste enhancer and also functions as a heat conductor, so that the fried material will lose most of the water it contains and then become dry. During the frying process, the oil will undergo a degradation reaction caused by several factors such as heat, air, and water, resulting in damage and a decrease in the quality of cooking oil (Winarno, 2004). Indications of damage or quality degradation in cooking oil, can be judged by the color becoming darker and not clear, unpleasant aroma due to rancidity, the oil becoming thicker, and high levels of fatty acids and peroxides (Prarudiyanto et al, 2015). .

Ketaren (Utari et al, 2015) states that peroxide is the result of the formation of unsaturated fatty acids that bind oxygen to the double bond. Peroxide is the most important value for determining the degree of damage to an oil or grease. The National Standardization Agency (BSN) of SNI in 1995 determined that the quality standard of cooking oil has a maximum peroxide value of 2.0 mg O_2/gr.

Economic conditions as well as the relatively expensive price of cooking oil, causes people in general to consume and use cooking oil repeatedly, which can lead to dyslipidemia, metabolic syndrome, atherosclerosis and obesity. Thus it is necessary to make efforts to improve or improve the quality of cooking oil. One of the efforts that can be done to improve the quality of oil is by adding activated charcoal (activated carbon).

According to Ginting (Utari et al, 2015) activated charcoal is a porous solid consisting of mostly free carbon elements that are covalently bonded, and treated by heating at high temperatures, so that it has a very large surface area. The activated charcoal heating process must be carried out in an optimum heating room without air leakage, so that materials containing carbon are only carbonized and not oxidized. Khairunnisa (Utari et al, 2015) states that activated charcoal can come from animals, plants, waste, and minerals that contain carbon, then processed by carbonization so that it becomes activated charcoal. One source of activated charcoal is sugarcane pulp.

According to Slamet (Asbahani, 2013) bagasse is a fibrous waste material from sugarcane plants whose juice has been extracted and contains a lot of cellulose. The remaining fiber from bagasse can also be used as fuel to produce energy in the sugar-making process.

Based on the research conducted by Utari et al, (2015) on "The effectiveness of activated carbon in reducing peroxide levels and color clarification in used cooking oil" at the Department of Public Health, University of North Sumatra, researchers are interested in conducting research with the title "The Effect of Adding Charcoal Active Sugarcane Bagasse (Saccharum officinarum L) on Reducing Peroxide Numbers in Cooking Oil".

The purpose of this study was to determine the percentage decrease in peroxide levels in cooking oil treated with bagasse activated charcoal (Saccharum offiinarum L).

LITERATURE REVIEW

Definition of Sugar Cane

Sugarcane comes from Papua and has been cultivated since 8,000 years BC. This plant spread along with human migration, from Papua to the Solomon Islands, New Hybrids, and New Caledonia. In Indonesia, the largest sugarcane producing areas are Java, South Sumatra, West Sumatra, Lampung and Nusa Tenggara. Sugarcane is the basic ingredient for making sugar with the scientific name (Saccharum officinarum L). Sugarcane is not only useful for providing a sweet taste but also useful as a flavoring agent, alcohol, cosmetics, fertilizer, and so on (Suwarto, 2010).

Sugarcane Dregs

Birowo (Apriliani, 2010) stated that bagasse or commonly referred to as bagasse, is a waste generated from the process of milking or extracting sugarcane stalks. In one extraction process, bagasse produced is about 35-40% of the weight of the milled sugarcane. Overall of the many bagasse produced, only about 50% has been utilized. The rest is still waste that requires more optimum handling so that it can be reprocessed.

Bagasse has physical properties, namely yellowish in color, fibrous (stringy), and soft. Bagasse produced from sugarcane plants is composed of water (water content 44.5%), fiber in the form of solids (fiber content 52.0%) and brix, which is soluble solids, including soluble sugar (3.5%).).

Bagasse has physical properties, namely yellowish in color, fibrous (stringy), soft and relatively requires a large space for storage in a certain amount of weight, compared to storage in the form of charcoal with the same amount (Apriliani, 2010).

Chemically, the main component of sugarcane bagasse is fiber which contains cellulose, hemicellulose, lignin, and there are other compounds called ash compounds.

Table 1. Chemical Composition of Sugarcane Bagasse

Chemical Composition	Content (%)
Ash	0,79
Lignin	12,70
Pentose	27,90
Cellulose	44,70
Cider (alcohol, benzene)	2,00
Solubility in hot water	3,70

Source: Center for Cellulose Industry Research & Development, 1986

Bagasse as sugar factory waste, is one of the organic materials that contain high enough carbon elements. So far, the use of bagasse is only limited to animal feed, raw material for making fertilizer, and fuel in the sugar-making process. Therefore, it is necessary to develop technology for optimum utilization of this waste. The high carbon content in bagasse is the basis for its use as activated charcoal (Karimah and Sudibandriyo, 2013).

Activated Charcoal

Ginting (Utari et al, 2015) stated that activated charcoal is a porous solid that is covalently bonded and has a very large surface area. Activated charcoal is produced from materials containing carbon elements by heating at high temperatures.

According to Sembiring (Utari et al, 2015) activated charcoal has an absorption capacity that is determined by the surface area of the particles, so this ability can be higher if the charcoal is activated by adding chemicals or by heating at high temperatures. Thus the charcoal will experience changes in chemical and physical properties, so this kind of charcoal is called activated charcoal.

Lempang (Aulia, 2017) states that the manufacture of activated charcoal is broadly divided into three stages as follows:

1. Dehydration is the process of removing water.
2. The carbonization process is the process of breaking down organic cellulose into carbon elements, and releasing non-carbon compounds.
3. The activation process is divided into 2 parts, namely:
   a. Chemical activation, in principle, is the immersion of charcoal with chemical compounds before heating. In this process, the charcoal is immersed in an activating solution for 24 hours, then drained and heated at a temperature of 300-600^{o}C for 1-2 hours. At high temperatures the activating agent will enter between the hexagonal layers and then open the closed surface. Chemicals that can be used are H_3PO_4, NH_4Cl, $AlCl_3$, HNO_3, NaOH, $KMnO_4$, SO_3, H_2SO_4, and K_2S.
   b. Physical activation, using weak oxidizing agents, such as water vapor, CO_2 gas, N_2, O_2 and other oxidizing gases. Therefore, in this process there is no oxidation of the carbon atoms that make up the charcoal. However, the oxidizing agent only oxidizes the components that cover the surface of the charcoal pores. This activation is heated at a temperature of 800-1000^{o}C. At temperatures below 800^{o}C, the activation process with water vapor or CO_2 gas takes place very slowly, while at temperatures above 1000^{o}C, it will cause damage to the hexagonal charcoal lattice structure.

According to Sembiring (Utari et al, 2015) the surface of activated charcoal is non-polar so that it can selectively adsorb gases and certain chemical compounds, depending on the size or volume of the pores and the surface of the activated charcoal.

Adsorption

Manocha (Asbahani, 2013) states that adsorption is the process of absorbing a substance on a surface that involves the interaction between liquid or gas molecules with solid molecules, so that the substance sticks to the surface of the adsorbent. This interaction occurs because of the attraction of an atom or molecule that covers the surface. The adsorption capacity of

activated carbon depends on the type of pores and the number of surfaces that can be used for adsorption. In adsorption, the terms adsorbent and adsorbate are used. Adsorbant is an absorbent medium while adsorbate is a substance that is absorbed or a substance that will be separated from the solvent (Mirwan, 2005). Adsorption is one of the separation methods that can be used to overcome industrial problems related to gas purification, odors in the drug and food industry, unpleasant odors and tastes in beverages and pollutants in the water treatment industry (Karimah and Sudibandriyo, 2013).

Oil and fat

Fats or oils are non-polar ester compounds that are insoluble in water, which are produced by plants and animals. Fats and oils have important functions in food processing, namely as energy sources contributing to the formation of texture and sensory quality of food products, heat transfer medium in the frying process, as well as solvents for fat-soluble essential vitamins (A, D, E, and K).). Fats and oils are widely used in food processing, both as ingredients and as heat transfer media in frying pans. The physicochemical properties of oils and fats greatly affect the quality, shelf life and characteristics of the food produced (Kusnandar, 2010).

Peroxide Number

Peroxide number is an unsaturated fatty acid compound that binds active oxygen in the double bond.

1. Factors that accelerate the formation of peroxides
   Djatmiko (Neliza, 2014) stated that the peroxide formation process was accelerated by the presence of light, acid atmosphere, humidity, and a catalyst. Several types of metals or salts contained in oil are catalysts in the oxidation process.
2. Factors that inhibit the formation of peroxides
   According to Ketaren (Neliza, 2014) good fat storage is in a closed, dark and cool place. Good containers are made of aluminum or stainless steel. Several kinds of organic compounds can inhibit the oxidation process, called antioxidants. Antioxidant compounds found naturally in oil are tocopherols (vitamin E), polyferols, gossypol, anthocyanins and flovones. In addition, synthetic organic compounds are added intentionally to inhibit the fat oxidation process. Ketaren (Utari et al, 2015) stated that the peroxide value is the most important value to determine the degree of damage to the oil. Unsaturated fatty acids can bind oxygen in the double bonds to form peroxides. This peroxide can be determined by the Iodometric method.

Lodometric Method

Basset (Nasution, 2015) states that quantitative analysis using iodine reducing compounds can be carried out using two methods, namely direct and indirect. The direct method is called iodimetry (iodine solution as the oxidizing equivalent), but this method is rarely used because iodine is a weak oxidizing agent. While the indirect method is called Iodometry (the analyzed oxidizing agent is reacted with excess iodide ion).

According to Sudarmadji (Neliza, 2014) in the Iodometry method, the sample is an oxidizing agent. The basic principle of the iodometric method is the measurement of the amount of iodine liberated from KI through oxidation by peroxides from fats or oils at room temperature in acetic acid and chloroform solvents, then free I_2 is titrated with $Na_2S_2O_3$ and starch indicator which produces blue starch iod, excess $Na_2S_2O_3$ and NaI which is indicated by a blue color change to clear. The principle of the reaction that occurs during the titration is as follows:

Sample (oxidizing agent) + KI----------→ I_2 (iod-free) + X (Reducing)

I_2 + $2Na_2S_2O_3$---------→ $2NaI + Na_2S_4O_6$

Figure 2. Reaction of iodine as a reducing agent

Iodium adalah oksidator yang lebih lemah dari pada kalium permanganat, dengan perubahan setengah reaksi reduksinya sebagai berikut :

$I_2 + 2e \text{----------} \rightarrow 2I^-$

Figure 3. Reduction half reaction

Indicators that can be used in Iodometry are 1% starch and chloroform. Starch with iodine forms a complex compound (iod-starch) which is blue in color. The formation occurs in a slightly acidic atmosphere and is slightly soluble in the presence of iodide.

RESEARCH METHOD

This research was conducted using the experimental method, namely a study by conducting experimental activities, which aims to determine the symptoms or effects that arise, as a result of certain treatments (Notoatmodjo, 2012). This research was conducted to determine the decrease in peroxide value in cooking oil with the addition of bagasse activated charcoal. This research was conducted at the Chemical Laboratory of the Aceh Government Health Analyst Academy Jalan.Tgk. Daud Bereueh No.168 A Banda Aceh. This research was conducted on 26–28 February 2017.

The population in this study is bulk cooking oil. The sample was Bulk cooking oil with added hydrogen peroxide (artificial sample) until the peroxide value was ± 6 meq O_2/100 gr. Data were collected by examining the peroxide value in cooking oil, before and after the addition of activated charcoal from bagasse using the Iodometry method. The data was processed from the level of peroxide value in cooking oil before and after the addition of activated charcoal from bagasse.

Work procedures

Tools and Reagents

The tools used in this research are: analytical balance, beaker glass, erlenmeyer, measuring pipette, stirring rod, measuring cup, measuring flask, funnel, reagent spoon, weighing plate, furnace, crush, pliers krush, mortar, oven, heating device , suction cups, burettes, clamps and stationary rods. The materials used in this study were: tissue, aquadest, filter paper, cooking oil and bagasse activated charcoal. The reagents used were: aquadest, acetic acid-chloroform (3:2), $Na_2S_2O_3$ 0.01 N, 1% starch, KI, 0.1 N NaOH.

Inspection Method

The method of examination using the method: Iodometry.

Procedure

1. Activated Charcoal Making Process
   a. The bagasse is cleaned of adhering impurities.
   b. Then washed and dried in the sun ± for 1 day.
   c. The dried bagasse was carbonized in a furnace at a temperature of 320^{o}C for 30 minutes until it turned black charcoal.
   d. It is then mashed with a mortar, then the charcoal activation process is carried out using a sodium hydroxide solution (NaOH 0.1 N) for 1 hour.
   e. Then the charcoal is filtered with filter paper.
   f. Dry back in the oven.
2. Peroxide Number Check
   a. Before adding activated charcoal
      1) Weighed 2 grams of cooking oil (artificial sample), put into a 100 ml Erlenmeyer.
      2) Added 15 ml of chloroform acetic acid solution (3:2), homogenized
      3) Then added 0.5 ml of saturated KI covered with plastic.
      4) Let stand for 1 minute and add 30 ml of distilled water.
      5) Titrate with 0.0109 N $Na_2S_2O_3$ solution until the color is light yellow, then add 1 ml of 1% starch. The titration is continued until the blue color disappears.
      6) The titration results are recorded and repeated three times.

b. With the addition of activated charcoal
   1) Take cooking oil with known peroxide levels beforehand.
   2) Put 100 grams each into 3 glass beaker containers.
   3) Added 1 gram of activated charcoal in the first glass beaker, 2 grams of activated charcoal
   4) in the second beaker glass and 3 g of activated charcoal in the third beaker glass.
   5) Let stand for 30 minutes.
   6) Then filtered using filter paper.
   7) Weighed each 2 g of the examination material into the Erlenmeyer.
   8) Then 15 ml of chloroform acetic acid solution (3:2) was added, shaken until the material was dissolved, added saturated KI and then closed. Let stand for 1 minute and add 30 ml of distilled water.
   9) Titrate with 0.0109 N $Na_2S_2O_3$ solution until the color is light yellow, then add 1 ml of 1% starch. The titration is continued until the blue color disappears.
   10) The titration results were recorded and repeated three times.
   11) Then the average titration result is calculated from each examination material.

Data analysis

The analyzed examination material data is calculated using the peroxide number formula:

$$\text{Milliequivalents per 1000 grams} = \frac{\text{Ht} \times \text{N} \times 1000}{\text{G}}$$

Description : Ht : Titration results
N : Normality
G : Sample weight, and

$$\text{Percentage (\%)} = \frac{a-b}{a} \times 100\%$$

Where: a = concentration before the addition of activated charcoal
b = concentration after addition of activated charcoal

Data Presentation

Percentage data of peroxide number before and after the addition of activated charcoal which has been analyzed is presented in tabular form.

RESEARCH RESULTS AND DISCUSSION

Research result

After conducting research on the effect of adding sugarcane bagasse activated charcoal in reducing peroxide levels in cooking oil using the Iodometry method, the data obtained can be seen in the following table:

Table 2. Data on Peroxide Numbers Before and After Addition of Sugarcane Bagasse Activated Charcoal

No	Description Sample	Charcoal Weight Active (%)	Titration Result (ml)	Peroxide Number (meq O_2/100gr)		Percentage Drop Rate (%)
				Before	After	
1	Control	-	1,1	5,995	-	-
2	Sample 1	1	0,66	5,995	3,597	40
3	Sample 2	2	0,26	5,995	1,417	76,36
4	Sample 3	3	0,23	5,995	1,253	79,09

Discussion

Cooking oil is oil derived from purified plant or animal fats. Cooking oil acts as a savory taste enhancer and also serves as a heat conductor. During the frying process, the oil will undergo a degradation reaction caused by several factors such as heat, air, and water, resulting in damage and a decrease in the quality of cooking oil (Winarno, 2004). High levels

of peroxide are an indication of damage to the cooking oil. One of the efforts made to improve the quality of oil is by adding activated charcoal (activated carbon).

This research was conducted with the aim of knowing the effect of adding sugarcane bagasse activated charcoal by varying the levels of activated charcoal, namely 1%, 2% and 3% which were added to each 100 g of cooking oil (artificial sample). The level of peroxide value before the addition of activated charcoal (control) was 5,995 meq O_2/100 gr. In the addition of 1% activated charcoal the peroxide value decreased by 40%, at the addition of 2% activated charcoal decreased by 76.36%, this is because bagasse activated charcoal contains high levels of cellulose, where the cellulose has been carbonized into carbon elements and undergo activation so that it has the ability to absorb peroxide value in cooking oil, while the process of absorption of peroxide value by activated charcoal goes through three stages, namely O_2 in cooking oil is adsorbed on the outside of the activated charcoal then moves towards the pores of the charcoal and is adsorbed onto the inner wall of the charcoal. active. While the addition of 3% activated charcoal decreased by 79.09%, this value was not much different from the decrease in peroxide levels in the addition of 2% activated charcoal, this was due to the addition of activated charcoal into cooking oil in absorbing the peroxide number also needed to be adjusted to the volume. cooking oil, because if the level of addition of activated charcoal is excessive, it can cause saturation of activated charcoal (Utary, et al 2015).

The amount of surface area of the adsorbate is proportional to the surface area of the adsorbent, so that if the surface of the cell wall of the adsorbent has been saturated by the adsorbate and has reached the maximum adsorption capacity, the addition of activated charcoal levels will no longer be able to increase the adsorption ability of the adsorbent.

Cooking oil containing high levels of peroxides can be caused by repeated use of cooking oil with high temperature heating which converts unsaturated fatty acids into peroxide groups, trans fatty acids, and free radical compounds that can cause symptoms of atherosclerosis, cancer and heart disease. coroner. For this reason, the National Standardization Agency (BSN) of SNI has determined that the peroxide content in cooking oil should not exceed 2.0 meq O_2/gr.

CONCLUSION

Based on the results of the research on the level of peroxide in cooking oil after the addition of bagasse activated charcoal (Saccharum officinarum L), it can be concluded as follows:

1. The addition of bagasse activated charcoal can reduce the number of peroxides.
2. The addition of 1% sugarcane bagasse activated charcoal can reduce the peroxide value by 3,597 meq O_2/100gr with a 40% decrease percentage.
3. The addition of 2% sugarcane bagasse activated charcoal can reduce the peroxide value as much as 1,417 meq O_2/100gr with a percentage decrease of 76.36%.
4. The addition of 3% sugarcane bagasse activated charcoal can reduce the peroxide value as much as 1.253 meq O_2/100gr with a percentage decrease of 79.09%.
5. The most optimal level of activated charcoal in reducing the peroxide value in cooking oil is 2% g of activated charcoal.

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