UTILIZATION OF ACTIVATED CARBON FROM PINEAPPLE PEEL WASTE WITH 1 HOUR OF 1 M NaOH ACTIVATION TIME AS AN ADSORBER FOR IMPROVING THE QUALITY OF CRUDE PALM OIL (CPO)

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Abstract

This research aims to determine the characteristics of active carbon produced from pineapple peel waste as an adsorbent to improve the quality of Crude Palm Pil (CPO). This research includes the physical and chemical characteristics of the activated carbon produced and the ability of activated carbon to improve the quality of Crude Palm Oil (CPO). Activated carbon from pineapple peel waste was activated for 1 hour using 1M NaOH. Sample testing was carried out by testing the levels of free fatty acids and carotenoids in Crude Palm Oil (CPO). The results of this research indicate that activated carbon from pineapple peel waste has the potential as an adsorbent for purifying carotene and absorbing Free Fatty Acids (ALB) in CPO. Utilizing pineapple peel waste provides positive benefits because the use of pineapple peel waste reduces environmental pollution and is a natural adsorbent to improve the quality of Crude Palm Oil (CPO).

Keywords: *Activated Carbon, Adsorbent, Crude Palm Oil, Pineapple Peel*

1. Introduction

Pineapple fruit (Ananas comosus (L. Merr) is a trade commodity that plays an important role in the food crop subsector in the agricultural sector. Based on data from the 2022 Central Statistics Agency, pineapple production in 2022 is 3 203 775.00 tonnes with Jambi province amounting to 119 862.00 tonnes. Pineapples have parts that are discarded, one of which is the skin which has an uneven texture and small spines on the outer surface. Pineapple skin is simply thrown away as waste, even though pineapple skin contains 12% cellulose, 6.5% hemicellulose and 11% lignin [1]. The cellulose, hemicellulose and lignin compounds contained in pineapple skin have the potential to be used as natural adsorbents because they have hydroxyl groups (-OH). This hydroxyl group will trap heavy metals by forming a complex interaction between the solid surface and the adsorbate [2].

Activated carbon or activated charcoal is a carbon compound whose adsorption capacity has been increased by an activation process. In this activation process, hydrogen, gases and water are removed from the carbon surface, resulting in physical changes on the surface [3]. Activated carbon can absorb chemical compounds or gases or its adsorption properties depend on the size or volume of the pores, the number of activated carbon pores and the surface area of the activated carbon. Adsorption is the process of separating certain components in the liquid or gas phase through a solid surface called an adsorbent, while the components that are absorbed are called adsorbate [4]. Absorption capacity is determined by the surface area of the particles and this ability can be higher if the charcoal is activated. The activated carbon activation process can be done in 2 ways, namely physically and chemically. The chemical activation process can be carried out with a NaOH solution to clean the surface of the pores, removing impurities [5]. Soaking time can reduce water content, as well as increase adsorption capacity and also reduce free fatty acid levels, the longer the adsorbent is [6].

Crude Palm Oil (CPO) is crude oil obtained by extracting palm fruit flesh and usually still contains dissolved and insoluble impurities in the oil. Indonesia's CPO production has increased from 37,965,224 tonnes in 2017 to 48,235,405 tonnes in 2022, an increase of 10,270,181 tonnes over the last 5 (five) years [7]. This high productivity makes palm oil competitive as an alternative oil that can be used in the food industry, machine lubricants, health products, biofuel and biodiesel and even cosmetics [8]. CPO products as cooking oil have two aspects in quality assessment. The first aspect includes fatty acid content, moisture and dirt levels. The second aspect includes taste, aroma, clarity and purity of the product. The formation of ALB occurs due to hydrolysis and oxidation reactions which are accelerated by the presence of heat, water, acidity and catalysts (enzymes). [9]. High levels of free fatty acids cause rancidity, changes in taste and color of the oil. The ingredients contained in CPO consist of major and minor ingredients. The major content is triglycerides (94%), while the minor content is tocopherols, sterols, phosphatides, and carotenoids which are one of the important ingredients in CPO [10]. Carotenoids give the characteristic orange-red color to crude palm oil. Cooking oil that is reddish in color is generally not liked by consumers. Consumers prefer oil that is yellow and tends to be clear. The bleaching process is carried out by absorbing carotenoid compounds which form the reddish color of CPO. The method generally used to reduce ALB and carotenoids is by adsorption using activated carbon [11].

In previous research, the manufacture of activated carbon from pineapple peel using the H2SO4 activator had potential as an adsorbent with characteristics of a carbon yield of 31.28%, a water content of 6.91%, an ash content of 6.94 and an iodine absorption capacity of 233,396 mg/g [12]. According to [12] conducting research on ALB adsorption using ATKS can adsorb free fatty acid levels on CPO with optimum conditions of 0.1 g adsorbent mass for 60 minutes with a decrease in free fatty acids from 7.321% to 6.297 %.

This research aims to determine the characteristics of active carbon produced from pineapple peel waste as an adsorbent to improve the quality of Crude Palm Pil (CPO).

2. Method

2.1 Tools and Materials

The materials used in this research were pineapple peel, CPO, distilled water, NaOH, label paper, tissue and plastic wrap. The tools used in this research are analytical scales, filter paper, 100 mesh sieve, beaker glass, measuring cup, oven, baking sheet, measuring flask, magnetic stirrer, hot plate, blender, pH meter, stir bar, separating funnel, pump vacuum, furnace and laptop.

2.2 Work Procedures

2.2.1 Pineapple Peel Sample Preparation

The pineapple skins obtained are sorted first by selecting good, good and pest-free pineapple skins to be used as research samples. The selected pineapple skin samples were washed thoroughly using running water and cut into small pieces. After the pineapple skin waste samples are clean, they are dried in the sun and continued with the drying process using an oven at a temperature of 105°C to achieve dry pineapple skin.

2.2.2 Carbonation of Pineapple Skin

Samples of dried pineapple skin were characterized by a change in color to brownish yellow. Then, it was carbonized in a furnace at 300^0C for 1 hour. The resulting pineapple peel charcoal is cooled and the yield is calculated by comparing the weight of the sample before and after carbonization.

2.2.3 Pineapple Peel Carbon Activation

The activation carried out in this research was chemical activation using the NaOH activator. First, weigh 10 grams of pineapple peel carbon, soak it in 100 ml of NaOH solution with a concentration of 1M (ratio 1:10) for 1 hour. Next, the pineapple skin is put into the NaOH solution and stirred using a magnetic stirrer on a hot plate for 1 hour to make it homogeneous. Then the washing process is carried out using filter paper and distilled water solution with the help of a time pump until a neutral pH is obtained from the washing results. After that, dry it using an oven at a temperature of 105°C for 12 hours so that it becomes active carbon.

2.2.4 Adsorption of Crude Palm Oil (CPO)

For the first step, prepare activated carbon and Crude Palm Oil (CPO) in a ratio of 1: 5 in a beaker glass. After that, the mixture is heated using a hot plate to reach a temperature of 60^0C and then homogenized using an electric motor at a constant speed of 12 rpm. After reaching the desired temperature and homogenization, the mixture is taken periodically every 2 minutes until it reaches an equilibrium state. The last step, the sample is filtered using filter paper.

In β-carotene, the adsorption process is carried out in a beaker glass with a weight ratio between activated carbon and palm oil of 1:3. Next, the mixture is heated using a hot plate to reach a temperature of 40^0C and homogenized by using an electric motor at a speed of 120 rpm for 2 hours. After that, the mixture is filtered using filter paper. After the filtering process is complete, the mixture is transferred into a container for analysis.

3. Results and Discussion

This research was conducted to improve the quality of CPO with the adsorption method using a type of activated charcoal bioadsorbent from pineapple peel and studying the effect of long soaking time using the NaOH activator in making activated charcoal, in refining process on CPO quality.

3.1 Carbonation of Pineapple Skin

In carbonization, the process of water evaporation and decomposition of the components contained in pineapple skin, namely cellulose, hemicellulose and lignin, occurs. The hemicellulose decomposition process takes place at a temperature of 100^0C to 150^0C, marked by the release of thin white smoke from the furnace chimney. The cellulose decomposition process begins at a temperature of 180^0C and ends at a temperature between 200^0C to 250^0C. This stage is characterized by the release of smoke that is thicker and darker in color, brownish black. The process of decomposing lignin begins at temperatures between 200^0C to 250^0C and ends at temperatures between 300^0C. In this process the color of the smoke produced returns to white and thin, and over time it disappears [14].

Figure 1. Carbonation of Pineapple Skin

3.2 Pineapple Peel Carbon Activation

The immersion process in the activating agent is carried out to reduce the tar content, so that the pores on the carbon surface become larger and more numerous [15]. The activatr used is NaOH which is alkaline.

Figure 2. Pineappe Pee Carbon Activation

3.3 Adsorption

The adsorption test was carried out using a hot plate and glass beaker with a ratio of 1: 3 for 2 hours at a speed of 120 rpm at a temperature of 40°C.

Figure 3. Adsorption of Pineappe Pee

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