Production of Activated Carbon from Pineapple Cores as an Adsorbent for Crude Palm Oil (CPO) with 1-Hour Activation Using NaOH and Variations in Adsorption Temperature and Time

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Abstract

Activated carbon is carbon that has been activated by a chemical substance so that it has a higher absorption capacity compared to ordinary carbon. The research objective that will be achieved through this research is to determine the ability of activated carbon to adsorb free fat content in crude palm oil (CPO). The research method used is using an activation time of 1 hour, adsorption time of 15, 30, 45, 60 and 75 minutes, adsorption temperature of 30, 40, 50, 60 and 70°C. The results showed that activation time had a significant effect on the adsorption capacity of CPO (Crude Palm Oil).

Keywords: Activated carbon, Crude Palm Oil, Adsorbent

I**ntroduction**.

Crude palm oil (CPO) Is the result of processing the flesh of oil palm fruit through a process involving fresh fruit bunches (FFB) sterilization, threshing, and pressing. Crude palm oil (CPO) is the primary product that adds approximately 30 % of value to the sale of fresh fruit bunches. Crude palm oil (CPO) serves as the fundamental ingredient for cooking oil production. A common issue encountered in the palm oil industry is the reddish color of cooking oil, which is generally disliked by consumers. Consumers prefer cooking oil that is yellow and tends to be clear.

Activated carbon is carbon that has been activated by achemical substance, giving it a higher adsorption capacity compared to regular carbon. Activated carbon can be produced from materials containing carbon elements. Activated carbon is carbon that undergoes further processing, namely the activation process, either through physical or chemical means, which opens up carbon pores and increases its surface area. However, the effectivenss of this activation process depends on factors such as temperature, activator and the duration of the activation.The pore structure of activated carbon is related to its adsorption capacity, where the greater the number of pores and the larger the pore size of activated carbon, the higher its adsorption capacity. High- quality activated carbon has a large surface area, typically ranging from 300 to 3500 m2/ gram**.**

Carbonization is a process of heating at a specific temperature using organic materials with very limited oxygen content, typically carried out in a furnace. This process leads to the decomposition of organic compounds. The solid material remaining after carbonization is carbon in the form of charcoal with narrow pores. Carbonization is commonly used in the production of activated carbon. The carbonization process is the most crucial step in the production of activated carbon. This is because during the carbonization process, the decomposition of hydrocarbon compounds like cellulose and hemicellulose takes place, resulting in pure carbon. Hence, it requires high pressure and heat to break the hydrocarbon chains. The carbonization temperature can influence the form of activated carbon.

Adsorption is the process of clustering soluble substances in a solution onto the surface of an adsorbent material, causing the material to enter and accumulate within the adsorbent. Both terms are often encountered together in a process, which is why it is referred to as adsorption. In adsorption, there are two key components: the adsorbent and the adsorbate. The adsorbent is the absorbing material, while the adsorbate is the substance being absorbed. The adsorption process can occur when solid or gas or liquid molecules come into contact with adsorbate molecules, leading to cohesive forces or hydrostatic forces and hydrogen bonding forces operating between the molecules throughout the material. These unbalanced forces cause changes in the concentration of molecules at the solid/fluid interface. Fluid molecules that are absorbed but do not accumulate/adhere to the adsorbent surface are referred to as adsorptive, while those that accumulate/adhere are called adsorbate. The adsorption process indicates where molecules will leave the solution and adhere to the surface of the adsorbent material due to chemical and physical reactions. Adsorption, as a method for treating liquid waste, is more commonly used because it is cleaner, more efficient, and cost-effective. Adsorption occurs through the interaction between the surface of the adsorbent material and the adsorbate molecules. Silica gel and activated carbon adsorbents have good adsorption capacity.

Sodium hydroxide, commonly referred to as caustic soda, is a chemical compound with high alkalinity. Sodium hydroxide is formed from a base oxide. It creates a strong

alkaline solution when dissolved in water. NaOH is used in various industrial applications, primarily as a base in the production processes of wood pulp and paper, textiles, aluminum, soap, and detergents. NaOH is a strong base activator frequently used in the chemical activation of adsorbents. Sodium hydroxide solution is a base activator that can be employed for activation.

Pineapples originate from Brazil and were introduced to Indonesia by Spanish and Portuguese sailors around the year 1599. Pineapple plants (Ananas comosus) have short stems. They are monocot plants that grow in clusters, producing offshoots. Their leaves are very long, with spines pointing upward at the tips (toward the end of the leaves), and the leaves emerge and are clustered at the base of the stem. Pineapple fruits contain vitamins (A and C), calcium, phosphorus, magnesium, iron, sodium, potassium, glucose, sucrose (sugarcane sugar), and the enzyme bromelain. Typically, pineapple fruits have parts that are considered waste, including leaves, outer skin, eyes, and the core (the central part). The skin is the outermost part, with an uneven texture and many small prickles on the surface. The eyes have a somewhat flat shape and many small, hole-like structures. The core, also known as the heart or core, is the central part of the pineapple fruit, which is elongated and has a somewhat firm texture with a slightly sweet taste. Pineapple cores contain cellulose (24.53%), hemicellulose (28.53%), and lignin (5.78%). Pineapple cores are typically used as animal feed or discarded. Pineapple processing primarily focuses on the use of the flesh, while the pineapple core is a byproduct of pineapple processing

Pineapple plants are typically utilized mainly for their fruit, with other parts being less commonly used. However, the leftover production of pineapple fruit generates a significant amount of solid waste in the form of peels and pineapple cores. When pineapples are processed in various industries, particularly in pineapple processing, pineapple cores are often produced as waste that has not been maximally utilized. So, in this regard, an idea has been conceived where waste from pineapples, such as the pineapple cores, can be utilized as an adsorbent to adsorb crude palm oil. This provides an opportunity not only to reduce waste but also to create employment opportunities for local communities through small-scale household industrie.

2.Method

The equipment used in this research includes a furnace, oven, glass beaker, spatula, reactor, digital scale, scissors, knife, tray, container, blender, pH paper, filter paper, separating funnel, vacuum pump, magnetic stirrer, 100-mesh sieve, hot plate, Erlenmeyer flask, and pipette. The materials used in this research are crude palm oil (CPO), pineapple cores, activated carbon from pineapple cores, NaOH (Sodium Hydroxide), and distilled water.In general, the methods used in this research are carbonization and activation methods.

2.1 Preparation of Raw Materials

In this stage, the pineapple cores are first subjected to a washing process to remove any impurities adhering to them. After they are clean, the pineapple cores are cut into small

pieces and dried under the direct sunlight. Subsequently, they are placed in an oven at a temperature of 105 °C to ensure that the pineapple cores are completely dry.

2.2 Carbonization of Pineapple Cores

This step is carried out by taking 100 grams of the dried pineapple cores, which are then placed in a furnace for carbonization at a temperature of 300°C for one hour. The results of this carbonization process are subsequently cooled and then finely ground using a blender.

2.3 Activation of Carbon

In this stage, carbon is mixed with a NaOH solution for the activation process using 4 grams of NaOH and 10 grams of pineapple core carbon (in a 1:10 ratio) and 100 ml of distilled water. Subsequently, the pineapple cores are added to the NaOH (Sodium Hydroxide) solution and the mixture is stirred using a hot plate and magnetic stirrer for 1 hour. Stirring is done to ensure homogeneity of the solution. This specific ratio is set to ensure that the pineapple core carbon to be activated is fully immersed in the activation solution.Then, washing is performed using filter paper and distilled water, assisted by a vacuum pump until a pH of 7 (neutral) is achieved. After that, drying is carried out for 12 hours at a temperature of 105°C using an oven to obtain activated carbon.

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 toreach a temperature of 60^{o}C 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 witha 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^{o}C and homogenized by using an electric motor at a speed of 120 rpm for 2 hours. After that, the mixtureis filtered using filter paper. After the filtering process is complete, the mixture is transferred into a container for analysis.

2.5 Result

The quality of edible oil is determined by several factors, among others, peroxide number, free fatty acid content and oil color. Therefore, the analysis carried out is the analysis of free fatty acid levels, peroxide number and oil color.

2.5.1 Carbon Activated

Activated carbon is activated for 1.5 hours, 2 hours, and 3 hours with a drying time of 12 hours. Activation using 1M NaOH solution.

Figure 1. Activated Carbon

2.5.2 Adsorption

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

Figure 2. Adsorption

Conclussion

This research includes the physical and chemical characterization of the activated carbon produced, as well as assessing the ability of activated carbon to absorb CPO. The research results show that activation time has a significant effect on the properties of activated carbon including surface area and adsorption strength on CPO. This research makes a positive contribution in managing pineapple tuber waste and reducing environmental pollution due to CPO, as well as opening opportunities for developing environmentally friendly adsorbents in the palm oil processing industry.

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