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The Production of Charcoal from Bamboo, Coconut Shell, and Palm Shell as Activated Carbon

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Abstract: Activated carbon filter is efficient in removing organics such as micropollutants, chlorine, and fluoride from drinking water or wastewater causing undesired taste and odor. The activated carbon filtration is used in treatment plants center and households to produce drinking water and treat effluents. In this research, the raw materials from bamboo, coconut shell, and palm shell were used to prepare the activated carbon (AC). The AC preparation was completed through the primary process, including the sieving and carbonization processes. After that, the activated carbon subjected to the secondary process of chemical activation process using sodium chloride (NaCl). The AC was evaluated in terms of pH-value, total dissolved solids, electrical conductivity, and absorption efficiency. Absorption efficiency was observed by discoloring methylene blue solution using AC from each material, from coconut shell, bamboo, and palm shell. Those AC can achieve higher absorption efficiency, be more stable, and cheaper than the existing market.

Keywords: Activated Carbon, Methylene Blue, Activation, Absorption, Water Treatment

1. Introduction

The wastewater is originated from domestic and industrial uses, commercial, agricultural activities, surface runoff, stormwater, and infiltration. Wastewater is usually conveyed through a sanitary sewer and then treated at a treatment plant. The issues of funds, treatment process, and treatment equipment may affect the wastewater treatment plant operation efficiency. This presents the application and production of activated charcoal adsorption in water treatment. Activated charcoal may be an excellent adsorbent in water treatment and pollution-free material. The activated carbons work by the principle of adsorption of the contaminant component. Adsorption is a process that involves accumulation of gaseous and solute components on the surface of adsorbent solids. The adsorption power and rate are determined by the type of activated charcoal, particle size, pore size, and distribution. In this study, the

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adsorption was determined by pH-value, total dissolved solids, electrical conductivity, and discoloring methylene blue solution.

1.1 Problem Statement

Contaminated water from human activities and natural has created various issues and discomfort to people's lives. Human daily life activities such as cleaning, washing, and market activities contribute to a huge wastewater amount. These activities always evoke problems to the environment and society, such as river pollution. Thus, this study seeks a suitable method to manage public wastewater quality.

Activation carbon for water treatment has been proposed and received increasing attention in a few years to decrease water pollution. The adsorption process provides a low-cost and high adsorption capacity by increasing the adsorbent's surface area. The adsorption efficiency can be increased by changing the equilibrium and kinetics state of both sorbent and adsorbent (Leman et al., 2016).

Thus, this study aims to produce activated carbon using bamboo, coconut shell, and palm shell as raw materials to activate a simple activated carbon method. Bamboo, coconut shell, and palm shell AC have a strong adsorption capacity which can be used to adsorb the organic pollutants and trace the heavy metal ions. All the processes were conducted through development of micropore, combined with biological regeneration, and it can fully extend the service life of activated carbon in water treatment.

1.2 Objective

This study aims to determine charcoal performances containing biomass products used in bamboo, palm shell, and coconut shell as alternative materials to produce activated carbon.

The objectives of this research are:

i. To convert bamboo, palm shell, and coconut shell into charcoal using the carbonization process
ii. To conduct on the activation method of charcoal into activated carbon
iii. To test the physical properties and adsorption of powder activated carbon made from bamboo, palm shell, and coconut shell using methylene blue solution

2. Materials and Methods

2.1 Materials

The primary purpose of this test is to determine and observe the efficiency of adsorbent properties of bamboo, coconut shell, palm shell as activated carbons. Three main processes involved in the preliminary stage namely collection of raw materials, carbonization process, crushing process, and sieving process to obtain the activated carbon in granular sizes and powder form. In the secondary process, the production of activated carbon (AC) was conducted by the chemical activation process using sodium chloride (NaCl). The chemical activation process of AC covered the precursor treatment with a chemical agent and then followed by heat treatment, which influence the carbonization process and porosity generation. When activation of carbon with NaCl completed, the activated carbon was tested by the adsorbent method. The adsorbent testing was conducted using methylene blue solution and activated carbon from each material.

Table 1: List of material and solution used for production of activated carbon

Description	Picture	Quantity
Bamboo		3-unit segments
Coconut shell		10 unit
Palm shell		2kg palm shell
Salt (sodium chloride, NaCl)		1 unit
Cookies cans		1 unit
Steam cake cooker		1 unit
Flour sieve		1 unit
Pestle and mortar		1 unit
Methylene blue solution		1 unit
Beaker 250ml		3 unit

TDS and EC pen digital meter		1 unit each
Distilled water		1 unit

2.2 Methods

The methodology started with the process of finding reference material or information related to this study. The references and information were retrieved from the most up-to-date and appropriate sources for review. To ensure the quality of this study, the process of identifying related sources of reference and information is crucial. Figure 1 illustrates the methodology flow chart for this study.

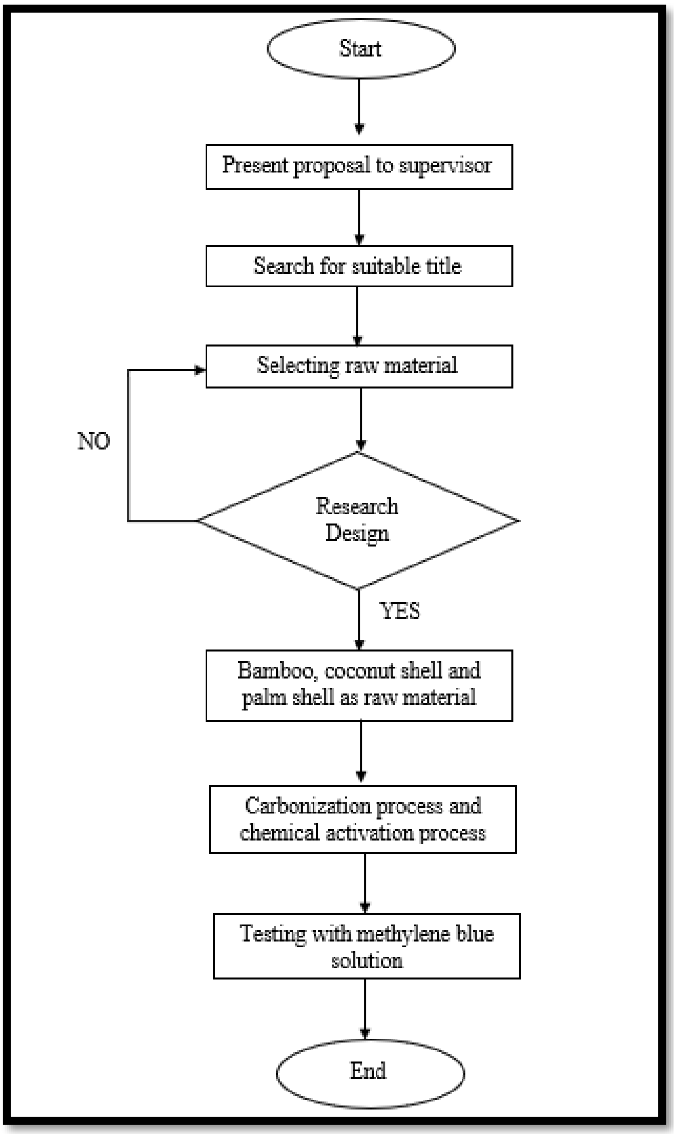


Figure 1: Methodology flowchart of this study

In this research, the test was conducted in conventional ways at home and cheaper cost. The AC was tested using methylene blue solution that included pH value, total dissolved solids (TDS), and electrical conductivity (EC). The primary purpose of conducting these tests is to determine the efficiency of adsorbent properties of the bamboo, coconut shell, and palm shell as activated carbon. Figure 2 illustrates the flowchart to produce activated carbon using selected material.


Collection of raw material


Carbonization process


Charcoal after carbonization process


Crushing process


Charcoal after crushing

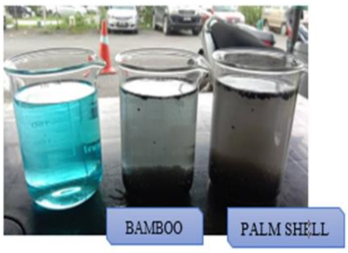

Sieving process


Activation process using NaCl


Charcoal soaked in 24 hour with NaCl


Drying process


Testing with methylene blue solution



Result of bamboo and palm shell AC

Result of coconut shell AC

Figure 2: Flowchart of producing Activated carbon using selected material

3. Results and Discussion

The testing of activated carbon was conducted with methylene blue solution. All the results were observed based on the time taken when burning the raw materials using conventional ways and low-cost burner. In the data collection, the times taken to burn the raw material to produce activated carbon are shown in Table 2.

3.1 Results

For the preliminary process, the time taken for carbonization process of bamboo, coconut shell and palm shell were recorded.

Table 2: Time taken to burn of bamboo, coconut shell and palm shell

Raw material		Time taken for burning process
Bamboo		57 minutes
Coconut Shell		56 minutes
Palm Shell		59 minutes

From Table 2, it can be inferred that the carbonization process of palm shells took longer time to be burned into carbon (59 minutes) compared to bamboo (57 minutes) and coconut shells (56 minutes). Palm shell has harder shell compared to bamboo and coconut shell. The carbonized sample were then crushed before undergoing sieving to obtain granular-sized carbon. The characteristics of carbon observed in this research were pH values, duration to burn the carbon, adsorption of methylene blue, total dissolved solids, and electrical conductivity. The pH values were collected after inserting a methylene blue drip and stirring with each of the activated carbon.

3.2 Data Analysis

Result of methylene blue decoloring were observed on the temperature, pH value, time, total dissolved solid, and electrical conductivity.

Table 3: pH value results after addition of methylene blue and activated carbons

Type	pH		
	Pure water	After adding methylene blue	After adding activated carbon
Bamboo	7.09	7.37	7.29
Palm Shell	7.06	7.32	8.09
Coconut Shell	7.08	7.34	7.52

Table 4: Total dissolved solid and electrical conductivity results after addition of methylene blue and activated carbon

Type	Total dissolved solid (ppm)		Electrical conductivity (µs/cm)	
	After adding Methylene blue	After adding activated carbon	After adding Methylene blue	After adding activated carbon
Bamboo	44	671	91	1342
Palm Shell	47	102	94	198
Coconut Shell	48	252	96	505

3.2 Discussions

From Table 3, the properties of activated carbon concluded that bamboo and coconut shell ACs have the optimum adsorption performance as activated carbon. The pH values of bamboo, coconut shell, and palm shell were 7.27, 7.52, and 8.09, respectively.

From the Table 4, the TDS of bamboo was higher with (671 ppm) compared to palm shell (102 ppm), and coconut shell (252 ppm). For electrical conductivity, bamboo has higher value of 1342 µs/cm compared to palm shell (505 µs/cm) and coconut shell (198 µs/cm). Lastly, the time taken for adsorption performance using methylene blue solution stirred with each activated carbon exhibited that bamboo and palm shell shorter time of 10.34 minutes and 10.32 minutes, while coconut shell slightly longer time of 10.50 minutes.

3.3 Figures

Figures 3 and 5 show the adsorbents from bamboo, coconut shell and palm shell ACs. This adsorption performance was evaluated based methylene blue solution decoloring by each activated carbon.

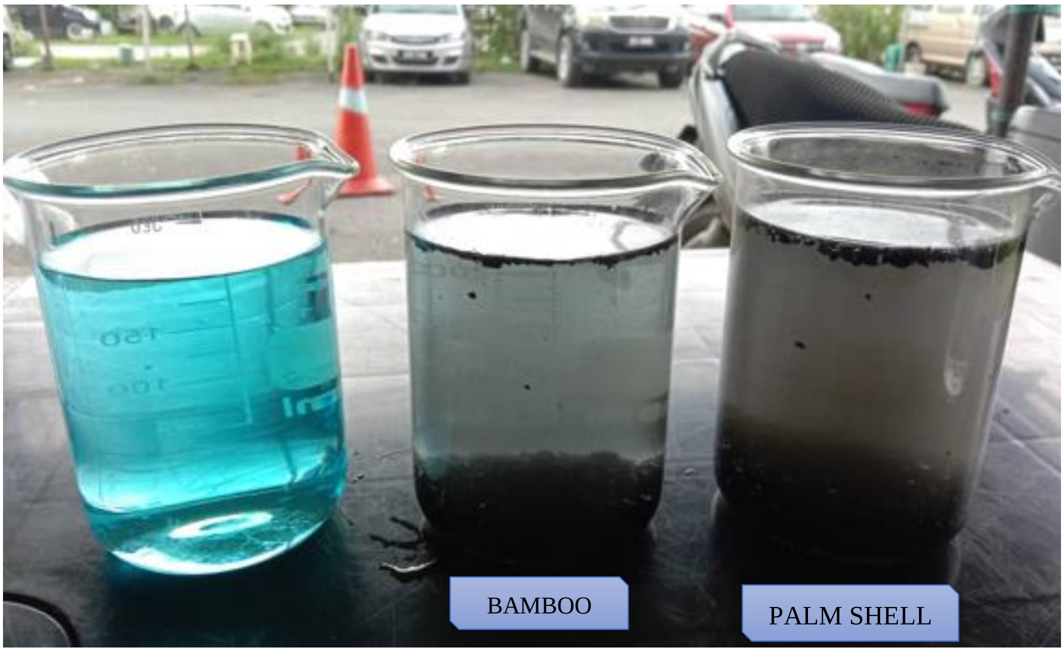


Figure 3: Decolored methylene blue after being adsorbed by bamboo and palm shell activated carbons

Figure 4: Decolored methylene blue after being adsorbed by coconut shell activated carbon

Figure 3, the adsorption from bamboo AC has a better performance than the palm shell AC. Bamboo has low inorganic content, volume, and cheap. It can be observed that the bamboo AC more clearly and adsorbed the methylene blue solution. From Figure 4, the coconut shell AC has higher adsorption performance than bamboo and palm shell ACs. The coal made from coconut shells produced extremely high-performance filters, attractive biomass fuel, and a good charcoal source. The coconut shell-based AC produced less dust as it has higher hardness compared to other activated carbons. It is evident that the coconut shell AC is the ideal carbon for water purification and adsorption.

4. Conclusion

From the result obtained, the objectives of this project have been successfully achieved. The first and second objective are to produce and identify the bamboo adsorbent performance, coconut shell, and palm shell as activated carbon. The activated carbons were produced from was using raw materials from bamboo, coconut shell, and palm shell.

This application of bamboo, coconut shell and palm shell ACs proved that the adsorption performance is significant to adsorb water pollution in domestic and industry. The properties of bamboo, coconut shell, and palm shell ACs gave good results. In fact, the disposal of these raw materials such as bamboo, coconut shell, and palm shell waste can be overcome by producing an activated carbon for water treatment. This technology has a great potential for creating affordable, efficient, and environmentally activated carbon.

Although the objectives of this study were achieved, several recommendations are suggested for future study as follows:

i. The production and method were inefficient during the carbonization process as the burner must rotate manually to make the burning process efficient and equal. The burner design can be improved using the motor to rotate and make work more efficient automatically.
ii. Instead of focusing on raw biomass material as AC for water pollution adsorption, we can also focus on other applications, for example the solar cell electrodes for water purification which can maximize the AC application.

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Appendix A

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