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The Production of Activated Carbon from Sago and Pandanus Amaryllifolius

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Abstract: Activated carbon is one of the most affordable and widely used materials for water purification, cleaning and having been used more recently. Under some condition sorbent tube are used for collecting hazardous gas and to calibrate activated carbon for air sampling tube and it will cause some of disturbance towards efficiency. Objective of the study will go to preparation of the sago and *pandanus amaryllifolius* as activated carbon. This research will go through pandan and sago as activated carbon and will be test the effectiveness as activated carbon. Method that use to make activated carbon is sago and *pandanus amaryllifolius* was collected from raw material. Sago and *pandanus amaryllifolius* will go through process of burning process at 400 °C - 600 °C and activation of carbon shell using KOH, NaOH, H_3PO. It will go through crushing process to the size 250-micron filter. After crushing the activated carbon, it will go through sieving process using 50-micron filter. The porosity of activated carbon from each sampling will be determined using Morphology analysis (SEM) analysis and Fourier Transform Infrared Spectroscopy analysis (FTIR). The chemical activation process with KOH was effective in creating well developed pores on the surface of the activated carbon leading produce large porous structures. The use of KOH activating agent produced active carbon's surface which was smoother. The best activated carbon is using *pandanus amaryllifolius* with activating agent KOH.

Keywords: Activated Carbon, Sago, *Pandanus Amaryllifolius*

1. Introduction

The increasing number of industrial projects that release volatile organic compounds into the atmosphere has led to the release of air pollution. This issue is considered a major environmental health hazard and is known to have negative effects on individuals' health. BTEX is a type of chemical that is

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known to evaporate rapidly and has a negative impact on air quality [1]. These chemicals are used as raw materials or as solvents in various industries. They are released into the environment through evaporation and leaking from underground fuel tanks. The BTEX emissions have caused concern among plant personnel [2]. One solution to reduce these harmful emissions is by producing activated carbon from the sago and pandanus amaryllifolius plants [3].

One of the most widely used materials for water treatment is activated carbon. This type of carbon has various advantages such as its high carbon content, low ash content, and its ability to absorb dissolved organics [4]. Some of these include its ability to provide a stable and high quality performance.

Due to its versatility, sago has been identified as a promising commodity in Malaysia. The country is the third largest producer of the sticky resin, which is mainly used as a fuel. In 2015, Malaysia produced over 600,000 tons of sago [5]. Its robust production is expected to continue due to its continuous growth. The versatility of the pandan plant has made it the most used ingredient in Malaysia. Aside from being used as an ingredient, it also produces various coloring products [6]. Pandan leaves can be found in grocery stores and specialty produce stores. The easiest way to preserve them is by placing them in a plastic bag [7].

The activated carbons derived from sago are the least dusty. They are well-suited for organic chemical adsorption since they are mostly micro porous [8]. When compared to other forms of activated carbons, sago-based carbon is more flexible, making it the best carbon for water filtration. pandan leaf actually have been used in activated carbon by in water based treatment. Activated carbon electrode made from pandan actually proves that pandan can be activated carbon [9]. Typically, the chemical use for activating agent for activated carbon is an acid, a strong base, or a salt (phosphoric acid, potassium hydroxides, sodium hydroxide, zinc chloride [12].

In the overview and understanding, there may be negative health effects related to the human respiratory system (for example, asthma, throat irritation, lung malignancy), cerebral discomfort, sluggish memory, eyes, nose, and skin aggravation [10]. To reduce toxins, a few scientists have been tasked with investigating methods for regulating VOCs such as adsorption, accumulation, photocatalytic oxidation (PCO), negative air particles (NAIs), and non-warm plasma, among others (NTP) [11] Adsorption in the mass division or filtering process has recently become a creative treatment technique in the condition application. At a low fixation level of part per million, the adsorption approach is effective (ppm). A larger surface region of the channel material and their presentation in both harmony and energy result in a higher adsorption limit.

The purpose of this research is to undertake experimental testing to assess the performance of charcoal containing biomass products, specifically Sago and Pandan, as an alternative to fossil fuels. The objectives of this research are:

i. To prepare the sago and pandan as activated carbon.

ii. To determine the physical parameters of pandan and sago derived from the carbonization process.

iii. To investigate the potential of sago and pandan as activated carbon.

2. Materials and Methods

2.1 Materials

This research study utilized the sago and *pandanus amaryllifolius* as activated carbon. Two materials are biomass sources. Pandan leaf and sago will undergo drying process for 3 days.

Figure 1: Pandan leaf

Figure 2: Sago

Figure 1 shows the pandan leaf and Figure 2 shows sago The chemical use to make activation of activated carbon are potassium hydroxide, sodium hydroxide and zinc chloride. This chemical use often as activating agent for activated carbon. These activating agent have one thing in common which is they dehydrating agent that impact pyrolytic breakdown and impede the production asphalt.

Figure 3: Potassium Hydroxide

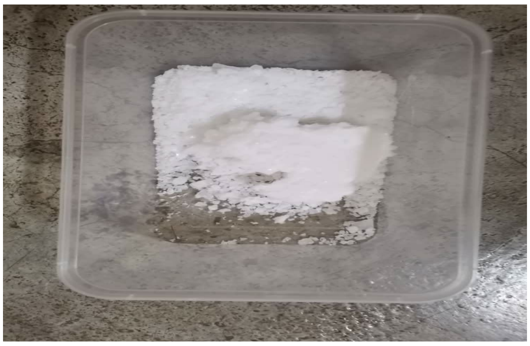

Figure 4: Sodium Hydroxide

Figure 5: Zinc Chloride

Figure 3 show potassium hydroxide and Figure 4 shows sodium hydroxide. This chemical use as activating agent including zinc chloride in Figure 5 The fundamental goal of this experiment is to determine and observe how activated carbon are made from sago and pandan. The preliminary stage involves three primary processes: the gathering of raw materials, the carbonization process, the crushing process, and the sieving process to obtain activated carbon in granular and powder form. The chemical activation method employing zinc chloride (ZnCl), potassium hydroxide (KOH), and sodium hydroxide (NaOH) was used in the secondary phase to produce activated carbon (AC). The chemical activation of AC consisted of treating the precursor with a chemical agent, followed by heat treatment, which influenced the carbonization process and the development of porosity.

2.2 Method

The technique began with the search for relevant reference material or information for this topic. For this evaluation, references and material were gathered from the most up-to-date and acceptable sources. The process of discovering similar sources of reference and information is critical to ensuring the quality of this study. According to past scientific research, there are two important processes required in the production of charcoal. There are three key stages in the preparatory process stage: gathering raw materials, carbonization process, and screening process. The goal of this method is to obtain activated carbon powder. The step for make activated carbon show in Figure 6.

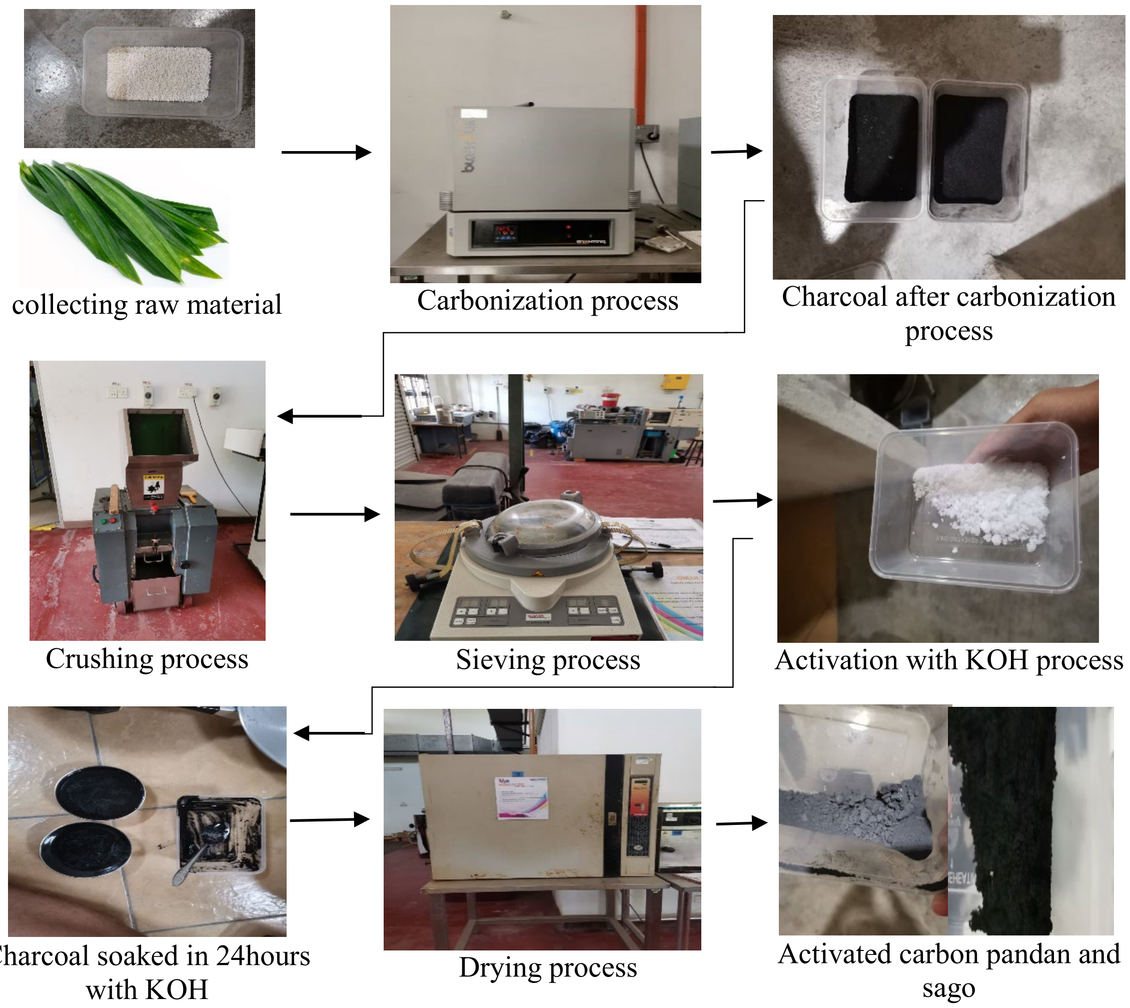

Figure 6: Flow process of producing Activated Carbon

3. Result and Discussion

3.1 Data Collection

Table 1: Time taken needed in the burning process of sago and pandan

	Sago	Pandan
Raw materials		
Time taken needed for the burning process	38 minutes	30 minutes

In Table 1 show the time taken needed in the burning process of sago and pandan. Depending on the hardness of the material, both processes take a considerable time to burn. The longer it takes to burn a material with a higher hardness, the more time it will take. Since a result of this procedure, both raw materials have completed the burning process, as there is no longer any smoked output, indicating that the burning process has ended.

3.2 Data Analysis

Table 2 show the proximate analysis comparison between activated carbon. It assists us in determining the quantity of moisture, volatile, and ash content in the sample, as well as the amount of residual carbon present. It demonstrates that activated carbon made from sago has a moisture content of 9.44 percent, a volatile content of 33.534 percent, and an ash content of 4.24 percent. The moisture concentration of activated carbon made from pandan is 2.41 percent, which is somewhat lower than that of sago carbon. The volatile content is 18.333 percent, while the ash content is 3.11 percent. In comparison to pandan activated carbon, sago activated carbon has a higher moisture content

Table 2: Proximate analysis comparison between activated carbon

Percentage (%)	Sago Activated Carbon	Pandan Activated Carbon
Moisture Content	9.44	2.41
Ash Content	4.24	3.11
Volatile Matter	33.534	18.333
Fixed Carbon Content	57.25	39.22

3.2.1 Percentage Moisture Content

Figure 7 show comparison percentage between moisture content between two activated carbons. Moisture content is one of the most important factors to consider when determining the quality of activated carbon made from sago and pandan. Pandan activated carbon has the lowest moisture level (2.41 %), whereas sago activated carbon has the highest moisture content (9.44 %). Compared to pandan activated carbon, this is somewhat higher

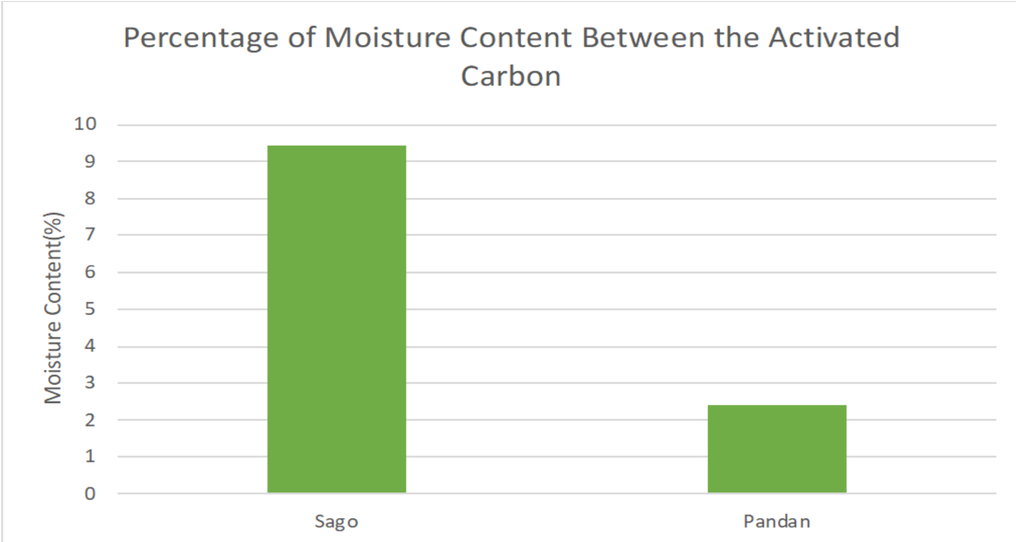

Figure 7: Comparison percentage of moisture content between the two activated carbon

3.2.2 Percentage Volatile Matter Content

Figure 8 show graph of percentage of volatile matter between the activated carbons. Sago activated carbon has a larger volatile matter content than pandan activated carbon, according to the percentage of volatile matter content. Sago activated carbon has a volatile matter value of 35.534 percent, while pandan activated carbon has a volatile matter value of 18.333 percent. Volatile matter has a value that ranges from 40 percent to less than 5 percent.

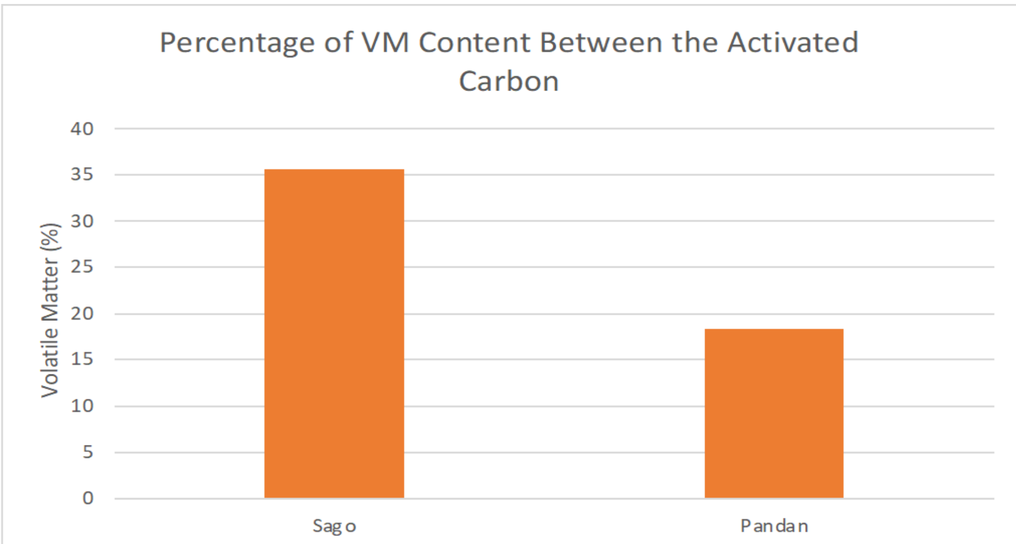

Figure 8: Comparison percentage of volatile content between two activated carbons

3.2.3 Percentage Ash Content

Figure 9 show comparison of percentage ash content between activated carbon. Sago activated carbon has a greater ash concentration than pandan activated carbon, with 4.44 percent and 3.11 percent, respectively. According to FAO (1987), excellent grade activated carbon should normally have an ash concentration of 3.00 to 4.00 %. In comparison to the high ash level, the reduced ash content can be used for thermal purposes. The environment and efficiency will be harmed as a result of the high ash concentration, which produces more dust and smoke.

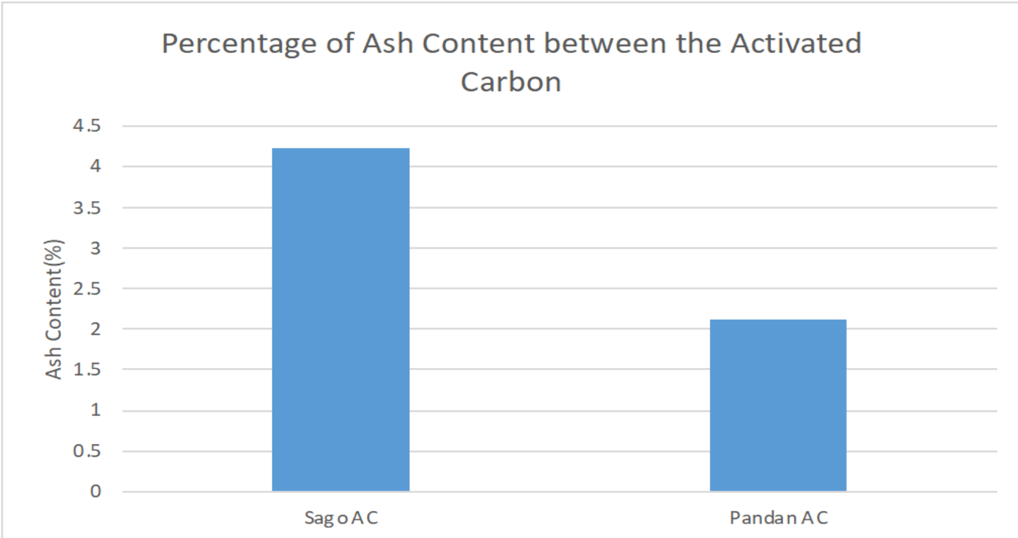

Figure 9: Comparison percentage of ash content between activated carbon

3.3 FTIR analysis

Figure 10 show FTIR analysis for AC pandan. For sample activated carbon *pandanus amaryllifolius* analysis in figure 10, the first peak at point 3365.99 (1/cm) and place between 3200 (1/cm)-3550 (1/cm) which is OH stretching vibration (intermolecular H bonds). The peak also broad. At second peak at the point 1434.89 (1/cm) in between point 1405-1465 for CH bending vibration which is contain CH2 bonding. At peak 1033.61(1/cm) is in group C-OH stretching vibration which is secondary cyclic alcohols. For next peak, the point is 873.98(1/cm) which is in the position group C=CH2 from point 885 to 895.

Figure 11 show FTIR analysis for AC sago. The result of the functional group analysis shows the spectrum patters of each sample. From activated carbon sago analysis in figure 11, the peak point at frequency range is 3361.77(1/cm) which is in the group of OH intermolecular H bonds and the peak is broad. At the second point from frequency range at 2041.82 (1/cm) the sample have C=C stretching. The absorption in the range between 2040 (1/cm)-2200 (1/cm) which is in C-C=C-C=CH bond. At second peak, the peak point at longevity is 1615.28 (1/cm) which is in C=C stretching vibration conjugated. Based on the data C=C stretching vibration conjugated between the point 1585 (1/cm) to 1625(1/cm). At peak 1035.60(1/cm) is in group C-OH stretching vibration which is secondary cyclic alcohols.

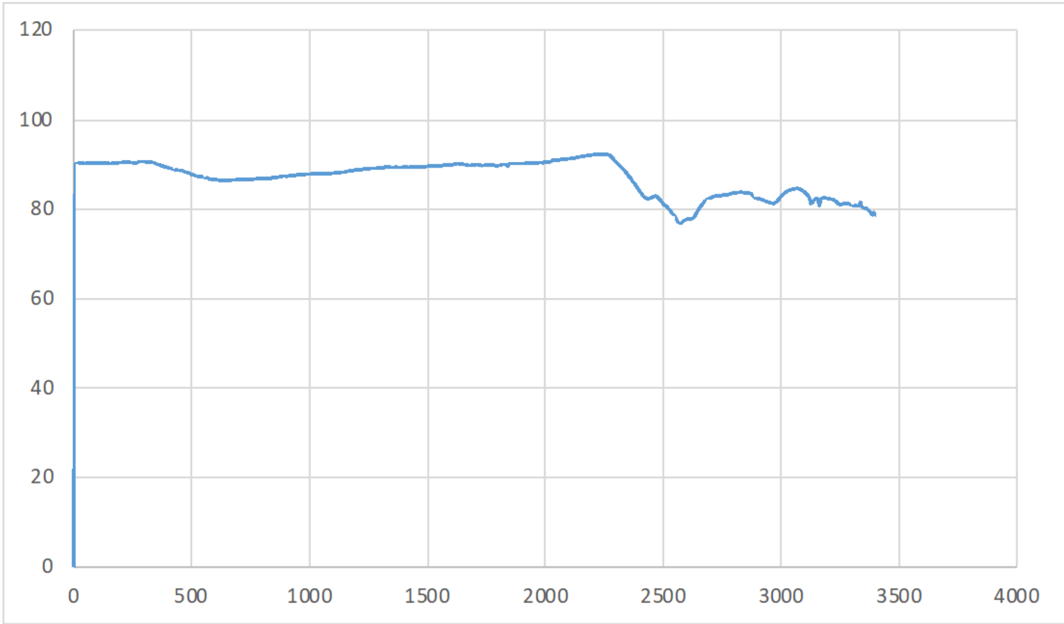

Figure 10: FTIR graph for activated carbon pandan

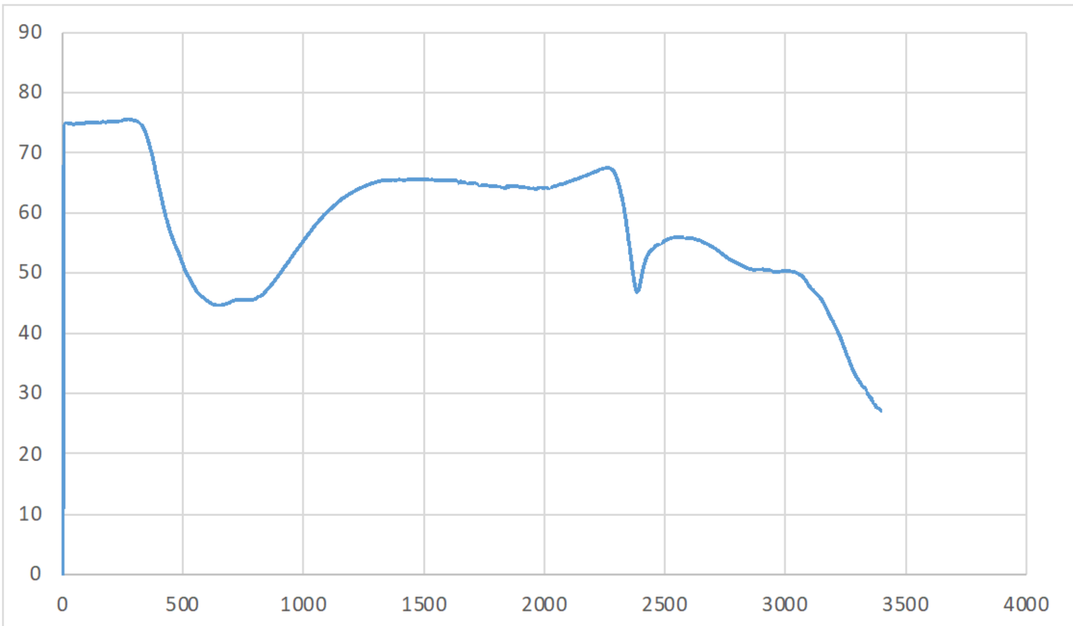

Figure 11: FTIR graph for activated carbon pandan

3.4 SEM Analysis

Figure 11 shows the results of the SEM test for activated carbon pandan. As shown in Figure 11, the chemical activation process with KOH was efficient in forming well-developed pores on the surfaces of the activated carbon, resulting in activated carbon with a massive porous structure. The activation temperature, activation contact duration, and KOH: Precursor ratio are all elements that contribute to the well-developed porosity on the surface. During the combustion of raw materials, the impregnation ratio with temperature had a substantial impact on forming the pore structure of the adsorbent. Chemical activation with KOH is thought to be the cause. Because of the reaction between carbon and KOH, it may result in larger pores in Figure 11.

The activation temperature, contact time, and KOH precursor ratio are all factors that contribute to the surface's well-developed porosity. The impregnation ratio with temperature had a significant impact on the formation of the pore structure of the adsorbent during the combustion of raw materials. The cause is assumed to be chemical activation with KOH. Figure 12 shows how the reaction between carbon and KOH might result in tiny holes. The findings of the SEM test for activated carbon sago are shown in Figure 12. The chemical activation process with KOH was ineffective in creating well-developed pores on the surfaces of the activated carbon, as illustrated in Figure 12, resulting in activated carbon with a porous structure.

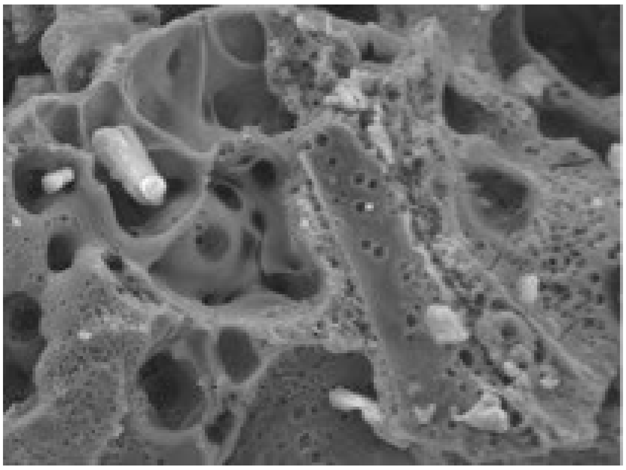

Figure 12: SEM image of AC pandan

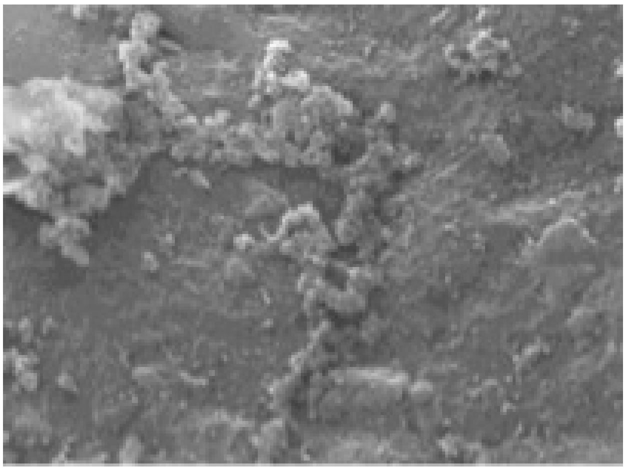

Figure 13: SEM image of AC sago

4. Conclusion

According to the results of activated carbon attributes obtained from the manufacture of activated carbon, pandan and sago activated carbon has the best performance as activated carbon. According to the results of the proximate analysis, sago has a higher value than pandan, with the exception of the percentage of fixed carbon content, which is 39.22 percent for pandan and 57.25 percent for sago. This suggests that pandan might be a feasible approach for adsorbing BTEX in the industry. The moisture percentage is 2.41 percent, the volatile matter percentage is 18,333 percent, and the ash percentage is 2.11 percent.

The usage of sago and pandan as activated carbon in this application demonstrated that the characteristics of activated carbon are considerably within the range of specification for household use in the adsorption of air pollutants such as BTEX in the industry. In addition, the other features of activated carbon yielded a positive result for the manufacture of activated carbon from pandan and sago. Meanwhile, the challenges related with sago and pandan waste disposal can be alleviated by manufacturing activated carbon from these agricultural wastes. Converting biomass into activated carbon is a cost-effective, efficient, and ecologically benign process.

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