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BRIQUETTES OF ACTIVATED CORNCOB CHARCOAL BURNING CHARACTERISTICS

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ABSTRACT
This study aims to find out and analyze the characteristics of briquettes in burning activated corn charcoal. The preparation procedure of this study includes material collection, carbonization, crushing, sifting through an 80-mesh sieve, activation, merging with adhesives, compaction, and drying. Sago powder is used as an adhesive with a mass ratio of 9:1. After being heated separately at 550°C and 650°C for 30 minutes and 20 minutes, the samples were compressed at various pressures. Another difference in compaction pressure also leads to similar results. Untreated corn cob briquettes reach their maximum temperature before activated corn cob briquettes. At an activation value of 550°C for 30 minutes and a compaction pressure of 70.33 kg/cm^2, the highest combustion temperature was 528°C. In this study, it can be identified characteristics that can improve the burning efficiency of corn charcoal. This research has implications for better combustion efficiency, can reveal factors that affect combustion efficiency.

Keywords: briquettes, carbon, charcoal, corncob.

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INTRODUCTION

By the increasing of world population, energy needs are also increasing. Currently, the world's energy is still dominated by non-renewable energy obtained from fossil fuel energy. If there is no exploration of other forms of energy, then it is certain that fossil energy reserves will be depleted faster. Therefore, other energy explorations are needed as the alternative to the fossil energy. One of the potential energies as a solution to this problem is biomass energy (Králík et al., 2023). Biomass energy comes from organic materials, so it is a renewable energy. One example of biomass energy is charcoal briquettes. Charcoal briquettes can be made from organic materials. Because it can be made from organic materials, biomass energy has other significant benefits apart from being an alternative to fossil energy, which can reduce organic waste (Otieno et al., 2022).

Briquette is a resized charcoal powder, solidified by pressure and blended with an adhesive agent to form a solid shape (Surup et al., 2020). A briquette's quality, which is reflected by its density, moisture content, ash content, volatile matter, fixed carbon, and calorific value, is greatly impacted by the manufacturing procedures (Saleh et al., 2017). The combustion characteristic of briquette depends on the quality mentioned before. Good quality briquettes must have a short ignition time, a low combustion rate to reach maximum temperature, a long combustion time at maximum temperature, and the temperature slowly decreases after reaching maximum temperature (Zuhri & Saifudin, 2018). Another way to improve briquette combustion characteristics is by activating the briquette and setting the optimum compaction pressure since the activation and compaction process can provide enough pores to trap oxygen. In this research, briquettes are made from corncob waste.

Based on the background above, this study aims to investigate and analyze the proximate and combustion characteristics of activated-charcoal briquettes. This study can improve the efficiency of corncob charcoal utilization and reduce the environmental damage caused by the inefficient combustion of corncob charcoal.

METHOD

This study was an experiment in research design. Corncob trash was used to make charcoal briquettes. The sago, which was utilized as the glue, was taken from the Ranomeeto region of Konawe Selatan regency, and the corncob waste (*Zea mays L.)* was taken from the Tongkuno area of Muna regency. First, corncob waste was dried in a furnace for 120 minutes at 110°C, and then it was carbonized in an electric furnace for 60 minutes at 499°C (L Lestari et al., 2019). An 80-mesh strainer sieved the charcoal powder to obtain grain homogenization (Lina Lestari et al., 2020). Subsequently, using an electric furnace, it was activated at two different temperatures of 550°C and 650°C for 5, 10, 15, 20, 25, 30 and 35 minutes. Sago powder was used as the adhesive ingredient, and activated charcoal powder was combined with it in a 9:1 mass ratio while being agitated with hot water. The mixture was put into a cylindrical mold with a diameter of 4 cm and a hole in the center with a diameter of 0.8 cm, and it was then solidified under three different pressures: 70.33 kg/cm^2, 94.22 kg/cm^2, and 117.78 kg/cm^2 (L Lestari et al., 2019). The resulting briquettes were then dried using oven for 48 hours at temperature of 60°C (Lina Lestari et al., 2017).

Combustion characteristics are represented by the temperature change when it starts to burn until becoming ash. The combustion time, combustion rate, and maximum briquette temperature was determined by burning it in outdoor at temperature of 25°C and wind speed of 0.25 m/s. The burning temperature was measured using an infrared thermometer (L Lestari et al., 2019). The proximate characteristics, such as the moisture content, ash content, volatile matter, and fixed carbon, was analyzed using the ASTM standard method (Deshannavar et al., 2018). The effect of the activation process on briquette's pores was characterized using Scanning Electron Microscope (SEM), and the result was processed using Image-J free software (Abràmoff et al., 2004; Kurniawan et al., 2011).

RESULTS AND DISCUSSION

Based on preliminary experiments, the lowest ash content was obtained in briquettes produced from activated charcoal at 550°C and 650°C for 30 and 20 minutes, respectively. Therefore, briquette parameter measurements were carried out under these conditions.

Moisture Content, Ash Content, Volatile Matter, and Fix Carbon of Charcoal and Activated Charcoal

Table 1 shows the moisture content, ash content, volatile matter, and fixed carbon. Activation treatment decreases the moisture content and volatile matter. However, the ash content and fixed carbon are increased. If the volatile matter is high, the burning could start at low temperatures, indicating that the charcoal is easy to ignite and burn. However, it will cause a fast and uncontrolled combustion process (Estiaty & Fatimah, 2018). Less than 7% moisture content is expected to control the burning, so it is easy to ignite. High ash content could be a challenge in the burning process. However, from the research results (Table 1), the ash content is about 7%. Therefore the activated corncob briquette still met the quality standard for briquette fabrication (Irmawati, 2020). Likewise, as the fixed carbon increase, it is expected to have a higher burning temperature.

Table 1. The Moisture Content, Ash Content, Volatile Matter, Fixed Carbon of Corncob Charcoal

Charcoal	Moisture content (%)	Ash content (%)	Volatile matter (%)	Fixed carbon (%)
Without activation	7.249	3.431	30.449	58.870
Activation (550°C, 30 minutes)	1.777	7.389	28.323	62.511
Activation (650°C, 20 minutes)	1.559	6.324	18.001	74.116

The Calorific Value of Activated Charcoal

The calorific value of corncob charcoal without activation treatment is 6764.12 cal/gr. In contrast, activation treatment at temperatures 550°C (30 minutes) and 650°C (20 minutes) causes the calorific value changes to 6771.98 cal/gr and 7674.86 cal/gr for 550°C and 650°C respectively. The increasing calorific value confirms the hypothesis that activated charcoal will produce an excellent burning characteristic.

Effect of Compacting Pressure on Briquette Fabrication

On the briquette fabrication, the adhesive was mixed with the charcoal by a mass ratio of 9:1, then compacted with various compacting pressure, specifically 70.33 kg/cm^2, 94.22 kg/cm^2, and 117.78 kg/cm^2, and then dried. The processes change their calorific value to 5929.49 cal/gr, 5698.26 cal/gr, and 5844.06 cal/gr, respectively (L Lestari et al., 2019). While the briquette from charcoal that activated at a temperature of 550°C for 30 minutes, its calorific value changed to 6467.71 cal/gr, 6532.23 cal/gr, and 6784.82 cal/gr; charcoal that is activated at a temperature of 650°C for 20 minutes, its calorific value changes to 5932.60 cal/gr, 5894.02 cal/gr, and 5905.59 cal/gr (L Lestari et al., 2019). The decrease in the calorific value is caused by the uplift of moisture content resulting from adding an adhesive. Likewise, briquette fabrication changes the ash content, volatile matter, and fixed carbon (L Lestari et al., 2019). However, the briquette still met the quality standard of the briquette (Vachlepi & Suwardin, 2013).

Briquette Burning Test

Briquette burned in a room with a temperature of 25°C, wind speed of 0.25 m/s, and a mass of 4 gr for each sample. The change in the combustion temperature of the briquette that compacted at a pressure of 70.33 kg/cm^2 is shown in Figure 1.

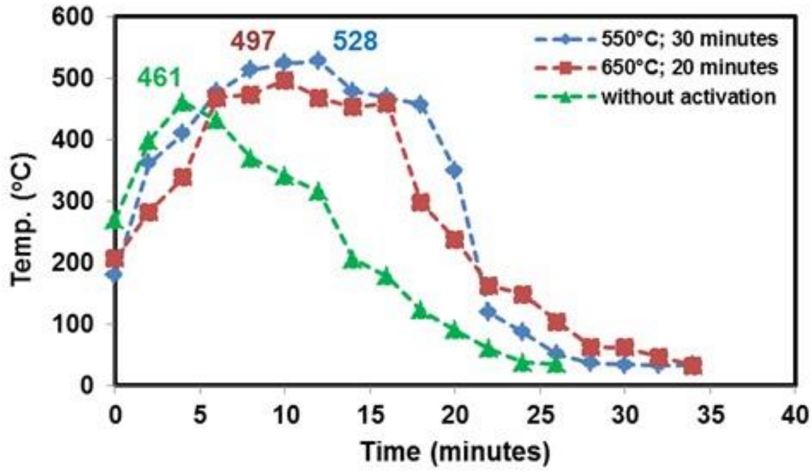

Figure 1. Change in Burning Temperature of Activated Charcoal That Compacted at 70.33 kg/cm^2

Figure 1 shows that the activation treatment causes the briquette burning to reach a higher maximum temperature than the briquette without activation treatment. Briquettes made from charcoal that activated at 550°C for 30 minutes could reach a maximum temperature of 528°C and stand for six to twenty minutes. Otherwise, the briquette made from charcoal that activated at a temperature of 650°C for 20 minutes could reach a temperature of 497°C and remains constant for six to seventeen minutes. Briquette made from charcoal without activation treatment reaches a maximum temperature of 461°C and quickly decreases to ash. Figures 2 and 3 show the change in the temperature of the briquette that compacted at a pressure of 94.22 kg/cm^2 and 117.78 kg/cm^2.

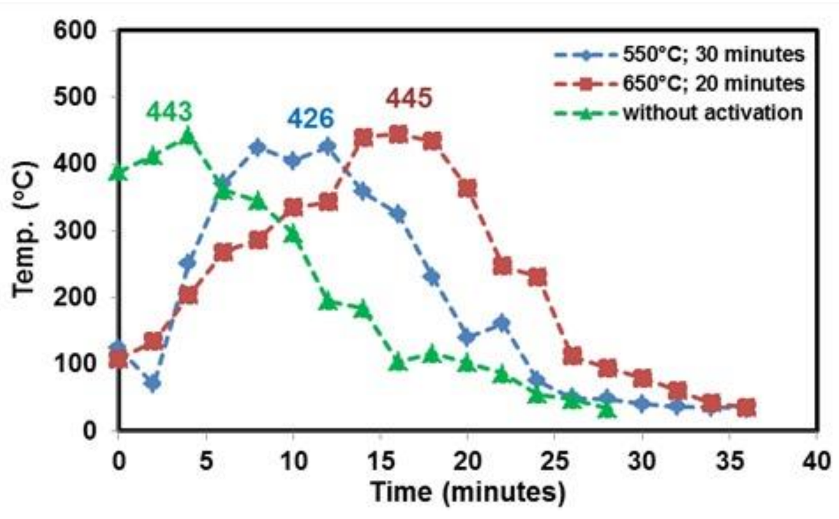

Figure 2. Change in Burning Temperature of Activated Charcoal That Compacted at 94.22 kg/cm^2

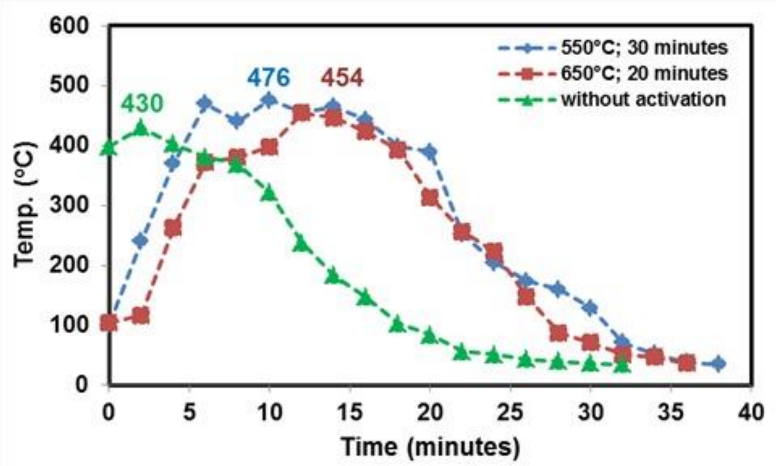

Figure 3. Change in burning temperature of activated charcoal that compacted at 117.78 kg/cm²

Figures 2 and 3 show a better burning characteristic of activated charcoal than the charcoal without activation treatment. The burning process of solid matter consists of several stages: heating, drying, devolatilization, and charcoal burning. During the devolatilization process, the volatile matter will escape in the form of CO, CO_2, CH_4, and H_2 gases (Abdulkareem et al., 2018). The devolatilization process is followed by the oxidation of briquette fuel, which rate depends on oxygen concentration, size, and charcoal porosity. Figure 4 shows SEM results for characterizing the charcoal and activated charcoal at 650°C for 20 minutes, with 2500 times magnification.

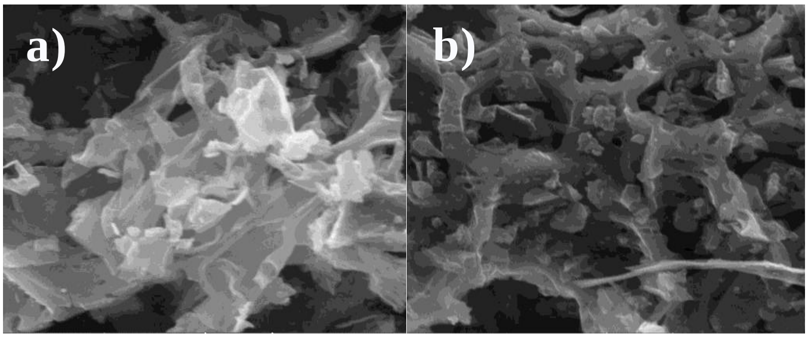

Figure 4. Pores Of Corncob Charcoals And Pores Of Activated Corncob Charcoals.

Figure 4. shows that the charcoal pores are still not overt, and its average pore diameter is 39.488 µm. Otherwise, the pores of activated charcoal seem more overt, represented by several black spots with an average pore diameter of 47.220 µm. These pores provide sufficient oxygen during the burning process, improving activated charcoal briquette burning characteristics.

CONCLUSION

Briquette produced with an activation treatment at a temperature and compacted pressure of 550°C (30 minutes) and 70.33 kg/cm², respectively, shows the preferable burning characteristic. Activation of charcoal will cause a reduction in water content and volatile matter so that the fixed carbon and calorific value increase. This results in the combustion characteristics of the briquettes being better than the briquettes made from charcoal without activation. Activation also causes a higher maximum briquette burning temperature and a longer burning duration.

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