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Production of Corncob (*Zea mays* L.) and Rice Husk (*Oryza sativa*) Briquettes Using the Pyrolysis Method as an Alternative Energy Source

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ABSTRACT

This study aims to utilize agricultural waste in the form of corn cobs (Zea mays L.) and rice husks (Oryza sativa) as raw materials for briquette production through the pyrolysis method to generate environmentally friendly alternative energy. The background of this research is based on the high production of agricultural waste that has not been optimally utilized and the increasing energy demand that requires renewable energy sources. The research method includes several stages: drying the raw materials, performing pyrolysis to produce charcoal, grinding and mixing with a binder, and molding the mixture into briquettes. The observed parameters include moisture content, ash content, calorific value, and burning time of the briquettes. The results showed that the combination of corn cobs and rice husks produced briquettes with good quality, characterized by low moisture content, relatively high calorific value, and stable burning performance. These findings demonstrate that corn cobs and rice husks waste can be processed into briquettes as an alternative energy source with the potential to replace fossil fuels and support the concept of sustainable energy.

Keywords: briquette, corn cob, rice husk, pyrolysis, alternative energy

1. INTRODUCTION

The increasing demand for environmentally friendly and renewable energy sources has become urgent due to the depletion of fossil fuel reserves. Biomass-based alternative energy sources, such as corn cobs (Zea mays L.) and rice husks (Oryza sativa L.), offer a sustainable solution to reduce dependence on conventional energy sources.[1] Biomass has great potential as a renewable energy resource because it can be processed into briquettes that are efficient and environmentally friendly. Biomass briquettes not only help reduce agricultural waste but also produce lower carbon emissions compared to fossil fuels, thus contributing to the reduction of atmospheric carbon dioxide levels.[2]

The production of briquettes from biomass involves several essential stages, including carbonization, mixing with a binder, molding, and drying. The carbonization process is a crucial step that converts biomass into charcoal, increasing its calorific value while reducing moisture and impurities.[3] Previous studies have shown that different types of biomass used in briquette production can lead to variations in fuel properties. For example, briquettes made from rice husks and coconut shells have demonstrated high calorific values and low gas emissions.[4] Research also suggests that the selection of appropriate binders, such as starch or molasses, significantly affects the briquette's mechanical strength and combustion stability.[5]

Corn cobs and rice husks are abundant agricultural residues with significant potential as raw materials for briquette production. Corn cobs contain a high fiber content that facilitates combustion, while rice husks are rich in lignocellulosic compounds.[6] The combination of these two biomass materials is expected to produce briquettes with superior quality, improved ignition properties, and longer burning time. In this study, corn cobs and rice husks are converted into briquettes through the pyrolysis method, which thermally decomposes biomass in limited oxygen to produce high-carbon charcoal. The resulting briquettes are evaluated based on moisture content, ash content, calorific value, and burning duration. It is hypothesized that the mixture of corn cobs and rice husks will yield briquettes with low moisture, high heating value, and stable combustion, thus providing an efficient and eco-friendly alternative energy source..

2. EXPERIMENTAL

2.1. Chemicals, Equipment and Instrumentation

This research was conducted at the Chemistry Laboratory, Department of Chemistry, Faculty of Mathematics and Natural Sciences (FMIPA), State University of Medan (UNIMED), located at Jl. Willem Iskandar, Pasar V, Medan, North Sumatra, Indonesia. The materials used in this study were corncob (Zea mays L.), rice husk (Oryza sativa L.), tapioca flour ($C_6H_{10}O_5$; Rose Brand, Indonesia), and kerosene ($C_{12}H_{26}$; Pertamina, Indonesia). The equipment and instruments utilized included a briquette mold (custom-made, stainless steel), 60-mesh sieve (Retsch, Germany), porcelain crucible (Iwaki, Japan), combustion drum (local fabrication), hot plate (IKA C-MAG HS 7, Germany), aluminum tray (Nego, Indonesia), analytical balance (Shimadzu AY220, Japan; ±0.0001 g), oven (Memmert UN55, Germany), and thermometer (Thermo Fisher Scientific, USA; range 0–250 °C)

2.2. Research Procedure

Corncobs and rice husks were first cleaned to remove any adhering impurities and then sun-dried for approximately three days until completely dry. The dried materials were subsequently carbonized in a closed combustion drum at 500 °C for one hour to produce charcoal. After cooling, the resulting charcoal was removed from the drum, ground using a mortar and pestle, and sieved through a 60-mesh sieve to obtain a uniform particle size.

The binder was prepared by mixing 1 g of tapioca flour with 17 mL of water in a 100 mL Pyrex beaker glass. The mixture was then heated on an IKA C-MAG HS 7 hot plate at 165 °C while being stirred continuously until it became thick and homogeneous.

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The briquette mixture was produced by blending the corncob and rice husk charcoal powders in various weight ratios of 2:3, 2.5:2.5, and 3:2 until homogeneous. The prepared binder was then added to the charcoal mixture and stirred thoroughly to ensure uniformity. The resulting mixture was placed into a cylindrical mold with a diameter of 3 cm and a height of 4 cm, followed by compaction to form solid briquettes. The briquettes were carefully removed from the mold and weighed using a Shimadzu AY220 analytical balance to determine their initial mass. They were then dried in a Memmert UN55 oven at 110 °C for 30 minutes. After drying, the briquettes were reweighed to obtain their final mass and subsequently analyzed to determine their quality parameters.

3. RESULTS AND DISCUSSION

3.1. Effect of Corncob and Rice Husk Composition Variations on Moisture Content

Based on Figure 1, it can be seen that the variation in corncob and rice husk composition affects the resulting moisture content. At a composition ratio of 2:3 (corncob : rice husk), the obtained moisture content was 8.305%. This value decreased to 8.176% at a 2.5:2.5 composition, which represents the lowest moisture content observed in this experiment. Subsequently, at a composition ratio of 3:2, the moisture content increased significantly, reaching the highest value of 8.585%.

This difference is likely due to the physical characteristics of the two raw materials. Corncobs have a denser structure and stronger water-binding capacity compared to rice husks. Therefore, a higher proportion of corncob in the mixture tends to increase the overall moisture content. Conversely, a greater proportion of rice husk results in lower moisture content due to its porous structure, which facilitates water release. Thus, increasing the corncob proportion tends to raise the total moisture content of the briquette material.

Moisture content greatly influences the quality of the produced charcoal briquettes. Lower moisture content leads to higher calorific value and better combustion performance. In contrast, high moisture content makes the briquettes harder to ignite, produces excessive smoke, and reduces ignition temperature and burning efficiency.

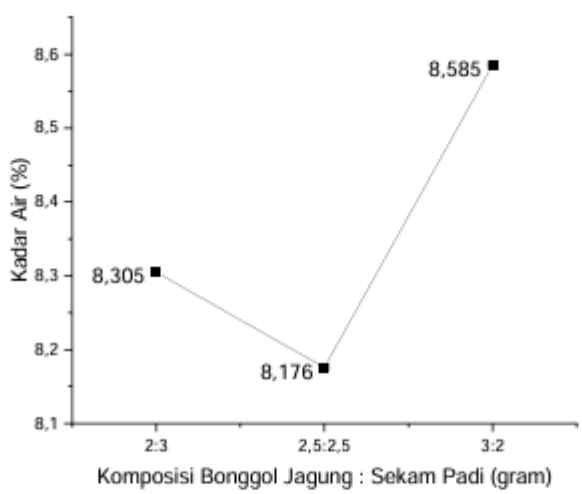

Figure 1. Effect of corncob and rice husk composition variations on moisture content

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3.2. Effect of Corncob and Rice Husk Composition Variations on Ash Content

As shown in Figure 2, the variation in corncob and rice husk composition significantly affects the ash content produced. At a composition of 2:3 (corncob : rice husk), the ash content obtained was 21.123%. This value increased to 24.875% at a 2.5:2.5 composition and reached the highest value of 26.735% at 3:2.

The increase in ash content with higher corncob proportions is due to the greater inorganic mineral content in corncobs compared to rice husks. Ash is the residue formed from the combustion of minerals such as calcium, potassium, magnesium, and silica. Because corncobs have higher density and mineral content, increasing their percentage directly contributes to the higher total ash content. This indicates that the proportion of raw materials plays an essential role in determining the mineral composition of the combustion residue.

Ash content is one of the key parameters determining briquette quality, as fuels with lower ash content exhibit better combustion characteristics. High ash content can decrease the calorific value and overall briquette quality. The use of binders may also increase ash content due to the presence of ash-forming components in the binder. Additionally, mineral salts formed during the carbonization process may further contribute to higher ash content.

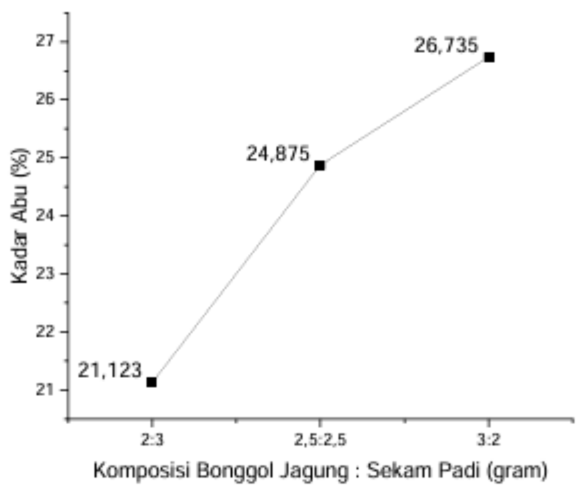

Figure 2. Effect of corncob and rice husk composition variations on ash content

3.3. Effect of Corncob and Rice Husk Composition Variations on Volatile Matter Content

cording to Figure 3, variations in corncob and rice husk composition influence the resulting volatile matter content. At the composition ratio of 2:3 (corncob : rice husk), the volatile matter content reached its highest value of approximately 34.0%. This value decreased significantly to 31.5% at a 2.5:2.5 composition, representing the lowest value, and then increased again to about 33.5% at a 3:2 composition.

These fluctuations in volatile matter content are influenced by the chemical properties and structures of each material. Volatile matter generally consists of organic compounds that vaporize during combustion, such as carbon, hydrogen, and other volatile compounds. Rice husk contains a high amount of volatile

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compounds due to its fibrous and silica-rich structure, resulting in high volatile content at the 2:3 composition. The decrease at 2.5:2.5 may be attributed to the balanced ratio of materials, producing fewer volatile compounds. The increase at 3:2 indicates that corncobs also contribute a considerable amount of volatile compounds, although their characteristics differ from those of rice husks.

A higher volatile matter content produces more smoke during combustion, as it involves reactions between carbon monoxide (CO) and alcohol derivatives. High levels of CO are harmful to health and the environment. Volatile matter is also affected by the briquette drying process—longer drying times reduce moisture content and consequently lower the volatile matter. Low volatile content results in faster smoke dissipation and improves overall briquette quality.

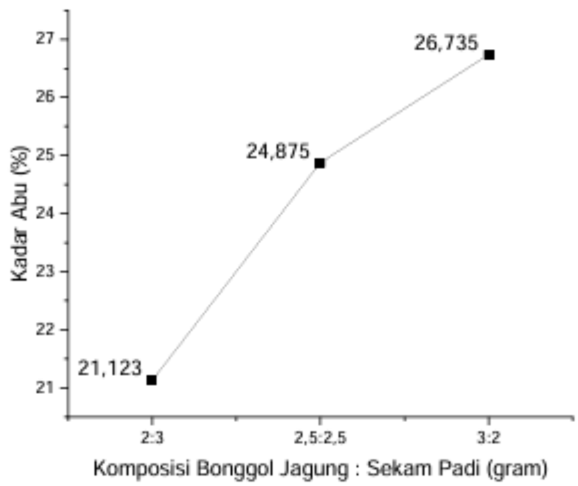

Figure 3. Effect of corncob and rice husk composition variations on volatile matter content

4. CONCLUSION

Based on the research results on the effect of corncob and rice husk composition variations on briquette characteristics, it can be concluded that different raw material ratios significantly influence moisture content, ash content, and volatile matter. The 2.5:2.5 (corncob : rice husk) composition produced the most optimal results, with the lowest moisture content of 8.176% and the lowest volatile matter of 31.5%, indicating better combustion properties and higher energy efficiency. Meanwhile, increasing the corncob proportion raised the ash content to 26.735% at the 3:2 composition due to its higher inorganic mineral content.

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