The effect of using jackfruit seed adhesives on the characteristics of corncob waste briquettes

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The effect of using jackfruit seed adhesives on the characteristics of corncob waste briquettes

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Abstract. To utilize it to be a useful fuel, corncob waste must be processed first, one of which is processed into briquettes. the use of jackfruit seed flour makes the water content and ash content of briquettes lower than using tapioca flour. The heating value of briquettes using jackfruit seed flour is also higher than using tapioca flour. This study aims to determine the effect of using jackfruit Seed adhesive on the characteristics of corncobs waste briquettes which include water content, ash content, volatile matter levels, and heat value. Knowing the characteristics of the best corncobs waste briquettes based on SNI standards. Corn cobs are first converted into charcoal by carbonization process after which the charcoal is mixed with an adhesive derived from jackfruit seed flour. Methods In this study, a mixture of corncob charcoal and jackfruit seed flour was 90%: 10%, 85%: 15%, and 80%: 20%. Then the mixture of charcoal and flour is printed with pressure variations of 100 kg cm^{-2}, and 120 kg cm^{-2}. Briquette characteristic parameters based on SNI 01-6235-2000 are water content, ash content, volatile matter content, and heating value. The results showed that the briquettes with the best characteristics were when variations in the composition of charcoal and jackfruit seed flour were 90%: 10%. The briquette has a characteristic water content of 7.01%, an ash content of 6.88%, volatile matter content of 17.89%, and a calorific value of 6241.81 cal g^{-1}. Overall, the briquette still does not meet the SNI 01-6235-2000 standard because the briquette's volatile matter level exceeds the specified maximum *limit* of 15%.

Keywords: corncob ch**arcoal,** briquette **carteristic, jackfruit seed a**dhesives

1. Introduction

One of the renewable energy which has great potential is biomass energy. Biomass energy sources in Indonesia have great potential, namely from agricultural waste such as rice husks, straw, bagasse, corn stalks, and cobs, and other agricultural wastes [1]. Biomass originating from agricultural waste is often considered a useless material so that the waste often ends up in landfills or burned. Though these wastes have the potential to be used as alternative fuels. In 2006, the use of fossil energy in Indonesia was recorded at 52.2% petroleum, 21.5% coal, 19% natural gas, 3.7% water, 3% geothermal and 0.2% renewable energy [2]. Fossil energy still dominates energy needs in Indonesia, the problem is that fossil energy is non-renewable energy, meaning that energy will eventually run out, so that alternative energy is needed as a substitute for renewable energy.

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Briquette is a solid fuel that results from compression or pressure whether or not using adhesive. One source of biomass energy that has the potential to be renewable energy is corncobs. Of the 100% total weight of corn, 30% is corn cobs, while the rest is the skin and seeds [3]. In 2015, corn production in Indonesia was 19.6 Million tons, meaning that there were around 5.9 Million tons of corn cobs produced. In general, corn cobs waste has not been utilized by the community, usually corn cobs are simply burned or thrown away. Of course, this can cause environmental pollution. Corncobs have a high enough HHV value, which ranges from 14.7-18.9 MJ kg^{-1} [4] so that it will produce good enough heat when burned. Because of that corn cobs have the potential to be used as an alternative fuel that is converted into briquettes. In South Kalimantan, corn production in 2013 was recorded at 107,043 tons. This means that there are around 35.681 tons of potential corn cob waste produced. The habit of farmers to date is corn cobs are always thrown or burned, when in fact the corn cobs can still be used. If it is not utilized, it will become waste and pollute the environment. Whereas corncob waste can be used as the main ingredient of animal feed and because it has a high calorific value, corncob waste also has the potential as an alternative fuel. Corncobs have a high carbon content.

As coconut shells, bagasse, corncobs, sawdust, dried leaves, and others. Making charcoal from biomass waste materials usually uses a carbonization process. Carbonization is the incomplete combustion process of organic materials with limited or no oxygen. During the process of flammable substances such as CO, CH_4, H_2, formaldehyde, methane, formic and acetic acid, and also non-combustible substances such as CO_2, H_2O, and liquid tar. The gases released have a high heating value so that they can meet the needs of heat during the carbonization process [5].

In general, the adhesive used in making biomass briquettes is tapioca flour or starch. But in this study the adhesive used is jackfruit seed flour, this is because, in research [6], briquettes that use jackfruit seed flour adhesives have slightly better characteristics than briquettes that use tapioca flour-based adhesives namely lower water content, lower ash content and higher heating value Characteristics of briquettes contained in this study are, (1) Moisture content, the water content of briquettes is the ratio of the weight of water contained in the briquettes with the dry weight of the briquettes. (2) Ash content, ash content is an inorganic substance that remains when the briquette is completely burned. (3) Volatile matter, volatile matter, or what is often referred to as volatile matter affects the burning of briquettes. The content of volatile matter affects the perfection of combustion and the intensity of the fire. (4) The heating value, the heating value is the amount of heat produced by the briquettes per unit weight of combustible material when perfect combustion [7].

2. Methods

2.1. Tools and materials
Tools and materials used in this study include corn cobs, jackfruit seeds, water, sieve sacker, scales, briquette molding equipment, stoves, used cans, mortars and pestle, plastic cups, wood mixers, and electric ovens.

2.2. Research procedure

2.2.1. Material processing
Corn cob that has been collected is cleaned, then cut into small pieces after it is dried in the sun until the material looks dry. Jackfruit seeds (2), that have been collected are cleaned, then boiled for about 1 hour. After that jackfruit seeds are ground until smooth, then dried in the sun to dry. Mash again jackfruit seeds to be smooth.

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2.2.2. Corn cobs

Dry corncobs are put into cans, then the cans are heated using a stove for 60 minutes.

2.2.3. Refinement of charcoal particle size

The refinement of charcoal particle size is done by manually pounding it using mortars and pestles.

2.2.4. Filtering

The screening of corn cobs charcoal is done by using a sieve sacker with a particle size of 40 mesh (1). If there is charcoal that does not pass it will be refined. Filtering of jackfruit seed flour is carried out using a sieve sacker with 60 mesh particle size (2).

2.2.5. Printing

In this study, variations were made on the composition of charcoal with flour and laying pressure. Heat the water to a boil then add the jackfruit seed flour then stir the adhesive mixture until it thickens. mixing is done from the total mass weight percent, i.e. a ratio of 90% corn charcoal with 10% jackfruit seeds. 85% corn charcoal with 15% jackfruit seeds, and 80% of corn charcoal with 10% jackfruit seeds.Next, mix the adhesive mixture with the corn cobs, stirring evenly. After that, the mixture of charcoal and adhesive is put into a cylindrical shape with diameter of 5 cm and height of 14 cm after it is pressed with a hydraulic device.

2.3. Drying

The drying process of the bike is done using an electric oven with a temperature of 90°C for 120 minutes.

Figure 1. Making process until briquette printing

Table 1. Corncob variations in the study

Sample code	Corncob (%)	Jackfruit Seed Flour(%)	Pressure (kg cm^{-2})
A1	90	10	100
A2	85	15	100
A3	80	20	100
B1	90	10	120
B2	85	15	120
B3	80	20	120

3. Result and discussion

From the results of the research that has been done, it is obtained the value of water content, ash content, volatile matter levels and the calorific value of the corn cob waste briquettes as shown in **Table 2**.

Table 2. Test results for the heating value of corncobs waste briquettes

Sample Code	Test result			
	Water content (%)	Ash Content (%)	Volatile Levels (%)	Calorific Value Cal gr^{-1}
A1	7.6643	6.6538	18.1494	6126.4027
A2	9.8159	6.4323	18.7370	5898.4232
A3	12.0595	6.2405	20.3581	5772.5275
B1	7.0073	6.8876	17.8983	6241.8137
B2	9.1915	6.7317	18.4807	5951.8225
B3	11.5085	6.4933	20.2564	5846.2300

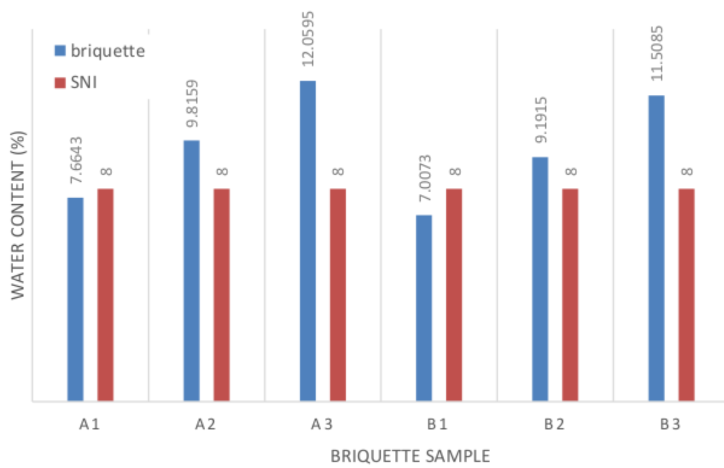

Figure 2. Water content of briquette samples and its comparison with *standard nasional Indonesia* (SNI)

Based on **Figure 2** the briquette with sample code A1 has a water content of 7.6643%, A2 has a water content of 9.8159%, A3 has a water content of 12.0595%, B1 has a water content of 7.0073%, B2 has a water content of 9.1915, and B3 in the amount of 11.5085. Of the six briquettes, only two met the SNI 01-6235-2000 moisture content standard regarding the quality of wood charcoal briquettes with a maximum moisture content of 8%, namely briquettes A1 with a water content value of 7.6643% and B1 of 7.0073%.

It is shown that the more adhesives the greater the water content of the briquettes. This is because the more flour composition in the mixture of charcoal and flour, the more water needed to thicken the flour. The results of this study are by research [8], which Nominalization making briquettes with variations in adhesive content, from the results of the study the more adhesive levels are used the briquette's water content will be higher. On the graph shows the greater the pressure of printing briquettes, the water content decreases. The results of this study are by research [9], which shows the greater the briquette printing pressure the smaller the moisture

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content. According to him, this is due at the time of printing, water will be wasted out in a certain amount. Briquettes that have high water content are caused by a less optimal drying process. The longer the drying process, the water content in the briquettes will decrease. Also, the water content will affect the value of the heat produced. The high water content will cause a decrease in the heating value [10].

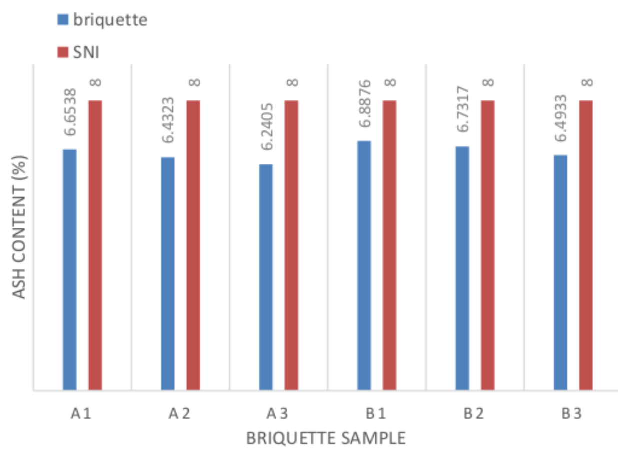

Figure 3. As content of each briquette sample and its comparison with *standard nasional Indonesia* (SNI)

Based on **Table 2** and **Figure 3**, the briquette with sample code A1 has an ash content of 6.8876%, A2 has an ash content of 6.7317%, A3 has a moisture content of 6.4933%, B1 has an ash content of 6.6538%, B2 has an ash content of 6,4323%, and B3 has an ash content of 6,2405%. The results show that the ash content of briquettes from each other is not too much different. The briquettes with the lowest ash content are B3 briquettes with ash content of 6.2405% and the briquettes with the highest ash content are A1 briquettes with ash content of 6.8876%. All of the six briquettes meet SNI 01-6235-2000 ash content standards regarding the quality of wood charcoal briquettes with a maximum ash content of 8%.

Figure 3 shows the more adhesive compositions the lower the ash content. This result is in accordance with the research [10] in that study the variation of adhesive levels was carried out, the results of the study showed that the more adhesive levels the ash content would decrease. Ash content is influenced by the content of ingredients found in adhesives and charcoal such as silica [11]. It is also shown that the greater the briquette printing pressure the lower the ash content. This result is in accordance with the research [12], in that study the variation of the briquette mapping pressures were carried out, the results of the study showed the greater the briquette printing pressure, the lower the ash content of the briquettes. This is due to the briquettes that are printed with higher pressure have lower water content so that it will allow more perfect burning when burning and produces less ash.

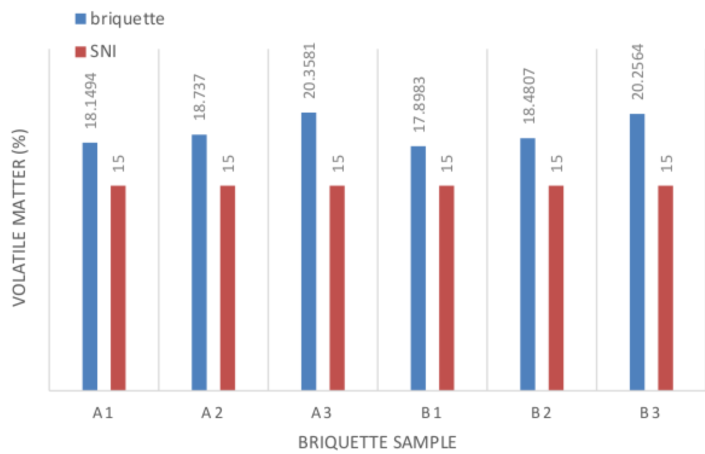

Figure 4. Volatile matter for each briquette sample with *standard nasional Indonesia* (SNI)

Based on **Table 2** and **Figure 4** the briquette with sample code A1 has a volatile matter level of 18.1494%, A2 has a volatile matter level of 18.737%, A3 has a volatile matter level of 20.3581%, B1 has a volatile matter level of 17.8983%, B2 has a volatile matter level of 18.4807%, and B3 has a volatile matter level of 20.2564%. Briquettes with the lowest levels of volatile matter are briquette B1 which has a volatile matter level of 17.8983% and briquettes with the highest level of volatile matter, namely A3 briquettes which has a volatile matter level of 20.3581%. This means that all briquettes have not met the standard value of the SNI 01-6235-2000 level of the volatile matter about the quality of wood charcoal briquettes with a maximum volatile matter content of 15%. It is shown that the more adhesive compositions, the higher levels of volatile matter. These results are by research [13], in that study variations of adhesive levels were carried out, the results of the study showed that the more adhesive levels, the higher the levels of volatile matter. This might be due to the large levels of volatile matter present in jackfruit seed flour.

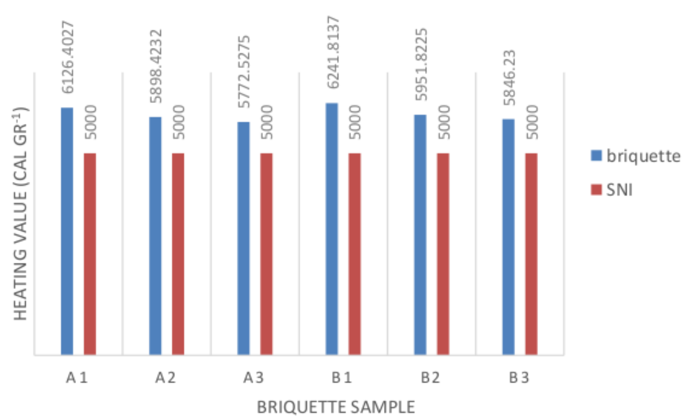

Figure 5. Briquette sample for calorific value

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The level of volatile matter depends on the authoring time and the temperature of the authoring. The level of volatile matter will decrease if the composition time is prolonged. Besides the type of adhesive used also affects the level of volatile matter. High levels of volatile matter in briquettes will cause more smoke when the briquettes are lit [11].

Based on **Table 2** and **Figure 5** the briquette with sample code A1 has a heating value of 6126.4027 cal gr^{-1}, A2 has a calorific value of 5898.4232 cal gr^{-1}, A3 has a heating value of 5772.5275 cal gr^{-1}, B1 has a heating value of 6241.8137 cal gr^{-1}, B2 has a heating value of 5951.8225 cal gr^{-1}, and B3 has a heating value of 5846.2300 cal gr^{-1}. The briquettes with the lowest heating value are A3 briquettes with a heating value of 5772.5275 cal $gr^{-1}$and the briquettes with the highest heating value are B1 briquettes with a heating value of 6241.8137 cal gr^{-1}. Of the six briquettes, all of them meet the standard heating value of SNI 01-6235-2000 about the quality of wood charcoal briquettes with a minimum heating value of 5000 cal gr^{-1}. The higher the heating value, the better the quality of the briquettes produced.

Figure 5 shows the higher the briquette printing pressure, the higher the heating value. This result is in accordance with the research [6], in that study the briquette printing pressure variants were carried out, the results of the study showed the greater the briquette printing pressure the higher the calorific value. Higher printing pressure will make the briquette water content lower. Low water content will make the heating value higher. It is shown also that the more adhesive compositions, the heating value will be lower. This result is in accordance with the research [8], in that study variations in the composition of the briquette adhesive were carried out, the results of the study showed that the more the adhesive composition, the lower the heating value. This might be due to the adhesive that contains a lot of water so that the combustion process is less than optimal, this is evidenced from the results of the water content test which shows the more glue the higher the water content of the briquettes.

4. Conclusion

The conclusions obtained from this study are as follows:

- The characteristics of corncobs waste briquettes in each briquette are A1 briquettes having a water content of 7.6643%, ash content of 6.6538%, volatile matter content of 18.1494%, and a heating value of 6126.4027. Briquettes A2 has a moisture content of 9.8159%, an ash content of 6.4323%, a volatile matter content of 18.7370%, and a heating value of 5898.4232 cal gr^{-1}. Briquettes A3 has a moisture content of 12.0595%, an ash content of 6.2405%, volatile matter content of 20.3581%, and a heating value of 5772.5275 cal gr^{-1}. Briquette B1 has a moisture content of 7.0073%, an ash content of 6.8876%, volatile matter content of 17.8983%, and a calorific value of 6241.8137 cal gr^{-1}. Briquette B2 has a moisture content of 9.1915%, an ash content of 6.7317%, volatile matter content of 18.4807%, and a calorific value of 5951.8225 cal gr^{-1}. B3 Briquettes has a water content of 11.5085%, the ash content of 6.4933%, volatile matter content of 20.2564%, and a heating value of 5846.2300 cal/ gr.
- From the results of the comparison of the six briquette samples, it can be seen that the briquettes with the best characteristics are briquettes with sample code B1 with a water content value of 7.0073%, an ash content of 6.8876%, volatile matter content of 17.8983% and calorific value of 6241.8137 cal gr^{-1}. However, overall the briquettes did not meet SNI 01-6235-2000 standards on the quality of wood charcoal briquettes. Because the level of volatile matter briquettes exceeds the maximum limit that has been determined that is a maximum of 15%.

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