# ENVIRONMENTALLY FRIENDLY BRIQUETTES MADE FROM A MIXTURE OF SNAKE FRUIT SKIN AND GOAT MANURE

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**ABSTRACT**

The purpose of this study is to make snake fruit briquette charcoal mixed with goat dung an alternative energy source that supports environmentally friendly technology. The samples used were snake fruit and goat dung as charcoal and tapioca flour as an adhesive. Each sample has 200 grams of charcoal and 30 grams of adhesive. The percentage of charcoal is 50% snake fruit bark charcoal and 50% goat dung charcoal. Snake fruit briquettes and goat dung are divided into 3 groups: A1 (87% charcoal: 13% adhesive), A2 (77% charcoal: 23% adhesive), and A3 (97% charcoal: 3% adhesive). In 3 samples tested with the percentage of charcoal flour to tapioca flour, the first one was produced in sample A1 (87%: 13%), which produced a moisture content of 9.87%, an ash content of 36.75%, and a calorific content of 5899 kcal/kg. The A2 sample (77%:23%) yielded a moisture content of 11.44%, an ash content of 32.13%, and a calorific content of 5634 kcal/kg. The A3 sample yielded a moisture content of 8.93%, an ash content of 41.38%, and a calorific content of 6339 kcal/kg. This study concludes that the best calorific value in the A3 sample is 97% charcoal briquettes with 3% adhesive, with a calorific value of 6339 cal/kg.

**Keywords:** briquettes; snake fruit skin; goat dung; eco-friendly technology

## Introduction

The use of firewood as an energy source is a practice that has been carried out since ancient times. Firewood is relatively easy to obtain in many areas, especially in rural areas and areas that are not reached by other modern energy sources. Although it is a renewable energy source, the use of firewood can also cause air pollution in the form of emissions such as particulates, carbon monoxide, and hydrocarbons.

One solution that can be used to reduce air pollution is to make briquettes. Serevina[1] conveys below. Briquettes are fuels that are environmentally friendly and renewable compared to fossil-derived fuels. Briquettes are made from unused organic waste, so they help reduce the volume of waste and minimize environmental impact. The burning of briquettes also produces lower emissions than fossil fuels such as coal or petroleum.

The skin of Snake Fruit contains nutritional value in the form of protein content, carbohydrate content, water content, and low fat. The results of phytochemical tests show that the meat and skin of Snake Fruit contain flavonoid compounds, tannins, and alkaloids.[2] Snake fruit can be used as briquettes because it has several properties that make it suitable as fuel. Snake fruit has high energy content, so it contains a lot of fiber and organic matter that burns well, producing enough heat.

Snake fruit can be mixed with other ingredients to support the energy in the briquettes, for example, with a mixture of goat dung. Livestock waste (goat dung) can be processed into biogas and briquettes. Goat

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manure is relatively easy to obtain as the main source of nutrients in organic cultivation. The need for manure is very large because of its low nutrient content. According to Hartatik and Widowati,[3] goat manure has a nutrient content of 0.70% N, 0.40% $P_2O_5$, 0.25% $K_2O$, a C/N of 20-25, and 31% organic matter. As biomass, it is reported that goat dung contains a fairly high energy of 4071.72 calories/gram and contains a high percentage of volatile matter, which is 57.32%, so that it has the potential to be used as Noach briquettes.[4]

Previous research on snake fruit briquettes was conducted by Kholil,[5] which showed that a composition variation of 75% snake fruit fronds and 25% snake fruit had a significant effect, with a density of 0.778 gr/cm³ at a pressure of 150 kg/cm². However, the study had limitations in terms of the narrow range of material mixtures, suboptimal charcoal composition, and lack of variation in the type of adhesive used. Therefore, this current research introduces improvements by exploring different material combinations, optimizing the proportion of charcoal, and using various types of adhesives to enhance the briquette quality, including calorific value, combustion time, and density.

## Methods

This study uses an experimental method to test the effectiveness of alternative raw materials in the manufacture of environmentally friendly briquettes. The techniques used in data collection include direct experiments in the laboratory, visual and written documentation of each stage of the process, as well as literature studies relevant to the briquette-making process and the characteristics of each material.

The equipment used in the briquette manufacturing process includes a manual grating machine for crushing raw materials, Manual smoothing tools (mortar and pestle), a Material mixing machine, Manual briquette molding, Digital scales to measure the mass of materials precisely, Knives for cutting materials if needed, Ovens for additional drying processes, and Tray as containers during the mixing and drying process. The materials used as samples in this study include: Snake fruit as the main biomass material, goat dung as a biomass additive, and tapioca flour as an adhesive. Research Time and Location

This research will be carried out in February 2025, located in a laboratory owned by PT SUCOFINDO Bengkulu Branch. The entire series of processes is carried out for 7 working days.

The stages of the briquette-making process are the collection and drying stage. Raw Materials: The main ingredients, in the form of snake fruit and goat dung, are collected and then dried in direct sunlight for two days. This process aims to reduce the moisture content in the material, making it more effective in the authoring process. Authoring: Once dry, the material is put into a sealed container for the authoring process. This process lasts for about an hour until the ingredients turn into charcoal. After the authoring process is complete, the charcoal is left to cool before further processing. Refining and Filtration: Charcoal from snake fruit and goat dung is then crushed using a mortar and pestle until it becomes a fine powder. After that, the powder is filtered using a sieve to ensure the uniformity of particle size. Weighing and Mixing of Materials: The finely refined charcoal powder is weighed as much as 200 grams for each sample. The composition of charcoal is divided equally, namely 50% from snake fruit bark charcoal and 50% from goat dung charcoal. Three variations of adhesive composition are used for each sample: A1: 87% charcoal and 13% adhesive, A2: 77% charcoal and 23% adhesive, A3: 97% charcoal and 3% adhesive. Each mixture consists of a total of 400 grams of material (200 grams of charcoal and 200 grams of adhesive). We dissolve tapioca flour as an adhesive in 200 ml of water, cook it to a boil, and then thicken it. After that, the adhesive solution is mixed with charcoal powder until it is even and homogeneous. Printing: Briquettes. The perfectly mixed briquettes are put into a manual mold and pressed until solid and perfectly shaped. Briquette Drying: The molded briquettes are then dried in the sun for three days to remove the remaining moisture content and strengthen the physical structure of the briquettes.

The Final Result After going through the drying process, the briquettes from a mixture of snake fruit and goat dung are ready to be used as an environmentally friendly alternative fuel.

## Results and Discussion

Based on the results of the test of burning snake fruit briquettes with goat dung, the data results are obtained in Table 1.

According to the Indonesian National Standard (SNI),[6] briquettes have a maximum moisture content of 8%, a maximum ash content of 10-12%, and a calorific value of more than 5000 kcal/gram.

In 3 samples tested with the percentage of charcoal flour to tapioca flour, the first one was produced in sample A1 (87%: 13%), which produced a moisture content of 9.87%, an ash content of 36.75%, and a calorific content of 5899 kcal/kg. The A2 sample (77%:23%) yielded a moisture content of 11.44%, an ash content of 32.13%, and a calorific content of 5634 kcal/kg. The A3 sample yielded a moisture content of 8.93%, an ash content of 41.38%, and a calorific content of 6339 kcal/kg. The results of the quality test of snake fruit briquettes with a mixture of goat dung with A3 samples (97% charcoal: 3% adhesive) showed the best results with a moisture content of 8.93%. For comparison, sample A2 (77% charcoal: 23% adhesive) produced the best ash content of 32.13%, and sample A3 (97% charcoal: 3% adhesive) produced the best calorific value of 6339 cal/kg. The results of the research carried out by previous researchers with materials from rubber seed shells mixed with goat dung showed that the A1 sample (87%:13%) produced a moisture content of 9.21%, an ash content of 20.53%, and a calorific content of 6036 kcal/kg. Sample A2 (77%:23%) yielded a moisture content of 9.04%, an ash content of 20.08%, and a calorific content of 6119 kcal/kg. The A3 sample yielded a moisture content of 8.63%, an ash content of 24.01%, and a calorific content of 6287 kcal/kg. [7]

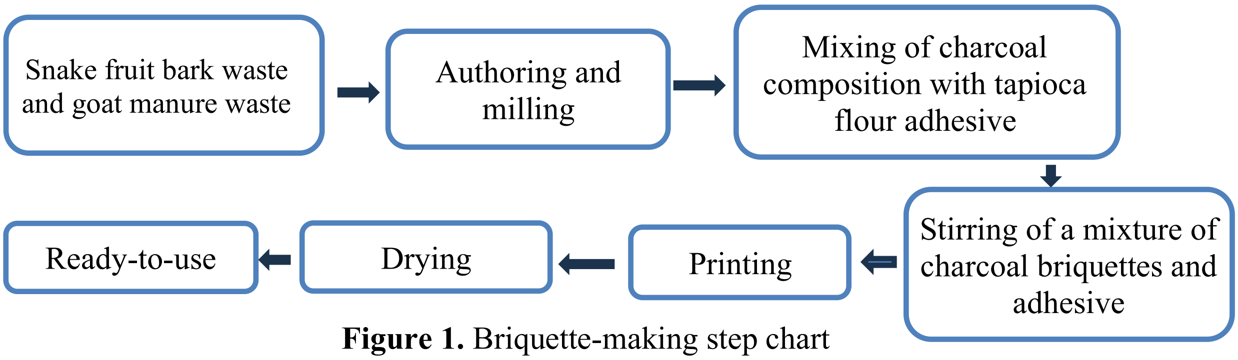


**Figure 1.** Briquette-making step chart

**Table 1.** Combustion of Charcoal Briquettes, Snake fruit and Goat Manure

| Sample Code | Percentage of Charcoal Flour and Tapioca Flour | Moisture Content (%) | Ash Rate (%) | Calorific Rate (kcal/kg) |
|---|---|---|---|---|
| **A1** | 87% : 13% | 9,87 | 36,75 | 5899 |
| **A2** | 77% : 23% | 11,44 | 32,13 | 5634 |
| **A3** | 97% : 3% | 8,93 | 41,38 | 6339 |

### a. Moisture Rate

Moisture content is one of the most important parameters for determining the quality of food, as water can affect its appearance and texture.[8] The quality of the briquettes is influenced by the moisture content; the higher the moisture content, the more difficult it will be for the briquettes to ignite. High moisture content results in lower calorific values.[9] It can be seen in picture 2 below:

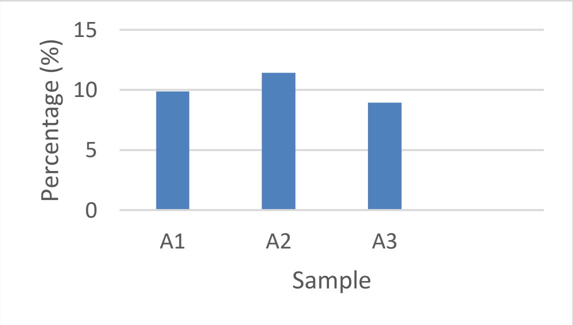


**Figure 2**. Moisture content test graph

Figure 2 shows the value of the moisture content of each briquette treatment. The measurement results showed that the lowest value was found in the composition of the A3 sample (97% charcoal: 3% adhesive) with a moisture content value of 8.93%; the composition of the A1 sample (87% charcoal: 13% adhesive) with a moisture content value of 9.87%; and the composition of the A2 sample (77% charcoal: 23% adhesive) with a moisture content value of 11.44%. This shows that the moisture content does not meet SNI standards, which, according to Iskandar[10] statement, states that the moisture content value in briquettes by SNI standards based on No. 1/6235/200 is a maximum of 8%. The high moisture content observed in the three briquette samples is attributed to several technical factors occurring during the production process. One of the primary factors is the low density of the briquettes, resulting from a suboptimal molding process. Briquettes with low density possess a looser pore structure, which leads to an unstable rate of moisture evaporation during the drying phase. This instability contributes to higher moisture retention. In addition, the uneven mixing of tapioca flour in the briquette dough also affects the water absorption capacity. The non-homogeneous distribution of the binding agent causes local variations in the briquette's structure and porosity, ultimately influencing moisture distribution and drying efficiency.

### b. Ash Rate

In the process of burning the briquettes, the remaining part is called ash. The ash content contained in a food ingredient indicates the amount of minerals in the food. Ash content is the result left behind from food samples that are completely burned in the frying process.[11] The higher the content of food ash, the worse the quality of the briquettes, and vice versa. The results of the measurement of the ash content of briquettes can be seen in Figure 3.

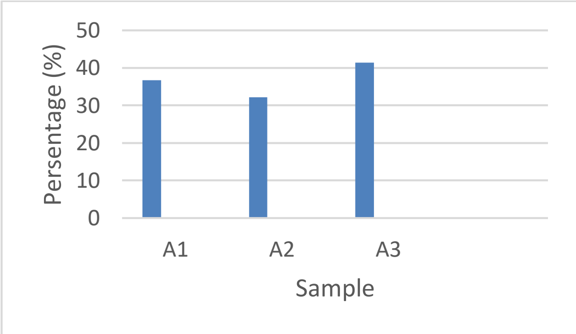


**Figure 3**. Ash content experiment graph

To find out the number of pieces of briquettes that are not burned, an analysis of ash content is carried out. In Figure 3, the highest ash content is in the composition of sample A3 (97% charcoal: 3% adhesive) with an ash content value of 41.38%, sample A1 (87% charcoal: 13% adhesive) with an ash content value of 36.75%, and sample A2 (77% charcoal: 23% adhesive) with an ash content value of 32.13%. The results of the ash content testing on the 3 samples, namely samples A1, A2, and A3, show that the ash content does not meet SNI standards. This is in accordance with the statement of Setyono & Purnomo,[12] which states that the ash content of briquettes based on SNI No. 1/6235/200 is only 10-20%. This condition is most likely caused by the high proportion of adhesive materials used in the briquette formulation, which contributes to an increase in ash content. Adhesives, particularly those based on starch such as tapioca flour, generally contain relatively high levels of non-organic minerals after the combustion process. The greater the proportion of adhesive added, the more inorganic residue remains, thereby increasing the overall ash content. This indicates that the formulation of raw materials and the composition of the adhesive play a crucial role in determining the final quality of the briquettes, including their combustion characteristics and solid residue content. According to Rahmadani et al.[13] an increase in the concentration of charcoal can lead to an increase in the value of the ash content of briquettes, and a decrease in the concentration of charcoal will decrease the value of the ash content of briquettes. Other factors may be due to the presence of particles or other materials that enter the authorship.

### c. Calorific Value

The calorific value of fuel is the amount of heat produced or caused by a gram of fuel by increasing the temperature of 1 gram of water from 3.50°C to 4.50°C, in units of calories. In other words, the calorific value is the amount of heat obtained from the combustion of a certain amount of fuel. The higher the specific gravity of the fuel, the higher the calorific value it obtains.[14] The calorific value is greatly influenced by the moisture content and ash content of the briquettes; the higher the ash content of the briquettes, the lower the calorific value will be. The results of the calorific value test can be seen in Figure 4.

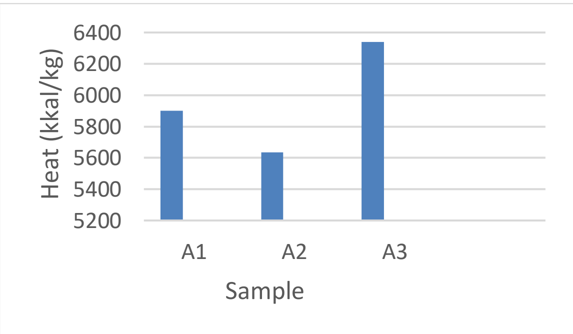


**Figure 4**. Calorific value experiment graph

Through the results of the tests that have been carried out, it was found that the heat value in the A3 sample (97% charcoal: 3% adhesive) has a higher calorific value of 6339 kcal/kg, sample A1 (87% charcoal: 13% adhesive) has a calorific value of 5899 kcal/kg, and sample A2 (77% charcoal: 23% adhesive) has a calorific value of 5634 kcal/kg. The calorific value that meets the SNI 01-6235-2000 standard is >5000 kcal/kg, which proves that the basic material of snake fruit mixed with goat dung has the opportunity to be developed into briquettes. Snake fruit briquettes with goat dung mixture produce a high calorific value; therefore, snake fruit briquettes mixed with goat dung are good for use as fuel.

Briquettes with lower moisture content and ash content have higher quality, which is characterized by an increasing calorific value.[15] From the test results, the moisture content, ash content, and heat content have not been balanced. In the A3 sample with a ratio of 97% charcoal and 3% adhesive, the lowest moisture content and the highest calorific value were obtained, but the ash content value was the highest. However, snake fruit briquettes mixed with goat dung have a high calorific value, so they can be developed as a good fuel.

## Conclusion

Based on the results of the research that has been carried out, it can be concluded that the quality test of snake fruit briquettes with a mixture of goat dung with A3 samples (97% charcoal: 3% adhesive) showed the best results with a moisture content of 8.93%. For comparison, sample A2 (77% charcoal: 23% adhesive) produced the best ash content of 32.13%, and sample A3 (97% charcoal: 3% adhesive) had the best calorific value of 6339 cal/kg. With the results obtained, snake fruit briquettes with goat dung can be used as an environmentally friendly alternative fuel by reducing the moisture and ash content of the briquettes.

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