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Briquetting of Cassava Peel (Manihot Esculenta) With Styrofoam Adhesive as Alternative Fuel

Afif Thaifuri[1*], Nurmahni Harahap[2]
MTsN 1 Banda Aceh, Indonesia

Abstract

Briquetting technology that uses cassava peels as a base material has the potential to reduce dependence on conventional fuels and maintain environmental sustainability. Cassava peel waste can be used as an alternative solid fuel source. The aim of this research is to explore the process of making briquettes from cassava peels with added styrofoam adhesive, which can be used as an alternative to petroleum and natural gas. The research involved five stages, namely preparation, drying, mixing, burning, and quality testing. The method used was experimentation by testing cassava peel briquettes against the parameters of briquette mass, combustibility, and water heating time. The results showed that the average mass of briquettes after the production process was about 0.16 kg. The fastest burning time is 67 minutes 02 seconds, and the fastest 100 mL water heating time is 1 minute 05 seconds.

Keyword: Briquettes; Cassava peel; Styrofoam; Alternative solid fuels

* Corresponding author, email: afifthaifuri17@gmail.com
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INTRODUCTION

Petroleum, as a non-renewable energy source, remains the main choice in daily life, even though we know that its use will deplete petroleum reserves and potentially present an energy crisis in the future. To overcome the potential energy crisis, there is a need to develop alternative energy sources. Among the various renewable alternative energy sources, such as solar, wind, geothermal, ocean heat, and biomass energy, biomass energy is a priority for development because Indonesia, as an agricultural country, has a lot of untapped agricultural waste.

One alternative fuel option that can replace oil and gas in industry and households is charcoal briquettes. Charcoal briquettes are solid fuels that are carbon-rich, have a high heating value, and can burn for a long time (Julius & Johannes, 1990). The advantages of using briquettes include a more economical cost than oil or wood charcoal, a longer burning period, safety of use, and ease of storage and transportation without the need for constant air circulation or refueling. Therefore, briquettes have been recognized as an alternative fuel in many countries (Tiara, 2022; Misbah, 2029; Abthal, 2024; Zikrullah, 2023; Rudi, 2021).

There are many raw materials that can be used to make briquettes, and one of them is cassava peel. The large production of cassava in Indonesia results in abundant cassava peel waste. Cassava peels are usually only used as animal feed or even thrown away as garbage, which contributes to environmental pollution. In addition to cassava peel waste, Styrofoam waste has also not received attention in processing. Therefore, this research aims to turn these two types of waste into products that have economic value and benefits.

Seeing the bright potential and economic value possessed by briquettes, research on the use of cassava peel waste to make briquettes as an alternative to petroleum and gas is very important. Based on the background of the above problems, the problem formulations in this study are: What is the mass, combustibility, and boiling time of water from cassava peel briquettes with styrofoam adhesive? Based on the formulation of the problem above, the objectives of this study are to determine the mass, combustibility, and boiling time of water from cassava peel briquettes with styrofoam adhesive (Cristina, 2024; Munidar, 2024; Paull, 2024; Rahmadanu, 2024).

The expected impact of the results of this study is as follows, theoretically: Material for reference and the development of ideas for further research is one of the efforts to increase knowledge about making briquettes from cassava peels and their benefits. Practically: being an input material for all communities in making briquettes from cassava peels; promoting the importance of utilizing briquettes as an alternative fuel.

The results of research (Hendra & Darmawan, 2000) with the title Making Charcoal Briquettes from Sawdust with the Addition of Coconut Shell concluded that charcoal briquettes with a composition of 90% sawdust charcoal and 10% coconut shell charcoal gave the best results for moisture content (3.51%), volatile matter content (22.18%), bound carbon content (73.82%), and calorific value (6,522.84 cal/g).

The results of research (Adnyana, Dana, & Kusuma, 2008) with the title Briquettes from Candlenut Shells concluded that briquettes with lower pressing forces will burn out the fastest; on the other hand, briquettes with the highest pressing force will burn the slowest. Economically, it can be seen that for heating, briquettes that have the shortest heating rate to reach the boiling point are needed. (Rismayani & Tayibnapis, 2011), with the title Making Bio-briquettes from Coconut Coir Waste and Bottom Ash, stated that using coconut coir waste has the advantage of not requiring clay or starch solution in making bio-briquettes because coconut coir waste has good adhesive properties. The results of research (Kalsum, 2016) with the title Making Charcoal Briquettes from a Mixture of Durian Skin, Corn Cob Waste, and Wood Sawdust Using Tapioca Adhesive states that wood sawdust, corn cobs, and durian skin are biomass waste that can be used as an alternative fuel source, namely by making them into briquettes with a mixture of tapioca adhesive that has a calorific value that can meet SNI briquette standards.

According to the results of research (Sulistyaningkarti & Utami, 2011) entitled Briquettes from Charcoal of Corn Cob Organic Waste, it can be concluded that charcoal briquettes made from corn cob organic waste using tapioca flour as an adhesive have superior quality compared to briquettes using wheat flour, especially in terms of moisture content, volatile matter content, ash content, bound carbon content, and calorific value. The results of the study (Mithen, Paloboran, & Musa, 2017) stated that there was an increase in public knowledge and awareness about the importance of the use of environmentally friendly alternative fuels, one of which is biocharcoal briquettes from corn cob waste, so it is expected to gradually change people's behavior towards the use of alternative fuels such as BBM and BBG.

Biomass is a type of solid waste that can be used as a fuel source. Biomass includes various types of waste, such as wood waste, agricultural residues, waste from plantations, forest waste, and organic components from industries and households. Energy produced from biomass has the potential to be an alternative energy source that can replace fossil fuels, such as petroleum, because it is renewable (Sinurat, 2011). Biochar is charcoal made from various kinds of biological materials or biomass, such as wood, twigs, leaves, grass, straw, and other agricultural waste. Bioarang can be utilized through processing, one of which is by making bioarang briquettes (Sinurat, 2011).

Cassava, which has the Latin name Manihot esculenta, is a tuber or long tree root with an average physical centerline of 2-3 cm and a length of 50–80 cm. The flesh of the tuber is white or yellowish in color. Cassava production in Indonesia is very large. As a cassava-producing country, the potential for cassava peel waste is also quite large. The scientific nature of charcoal powder tends to separate them from each other. With the help of adhesives or glue, charcoal grains can be brought together and shaped (Muzi & Mulasari, 2014). However, the problem lies in the type of adhesive chosen. Determining the glue used greatly affects the quality of the briquettes during combustion and ignition.

Waste is one of the scourges of life, and one of the wastes that can no longer be processed by factories is styrofoam waste. (Ningsih, 2012) mentioned that polystyrene foam is widely known as styrofoam. At the beginning of its appearance, styrofoam was used as an insulator in building construction materials, not for food packaging. Styrofoam is made from styrene monomer by suspension polymerization at a certain pressure and temperature, after which it is heated to soften the resin and evaporate the remaining expansion. Styrofoam, or foam, is still classified as a type of plastic. Styrofoam is made from polystyrene, which is a synthetic polymer material (Wirahadi, 2017).

METHOD

Type of Research

This research uses qualitative and quantitative approaches (mix method).

Time and Place of Research

This research was conducted from August to November 2022. The research was conducted at the Science Laboratory of MTsN 1 Banda Aceh.

Target/Subject of Research

The method used in this research is experimental. By observing the mass, combustion power, and boiling time of water from briquettes derived from cassava peels collected from cassava chips and tape-making places around Banda Aceh City.

Procedure

a. Clean and dry the cassava peels in the sun until they look dry.
b. Put the cassava peels into a drum and burn them.
c. When the cassava skin looks all burned, the drum is immediately closed. Wait for about 15 minutes until the heat of the drum is gone.
d. The charcoal is removed and separated between those that burn and those that do not, and between those that become ash; only those that become charcoal are taken.
e. Then grind the burning charcoal until smooth.
f. Prepare Styrofoam and liquefy it using tinner and tongue-in-law water. Mix with charcoal powder to make a sticky dough. Once ready, stir the mixture until it is well mixed and becomes a slightly sticky dough.
g. After the charcoal powder is well mixed, the dough is removed, and then briquette molding. is carried out.
h. The briquettes are densely molded using paralon pipes or bamboo.
i. The briquettes are dried for 2–3 days until completely dry. And the briquettes can be used.

Data, Instruments, and Data Collection Techniques

The data in this study were obtained from observations and repetition of treatments in the manufacture of cassava peel briquettes. Data collected:

a. Mass of briquettes.
b. Briquette combustibility.
c. Water boiling time.

Data Analysis Technique

a. Mass of briquettes
   - The mass of briquettes produced / Kg of cassava peel was obtained by weighing the briquettes with a scale.
   - The number of briquettes needed to boil 100 mL of water.

b. Combustibility of briquettes
   - Based on the combustibility test of 1 piece of briquette, by calculating the time with a stopwatch / hour.
   - The time taken to burn the briquettes was measured using a stopwatch/hour.

c. Water boiling time
   - The time taken to boil 100 ml of water was measured using a stopwatch/hour.
   - Time taken to reach the boiling point (100 ^{o}C) of 100 mL of water.

FINDING AND DISCUSSION

Finding

The briquettes have been made from a mixture of cassava peel charcoal powder and styrofoam adhesive and then carried out a natural drying process for 3 days. Furthermore, the physical and mechanical properties of the obtained briquettes were tested. To determine the characteristics of the briquettes, it is necessary to measure the physical and mechanical parameters, including briquette mass, combustibility test, and water boiling time test. The optimum application of briquettes is through the combustion process with the combustion power test. The results can be seen in the table.

1. Yield of Cassava Peel Briquettes

The average value of briquette yield aims to determine the mass of briquettes produced after the briquetting process. The amount of briquettes produced will be compared to the mass of cassava peel before the manufacturing process and expressed in kg. The results of the cassava peel briquetting process can be seen in Table 1.

Table 1. Mass of Briquettes/Kg of Cassava Peel

Experiment	Mass of Cassava Peel	Mass of Briquettes Produced (Kg)
1	1 Kg	0,15
2	2 Kg	0,31
3	3 Kg	0,47
Average Briquette Mass (Kg)		0,16

2. Fuelability Test

Briquettes are burned to observe their ignition properties, such as the length of time for initial ignition (self-burning time) and the length of the flame until it becomes ash (burning time). This test was conducted to determine the effect of burning time on the combustibility of one piece of briquette produced. Based on Table 4.2, It can be seen that the fastest self-burning time is in experiment 3, with a burning time of 67 minutes and 02 seconds. As for the longest self-burning time, that is in experiment 2, with a long burning time of 67 minutes and 5 seconds.

Table 2. Burning power of cassava peel briquettes

Experiment	Number of Briquettes	Burning Time (Minutes)
1	1 Piece	67,3
2	1 Piece	7,5
3	1 Piece	67,2
Average Burn Time		67,3

3. Boiling Time Test

The fastest water boiling time test value in experiment 1 was 1 minute, 05 seconds. While the value of the longest water boiling time test in experiment 3 was 1 minute, 8 seconds,.

Table 3. Boiling Time of 100 mL of Water

Experiment	Water Volume	Briquette Mass	Boiling Time (Minutes)
1	100 mL	100 grams	1,05
2	100 mL	100 grams	1,07
3	100 mL	100 grams	1,08
Average Boiling Time (Minutes)			1,07

Discussion

a. Burning Power

The test results in Table 2 indicate that the best results for combustibility were obtained in Experiment 3. The average burning time in Table 2 was 67.3 minutes. The second-best result was in experiment 1, with a combustibility value of 67.3 minutes. The results of this study are in accordance with research conducted by Sirajuddin (2021), which states that the combustibility in question is the ratio between the amount of material in the briquette that burns and the time used during the briquette combustion process. Combustion is influenced by air cavities, so if the material has a large cavity due to its low density, more material will burn.

b. Analysis of Time to reach boiling point of water

The purpose of determining the time to reach the boiling point of water is to find out how long it takes for cassava peel waste biochar briquettes to reach the boiling point of water (100 °C) from 100 ml of water. In this activity, the time to reach the boiling point of water ranged from 1.05 to 1.08 minutes (Table 3). The time taken to heat 100 ml of water to boiling was conducted to determine the length of time the briquettes burned until the water boiled. Observations used 100 g of briquettes. Based on the results of observations made on the time to reach the boiling point of water, as shown in Table 3, Based on Table 3, it can be seen that the fastest boiling time is found in experiment 1, which is 1 minute 05 seconds, while the longest boiling time is found in experiment 3, which is 1 minute 08 seconds. The results of this study are in accordance with research conducted by Widyastuti (2013), which states that for the calorific value (water boiling point temperature and burning rate) of porous blotong briquettes, through objective observations, the quality of heat produced is higher or hotter, so that the water cooking process is much faster to boil.

CONCLUSION

Based on the results of the research and discussion, it is concluded that cassava peel waste can be processed into charcoal briquettes and activated charcoal. The resulting charcoal briquettes can be effectively used as alternative energy to replace fuel oil and gas. This research also shows that the use of Styrofoam as an adhesive material for making cassava peel briquettes gives good results, with briquettes that are not brittle and have optimal adhesive strength. This signifies the great potential of utilizing waste and alternative materials to produce environmentally friendly and sustainable energy sources.

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