

Optimization of Making Charcoal Briquettes from Rice Husks with Variations in the Composition of Adhesive Materials and Compaction Pressure

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ABSTRACT

This study was done to find a way to turn the rice husk trash. This study aims to generate high-quality briquettes by optimizing the composition of adhesive materials and compaction pressure during the production of briquettes from rice husks. This study's methodology was an experimental one. Testing briquette quality involves measuring their moisture content (%), ash content (%), and calorific value (cal/g) in accordance with SNI 01-6235-2000, which is the standard for briquette quality. The conclusion is briquette samples with a 70:30 composition of charcoal and adhesive and high compaction pressure are the most ideal samples, as evidenced by the fact that they passed the moisture content test and created products with the lowest ash content and highest calorific value.

INTRODUCTION

Located in Pandeglang Regency, Banten Province, Cikeusik is a subdistrict. In the province of Banten, Cikeusik is renowned for producing a fair amount of rice. The majority of residents in Cikeusik District work as farmers and depend on agricultural products as their primary source of income because it has a very vast paddy field. Despite being a large-scale rice producer, the Cikeusik community has not fully utilized the natural resources from rice agricultural goods, particularly in the use of the remaining rice milling process, specifically the use of rice husks as high-value products. Until now, rice husks have only been utilized as animal feed, planting medium for aesthetic plants, or even as rubbish that is simply thrown away.

One of the renewable energy options that is now growing in popularity as a replacement for firewood and fossil fuels is charcoal briquettes. One of the agricultural wastes that has the potential to be used as a starting point for the production of charcoal briquettes is rice husks. However, to create charcoal briquettes of high quality from rice husks, the right adhesive and compression pressure are needed. Briquettes are fuels made from biomass that have been compressed and densified to create a product that is generally tiny, irregular in size, and difficult to utilize in its original form. Briquettes can take the place of coal and firewood. (Hambali et al, 2007).

Sulistiyanto (2006) claims that there are three different sorts of briquettes based on the raw ingredients that make them up: coal briquettes, bio-coal briquettes, and biobriquettes. This bioricket is further broken down into two categories: carbonized biobriquettes, also known as charcoal briquettes, and non-carbonized biobriquettes, which are produced without the use of combustion. One kind of briquette that undergoes a carbonization or authoring process before being compacted to increase quality is charcoal briquettes. The type of charcoal powder, its specific gravity, fineness, carbonization temperature, pressing pressure, and carbonization rate are the variables influencing the characteristics of charcoal briquettes. (Kurniawan dan Marsono, 2008: 31).

As a guide for the charcoal briquette quality parameter test that we conducted, we used SNI standard No. 1/6235/2000, the specifications of which are provided in the accompanying table.:

Table 1. SNI Standard No1/6235/2000

No.	Parameter	SNI Standard
1.	Water Content (%)	≤ 8
2.	Ash Content (%)	≤ 8
3.	Calorific Value (cal/g)	≥ 5.000

Based on a substance's dry weight and wet weight, its water content is calculated. Another crucial attribute is water content. If the mold has a high moisture content, the energy needed for combustion will be utilized to evaporate the moisture, which might reduce the briquettes' calorific value and jeopardize their stability. Briquettes of charcoal are susceptible to severe fungal development. (Miharja, 2018).

All briquettes contain minerals, which are quantifiable by their residual weight after being completely burned. Ash is the term for this substance that is left. When briquettes are burnt, ash on them causes a crust to form on the surface of the charcoal, which is highly unfavorable. Additionally, non-gray briquettes might impact the qualities of other briquettes, such as fixed carbon. Briquettes with a high ash content and strong alkaline oxidation can not only cause crusts to form during combustion in the form of slag and fouling, but they can also have a lower calorific value and lower quality. (Faizal dkk., 2015). Heat is energy that travels as a result of temperature changes. The temperature at which heat transfers from an object with a high temperature to an object with a low temperature determines the direction of heat flow.

The employment of various adhesive materials in the creation of charcoal briquettes from rice husks has been the subject of several prior investigations. For instance, Theo Ardianto Utomo's research from 2019 demonstrates that using tapioca flour as an adhesive result in briquettes with a better calorific value and good durability than those made with sago flour and molasses. Jaksen M. Amin's research from 2023 found that differences in the composition of rice husks and adhesives had an impact on the amount of moisture, ash, flying compounds, and fixed carbon. Additionally, the more water that is present in briquettes, the more flying particles there will be, the higher the carbon content, and the greater the requirement for fuel. Therefore, in this study, variations in the composition of adhesive materials must be considered to find the optimal composition in producing charcoal briquettes from quality rice husks.

Another important element in the production of charcoal briquettes is compaction pressure. The impact of compaction pressure on the chemical and physical characteristics of charcoal briquettes has been investigated in a number of research. According to research by Muh. Arafatir Aljarwi et al. (2020), the calorific value and combustion rate produced increased with increasing pressure. According to research by Johan Priatna (2019), variations in the printing pressure used to make briquettes have an impact on their physical characteristics. The higher the printing pressure used to make briquettes, the higher the density value and the better the bonds between the particles, which enable the briquettes to maintain their shape when subjected to compressive forces during distribution.

Due to this, it is quite pertinent and intriguing to study the optimization of producing charcoal briquettes from rice husks with variations in adhesive content and compaction pressure. To find the ideal circumstances for producing charcoal briquettes from rice husks, optimization study on the process was conducted using modifications in adhesive content and compaction pressure. In order to make charcoal briquettes of high quality, this research intends to optimize the composition of adhesive materials and compaction pressure during the production of charcoal briquettes from rice husks. This study is anticipated to help create rice husk charcoal briquettes that are high-quality, sustainable, and environmentally benign and can aid in resolving environmental issues related to agricultural waste. Additionally, this study can serve as a guide for business and society to produce charcoal briquettes of high quality from rice husks.

METHODOLOGY

By performing trials through the subsequent steps, research methods for improving the production of charcoal briquettes from rice husks with variations in adhesive content and compaction pressure are carried out:

1. Prepare tools and materials

Prepare the appropriate equipment and rice husk material that has been heated or carbonated in cans to create husk charcoal. This material has been dried with a moisture content of less than 10%. Additionally, prepare the tapioca flour, which will be used as the glue.

Tools needed:

- Gas stove
- Cans/barrels
- Mixer
- Charcoal Collider
- 60 Mesh Screen
- Transparent Lid Pan
- Gram Scales
- Briquette Mold
- Container / Tampah
- Portable Gas Cylinder 230g
- Portable Gas Torch
- *Infra Red* Thermometer

Ingredients needed:

- Dry Rice Husk
- Tapioca Flour
- Water

2. Briquette making

Rice husk charcoal flour and adhesive with variations in the composition ratio between husk charcoal and tapioca flour is mixed with hot/boiling water after the rice husks have been carbonated, mashed, and filtered through a 60-mesh screen. Then, create briquettes using different low, medium, and high compaction pressures.

The following table illustrates how many samples the rice husk briquette mold may produce – up to nine:

Table 2. Briquettes Sample

Husk Charcoal Composition with Adhesive	Compaction Pressure Variations		
	Low	Medium	High
70:30	A1	A2	A3
80:20	B1	B2	B3
90:10	C1	C2	C3

3. Drying Process

After the charcoal briquettes are formed, then the charcoal briquettes must be dried to reduce their moisture content. Charcoal briquettes can be dried naturally by the sun drying method, which is by drying in the sun for 4-5 days. After drying, charcoal briquettes can be stored in suitable conditions to avoid insect or fungal attacks.

4. Charcoal Briquette Quality Testing

To determine whether the charcoal briquettes produced are in accordance with the anticipated standards or have not met the standards, the quality of the charcoal briquettes that have been produced is tested, including moisture content, ash content, and calorific value.

a. Water Content Test

Based on a substance's dry weight and wet weight, its water content is calculated. Another crucial attribute is water content. If the mold has a high moisture content, the energy needed for combustion will be utilized to evaporate the moisture, which might reduce the briquettes' calorific value and risk their stability. Calculating the percentage moisture content, or %MC, enables one to determine the moisture content of briquettes:

$$\% \text{ Water Content} = \frac{b-c}{b} \times 100\%$$

Information:

b = mass of sample before oven / heated (g)

c = mass of sample after oven / heated (g)

b. Ash Content Test

The byproduct of burning briquettes is ash. Silica, one of the components of ash, has a negative impact on the calorific value of briquettes. If the material used to make the briquettes is first carbonized, the number of components added to the composition will affect how much ash is in the final briquettes. This is due to the fact that the carbonization process wastes a lot of the content that many materials have. Briquettes' ash content can be determined by multiplying the percentage ash content, i.e.:

$$\% \text{ Ash Content} = \frac{c}{a} \times 100\%$$

Information:

c = mass of ash (g)

a = mass of sample before ashing (g)

c. Calorific Value Test

Heat is energy that travels as a result of temperature changes. The temperature at which heat transfers from an object with a high temperature to an object with a low temperature determines the direction of heat flow. Calorific Value is a measurement of a fuel's thermal energy and a key element in evaluating fuel costs. The quantity of heat energy that each kilogram of fuel may emit when burned entirely.

According to (Haliday, 1985 in Soelaiman 2013: 17), type C heat, a property of a substance, is the heat capacity of an object's mass union. When items of mass m must be heated, with heat type c, the temperature must rise from initial temperature T1 to T2, as shown below, where the type of heat is a constant. The amount can be estimated by doing the following:

$$Q = m.c.\Delta T$$

Information:

Q = the amount of heat released (J)

m = mass of a substance given heat (kg)

c = heat type of substance (J/kg°C)

ΔT = increase/change in substance temperature (°C)

Calorific Value = $\frac{Q}{\Delta m}$

Q = the amount of heat released (J)

Δm = Change in briquette mass before and after combustion

5. Data Analysis and Optimization

Following quality testing, we examine the information obtained to be descriptively analyzed using tables and graphs and compare it to the SNI briquette quality standards until we identify the most advantageous comparison of adhesive composition and compaction pressure for producing charcoal briquettes from rice husks.

6. Presentation of Research Results

Research results are presented in the form of reports that can be published in scientific journals or seminars. The presentation of the results of this research aims to contribute to the development of science and technology in the field of making charcoal briquettes from rice husks. By performing trials through the subsequent steps, research methods for improving the production of charcoal briquettes from rice husks with variations in adhesive content and compaction pressure are carried out

7. Data Analysis and Optimization

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8. Presentation of Research Results

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RESEARCH RESULT

In order to test briquettes for water content, ash content, and calorific value, they must first be dried using the sun drying method or by relying on the sun's heat for five days. Testing for water content is used to determine how much water is still present in briquettes. This water is trapped in the husk charcoal particles, which cannot be fully dried out, and a small amount of water is also trapped in the tapioca flour used as the adhesive.

The unburned portions of the briquettes that have lost their carbon elements have to be identified by measuring the ash concentration. The ash concentration is inversely correlated with the amount of inorganic materials in the briquettes. Briquettes' calorific value is tested in order to assess their production quality. Briquettes' calorific value can also be used to assess their viability as an alternative fuel.

At the MTs Negeri 6 Pandeglang Science Lab, tests on moisture content, ash content, and calorific value were separately performed. The results of each sample's rice husk briquette test are shown in the table below:

Table 3. Test Results of Water Content, Ash Content, and Calorific Value of Briquette Samples :

No	Sample	Types of Testing	Value	SNI Standard	Description
1	A1	% Water Content	4.67	< 8%	Meet SNI Standards
		% Ash Content	31.53	< 8%	Does Not Meet SNI Standards
		Calorific Value (kal/g)	366.07	> 5.000 kal/g	Does Not Meet SNI Standards
2	A2	% Water Content	4.33	< 8%	Meet SNI Standards
		% Ash Content	30.08	< 8%	Does Not Meet SNI Standards
		Calorific Value (kal/g)	279.62	> 5.000 kal/g	Does Not Meet SNI Standards
3	A3	% Water Content	4.26	< 8%	Meet SNI Standards
		% Ash Content	29.87	< 8%	Does Not Meet SNI Standards
		Calorific Value (kal/g)	394.23	> 5.000 kal/g	Does Not Meet SNI Standards
4	B1	% Water Content	3.92	< 8%	Meet SNI Standards
		% Ash Content	34.65	< 8%	Does Not Meet SNI Standards
		Calorific Value (kal/g)	322.58	> 5.000 kal/g	Does Not Meet SNI Standards
5	B2	% Water Content	3.82	< 8%	Meet SNI Standards
		% Ash Content	35.66	< 8%	Does Not Meet SNI Standards

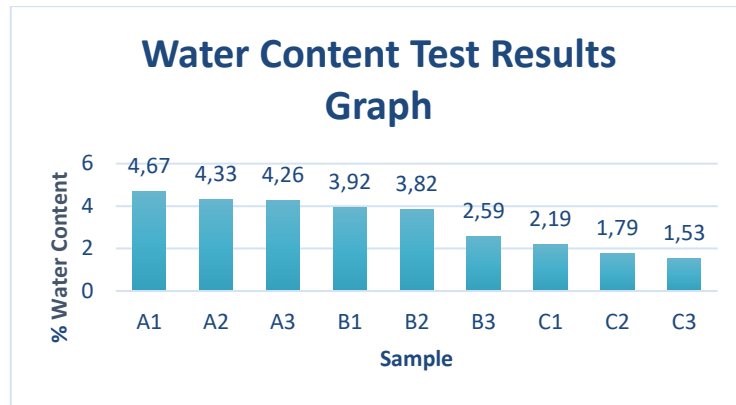
		Calorific Value (kal/g)	330.65	> 5.000 kal/g	Does Not Meet SNI Standards
6	B3	% Water Content	2.59	< 8%	Meet SNI Standards
		% Ash Content	31.06	< 8%	Does Not Meet SNI Standards
		Calorific Value (kal/g)	341.66	> 5.000 kal/g	Does Not Meet SNI Standards
7	C1	% Water Content	2.19	< 8%	Meet SNI Standards
		% Ash Content	39.5	< 8%	Does Not Meet SNI Standards
		Calorific Value (kal/g)	250	> 5.000 kal/g	Does Not Meet SNI Standards
8	C2	% Water Content	1.79	< 8%	Meet SNI Standards
		% Ash Content	39.3	< 8%	Does Not Meet SNI Standards
		Calorific Value (kal/g)	262.5	> 5.000 kal/g	Does Not Meet SNI Standards
9	C3	% Water Content	1.53	< 8%	Meet SNI Standards
		% Ash Content	36.23	< 8%	Does Not Meet SNI Standards
		Calorific Value (kal/g)	269.73	> 5.000 kal/g	Does Not Meet SNI Standards

DISCUSSION

The findings of the tests for the water content, ash content, and calorific value will then be used to further discuss the following:

a. Water Content

Briquettes will be hard to burn due to their high water content, which hinders the combustion process because the water molecules in the material must first be eliminated before the substance can burn. Briquettes will be simple to burn during testing due to their low water content. This is in line with the findings of Ismayana's (2011) study, which found that briquettes must have a low water content in order to have a high calorific value and be simple to pre-burn. The following briquette Water Content test result graph shows the results of the water content test.:



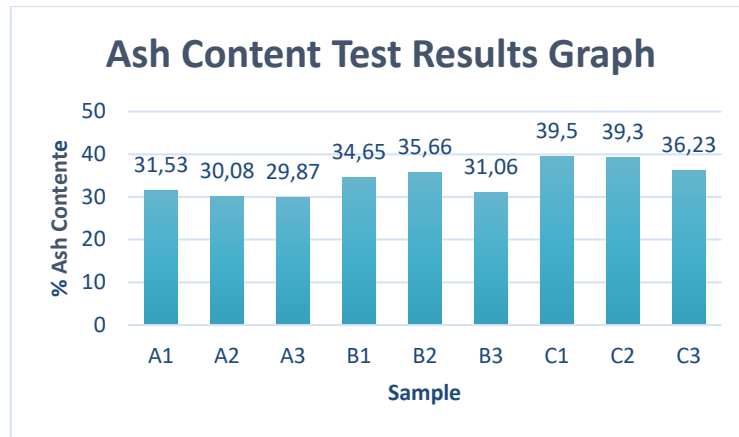
Picture.1 Diagram Water Content Test Results Graph

It is clear from the graphic data above that the A1 briquette sample, which has a composition of rice husk charcoal and adhesive 70:30 and low compaction pressure, has the greatest Water Content of 4.67%. While C3 briquette samples with a composition of rice husk charcoal and adhesive 90:10 and high compaction pressure exhibit the lowest Water Content of 1.53%. Due to the substantial amount of tapioca adhesive employed in the material's construction, briquettes have a high-water content. In keeping with Maryono's (2013) research, which indicates that the water content is increased by increasing the starch concentration. This is because charcoal is easily absorbed by water and air because it lacks moisture resistance and has starch sticky qualities.

These findings also lead us to the conclusion that the water content of all briquette samples generated complies with the Indonesian National Standard (SNI), which states that the water content of briquettes should not exceed 8%. This demonstrates that using the sun to dry things for five days produced the best outcomes.

b. Ash Content

The higher the adhesive content, the higher the Ash Content produced. In addition, the high Ash Content is also influenced by the high content of inorganic ingredients found in tapioca flour and rice husks. Although the adhesive material provides additional ash to the briquettes, the adhesive material must still be used because briquettes that do not use adhesive materials have low density so briquettes will be easily destroyed so it is difficult to use as fuel. High ash content will cause scale and can reduce the quality of the briquettes produced because it will reduce the Calorific Value and burning rate of briquettes. The results of the Ash Content Test of Rice Husk Charcoal Briquettes can be seen in the following Ash Content test result graph:



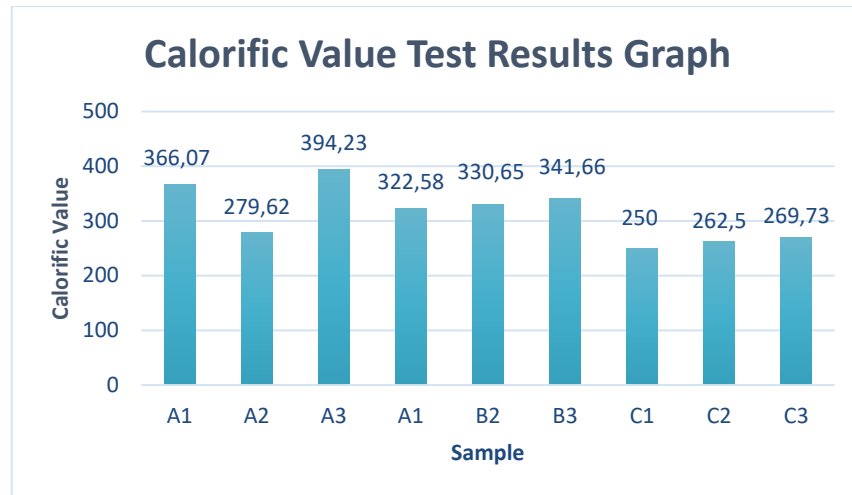
Picture. 2 Ash Content Test Results Graph

As can be observed from the graphic data of the ash content test results above, the entire briquette sample generated does not match the Indonesian National Standard (SNI), which states that ash content briquettes should have a maximum of 8%. The C1 sample yielded the highest ash content, which was 39.50%, while the A3 sample yielded the lowest ash content, which was 29.87%. The quantity of rice husk charcoal mass used affects the briquettes' high Ash Content. According to Ismail and Waliudin (1996), rice husks contain 50% cellulose, 30% lignin, and 15-20% silica by weight. The amount of Ash Content produced is significantly impacted by the high silica content of the husks. The more silica there is in the material, the more ash is formed on the briquettes.

c. **Calorific Value**

Briquette production may result in a reduction in the raw material's calorific value in addition to an increase in calorific value. Because there is less bonded carbon present, there is less charcoal present, which results in a loss in value. In addition, the use of adhesives causes Calorific Value to fall due to the inclination of adhesives that have low Calorific Value.

Triono (2006) asserts that a number of factors affect both high and low calorie values. The first factor is raw materials, as each one will undoubtedly have a different calorific value depending on its properties. Carbonization is another component that impacts the calorific value; the lower the calorific temperature, the lower the calorific value will be because the higher the levels of water, ash, and vaporizing agent are, the higher the calorific value will be, but the lower the bound carbon content is, the lower the calorific value will be. The following graph shows the outcomes of the Calorific Value Test of Rice Husk Charcoal Briquettes:



Picture.3 Calorific Value Test Results Graph

From the graphic data of the Calorific Value test results above, it can be seen that the Calorific Value in all samples of rice husk charcoal briquettes made does not meet the briquette quality standards based on SNI No. 01-6235-2000, which is $>5,000$ cal / g. The highest Calorific Value was obtained from sample A3 with Calorific Value of 394.23 cal / g and the lowest was sample C1 with Calorific Value of 250 cal / g. Due to the extremely high Ash Content in all samples, Calorific Value is much below SNI. Because silica minerals, which make up the majority of ash, have a negative impact on the calorific value produced, the quality of briquettes decreases as the ash content rises. Ash is a non-combustible material that remains in solid fuels after combustion and associated reactions are complete, according to Jamilatun (2011). Ash can lower the calorific value of solid fuel, which will lower the quality of that fuel.

CONCLUSIONS

All samples examined did not meet the requirements of SNI No.1/6235/2000, it may be inferred from the findings of the research that has been done. Although all samples passed the test for water content and fulfilled the criteria, none of the samples passed the tests for ash content and calorific value. It is also clear from the test findings that the A3 sample had a different composition of the adhesive material and the best compaction pressure. When compared to other samples, the husk charcoal and adhesive mixture, which has a 70:30 ratio, has the highest calorific value, the smallest ash level, and water content that meets standards. Crust will result from high ash content, and it can also lower the calorific value and burning rate of the briquettes, which will lower their quality. The water content of the briquettes will decrease and their calorific value will increase as the compaction pressure increases.

ADVANCED RESEARCH

In this study, due to limited equipment, researchers only used simple tools to measure the water content of briquettes, the ash content of briquettes and the calorific value of briquettes. The tools for printing briquettes are still very simple. It is recommended to future researchers that in order to maximize research results and more accurate measurements, use standardized tools such as printing machines, machines measuring water content, ash content and heating value. In further research, we also recommend that because the silica content of the husk is very high, it is recommended to add other ingredients such as corn cobs, wood shavings, palm kernel shells.

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