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Research Article

Making Briquettes Variation Ingredient Durian Peel, Husk Rice, and Shell Coconut -- Impact on Strength, Burnability, Temperature, and Calorific Value

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Abstract.
The study aims to develop and test the characteristics of briquettes made from durian skin with a mixture of various compositions conducted that obtained briquettes from ingredients such as 100% durian peel, 100% husk rice, 100% shell coconut, 50% durian peel and 50 % shell coconut, 70% durian peel and 30% shell coconut, 50% durian peel and 50% husk, 70% durian peel and 30% husk, and 30% durian peel and 70% husk. Have been tested for variable endurance after dropping from a height of 180 cm as influenced by variation mixture that results in the test obtained the missing mass by consecutive 0.1 gr, 10 gr, 15.8 gr, 3.6 gr, 0.3 gr, 0.4 gr, 0.4 gr, 0.4 gr, 0.3 gr, and 0.4 gr. Test time burning by consecutive are 174 minutes, 120 minutes, 502 minutes, 410 minutes, 376 minutes, 406 minutes, 380 minutes, 367 minutes, and 280 minutes. The resulting calorific value consecutive are 105.8 kcal /kg, 124.9 kcal /kg, 135.3 kcal /kg, 38.2 kcal /kg, 121.5 kcal /kg, 59 kcal /kg, 95 kcal /kg, 128.4 kcal /kg, and 128.4 kcal /kg.

Keywords: briquettes, durian peel, husk rice, shell coconut

1. INTRODUCTION

Nonrenewable energy consumption contributes to greenhouse gas emissions and accelerates resource depletion. In this framework, the use of agricultural and industrial solid residues such as rice husk, coconut shell, wheat straw, sugar cane bagasse, sawdust, wood shavings, and forest residue, among others, as an alternative energy source to reduce the use of fossil fuels has been extensively investigated [1–3]. Despite the fact that a large number of rice husks are generated, it is one of the agricultural

leftovers that is used the least to generate electricity in poor countries. Around 134 million tonnes of rice husks are produced globally each year, with 90% of them being burned in the open air or dumped into rivers and oceans to be disposed of [4].

Indonesia is a country rich in agricultural crops with the potential to be utilized as biomass-based renewable energy. There is a potential capacity of 50,000 MW, but only 320 MW, or 0.64 percent, of that capacity, has been used [5]. Palm oil, rice mill waste, wood, poly-wood, sugar mill waste, cacao, and other agricultural waste all have biomass potential in Indonesia that is already being exploited. Durian peel is a waste that isn't extensively used yet in this scenario. Indonesia produces 683,232 tons of durian per year. Many types of high-quality durian are available not only in Indonesia but also from imports, which increased from 2004 to 2010. The majority of durian shell waste is exclusively used as a source of energy.

Although the production of non-traditional briquettes has become more prevalent in recent years, conventional briquettes have shown to be less efficient in terms of industrial and home applications due to limited characteristics and low thermal efficiency due to the single fuel ingredient. As agricultural science advances and the necessity for briquettes with acceptable thermal quality becomes apparent, new combinations of accessible agro-waste ingredients are developed with good thermal and calorific qualities and their use results in high-quality briquette manufacture. Briquette materials that have been widely used are coconut shells, rice husks, coconut husk, wheat straw, sugar cane bagasse, sawdust, wood shavings, and forest residue. Coconut shell is the most widely used material because of its quality and availability. Not many people use durian peel to make briquettes, even though in Indonesia many areas produce durian fruit in abundance. So it is necessary to analyze the quality of briquettes from this durian skin material and its combination with coconut shells and rice husks.

Briquetting is the process of densification of residues into a high-density product that can be used for heat-generating in households and small-scale home enterprises, as well as power generation in large companies [6]. The science of compaction of loose material is used by the majority of civilizations on the planet for fuel production [7]. Briquettes' potential for heat and electricity production was identified during the first and second world wars [8]. Sawdust and other waste materials are becoming denser in Europe and America as a result of fuel constraints. The screw extrusion technique was created and invented in Japan in 1945, and by 1969, there were 640 facilities in the country [9]. Briquetting is an industrial process that began in the second half of the nineteenth century. Much has changed in today's world.

Briquette is a biomass-based energy source that can be made from residential, agricultural, and industrial waste streams. Briquettes are a sustainable, environmentally beneficial, healthy, and non-fossil fuel alternative. Charring feedstock before pelletization into briquettes has been shown to increase calorific value while lowering combustion emissions [10]. To improve their potential to replace firewood, charcoal, and fossil as home cooking and heating fuels, charred briquettes must be produced at a low cost and in large quantities. Biomass briquettes have a lower carbon footprint and are superior to alternative cooking fuels such as wood in terms of heat output per unit mass, moisture content, and storage space [11]. According to Bonsu et al. [12], the correct use of briquettes can assist mitigate climate change impacts by reducing over-reliance on wood for home and commercial heating. Briquetting agricultural wastes can also help to enhance sanitary conditions.

Indonesia is one of the three largest durian-producing countries in the world [13]. Indonesia is one of the countries that add to this list by producing millions of tons of durian per year. With this abundant wealth, of course, it also produces abundant durian skin waste as well. This durian skin waste has not been utilized properly. So this research turns durian waste that is not utilized into charcoal briquettes that can be used as fuel. Briquettes that have been widely developed, especially on a large scale, usually come from coconut shells and rice husks, because these materials produce good quality briquettes and are also abundantly available. Therefore, this study aims to determine the potential of charcoal briquettes from durian peel, coconut shells, rice husks, and their combination. The results of this study will be seen in terms of strength, burnability, temperature, and calorific value which can then be utilized depending on the need for the use of charcoal briquettes.

2. RESEARCH METHOD

2.1. Materials

Durian peel, coconut shells, and rice husks were collected from Serang City, Banten Province, Indonesia, which is one of the non-depleted durian producing areas in Indonesia. These raw materials are frequently dumped, resulting in public nuisance and pollution. The study team gets the raw materials for free because they have little commercial value and are easily available. However, it is projected that as briquette production and sales expand, raw materials will no longer be available for free. Meanwhile, coconut shells and rice husks have been widely traded in the form of charcoal, because they

have been widely used by the community. So that researchers can directly proceed to the grinding process.

2.2. Production of Briquettes

Durian peel material is requested from the durian seller for free, then it is cut into small pieces and then dried in direct sunlight for 3-4 days and then burned in a barrel. Coconut shells and rice husks are purchased in a state of charcoal. The stages of making and testing briquettes are presented in Figure 3.

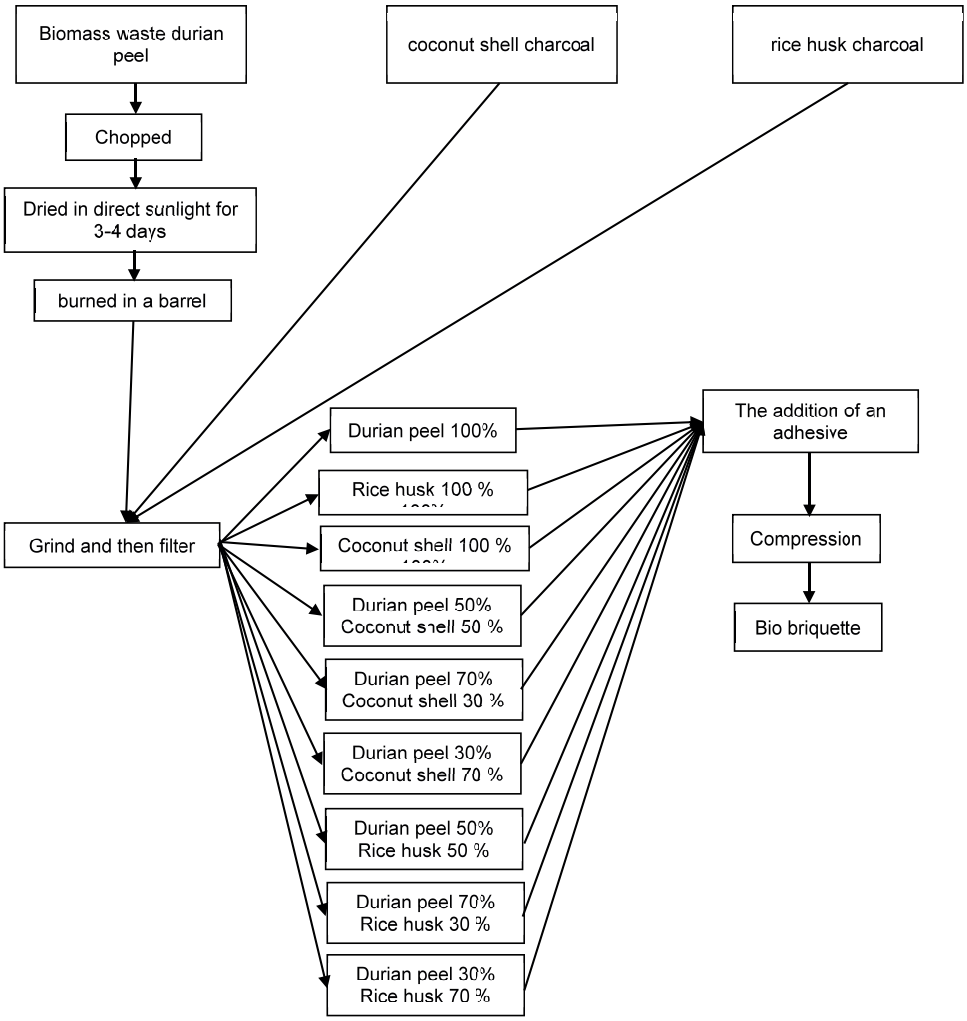

Figure 1: Flow chart of the manufacture bio briquette.

2.3. Data Analysis

The drop test was carried out to determine the strength of the briquettes. The mass of the briquettes to be tested is measured first. Briquettes are dropped from a height of 180

cm. After the test is complete, the briquettes (largest chunks) are weighed again. The procedure for calculating the number of missing particles uses the following equation:

$$missing\ particles = \frac{m_a - m_b}{m_a} x100\%$$

Where, m_a = initial weight of briquettes (kg)

m_b = final weight of briquettes (kg)

The procedure for testing the combustion power is to heat and weigh the specimen until it runs out and record the required time. The temperature of the briquettes is recorded every 1 minute from the temperature of the water above it until the briquettes burn out. The calorific value is measured using the equation:

$$Q = mc\Delta T$$

Where, Q = caloric value (J)

m = water mass (kg)

c = specific calorific value of water (J/kg˚C)

ΔT = temperature change (˚C)

3. RESULTS AND DISCUSSION

3.1. Strength of Briquette

Drop test aims to find out how much resistance or strength the briquettes are when hit by a hard object. This property is useful during the process of packaging, distributing, and storing briquettes [14]. Particles released from the main body of the briquette become a measure of the strength of the briquettes. The few particles that are released indicate that the briquettes are resistant to impact. The percentage of mass lost after the briquette is dropped at a height of 180 m can be seen in Figure 2.

Coconut shells 100% had the most mass loss. While the durian peel 100% had the least mass loss. So in terms of strength, durian skin briquettes have the best strength.

3.2. Burnability of Briquette

Burning power measurement to see the length of time the briquettes can last when continuously heated. This measurement is certainly very necessary for consumers who need fuel for a longer time. Therefore the fuel power of each briquette can be seen in

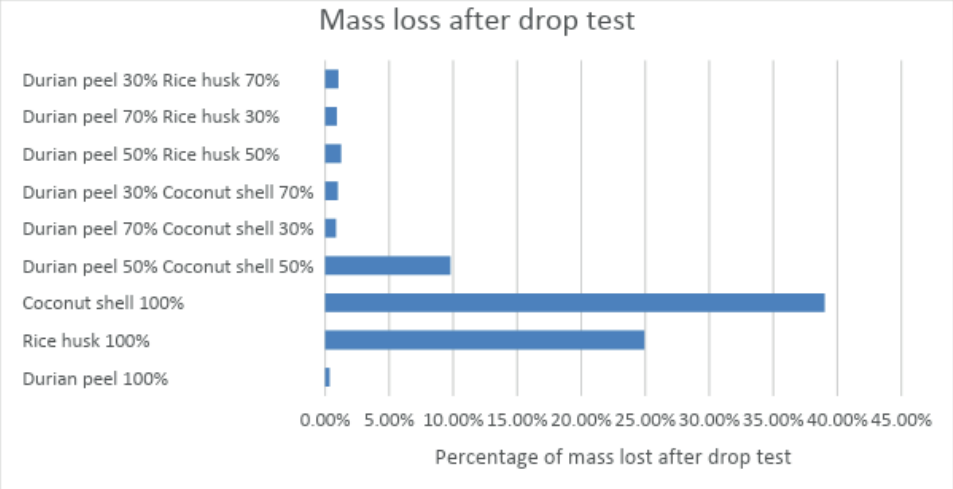

Figure 2: Mass loss after drop test.

Figure ??. A mixture of 50% durian peel and 50% coconut shell has the longest burning time. Meanwhile, 100% rice husk briquettes run out faster when burned.

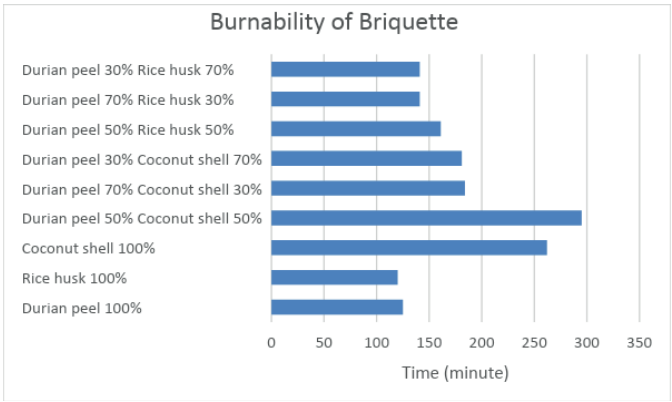

Figure 3: Burnability of briquette.

3.3. Water Temperature of Heating Briquettes

The measurement of the temperature of the water heated by the briquettes provides information on the rate of combustion produced by the briquettes. The temperature of the water after burning the briquettes can be seen in Figure 4. It can be seen that a mixture of 30% durian peel and 70% rice husk produces a fast burning rate.

3.4. Caloric Value

The calorific value describes the amount of heat released during combustion of a specified amount. The higher calorific value takes into account the latent heat of

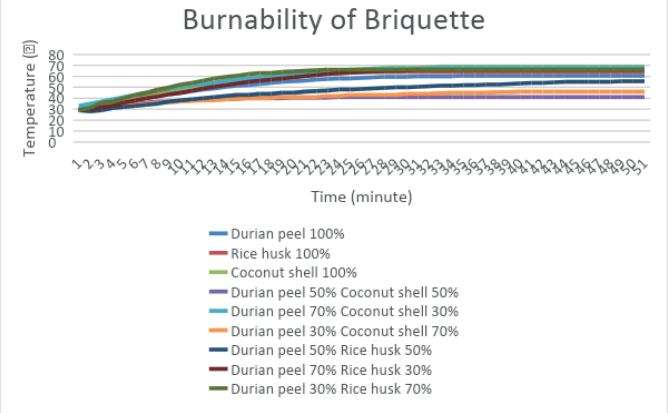

Figure 4: Water temperature of heating briquettes.

vaporization of water in the combustion products, and is useful in calculating heating values for fuels where condensation of the reaction products is practical. The calorific value in Figure 5 shows that 100% coconut shell has the greatest calorific value, followed by a mixture of 70% durian peel and 30% rice husk, the same as 30% durian peel and 70% rice husk.

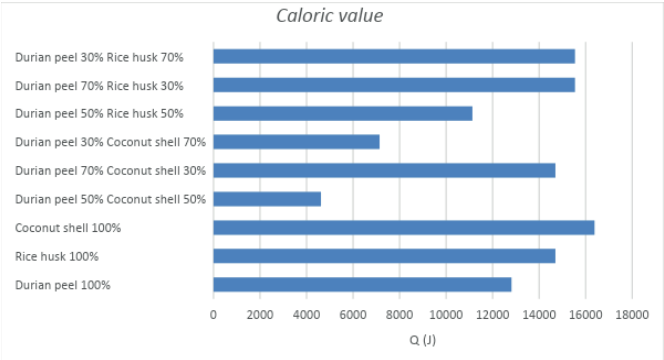

Figure 5: Caloric value.

4. CONCLUSION

This study was conducted to measure the Strength, Burnability, Temperature, and Calorific Value of briquettes made of 100% durian peel, 100% husk rice, 100% shell coconut, 50% durian peel and 50% shell coconut, 70% durian peel and 30% shell coconut, 50% durian peel and 50% husk, 70% durian peel and 30% husk, and 30% durian peel and 70% husk. The best strength of briquettes is from durian peel 100% while the worst is from 100% coconut shells. The longest burning time is achieved with a mixture of 50% durian skin and 50% coconut shell, but 100% rice husk briquettes burn out faster. In heating water, a mixture of 30% durian skin and 70% rice husk produces

a fast burning rate in heating the water. The calorific value 100% coconut shell has the greatest, followed by a mixture of 70% durian peel and 30% rice husk, the same as 30% durian peel and 70% rice husk. From this data can use briquettes that are tailored to user needs.

References

[1] Akolgo GA, Essandoh EO, Gyamfi S, Atta-Darkwa T, Kumi EN, Maia CM. The potential of a dual purpose improved cookstove for low income earners in Ghana – Improved cooking methods and biochar production. Renew Sustain Energy Rev. 2018;82:369–79.

[2] Awodumi OB, Adewuyi AO. The role of non-renewable energy consumption in economic growth and carbon emission: evidence from oil producing economies in Africa. Energy Strategy Reviews. 2020;27:100434.

[3] Kemausuor F, Kamp A, Thomsen ST, Bensah EC, Østergård H. Assessment of biomass residue availability and bioenergy yields in Ghana. Resour Conserv Recycling. 2014;86:28–37.

[4] Quispe I, Navia R, Kahhat R. Life cycle assessment of rice husk as an energy source. A Peruvian case study. J Clean Prod. 2019;209:1235–44.

[5] Pambudi NA. "Energi alternatif itu bernama biomassa," http://alpensteel.com/article/51-111-energi-lain/279-energi

[6] Oladeji JT, Enweremadu CC. The effects of some processing parameters on physical and densification characteristics of corncob briquettes. International Journal of Energy Engineering. 2012;2(1):22–7.

[7] Nhuchhen DR, Abdul Salam P. Estimation of higher heating value of biomass from proximate analysis: A new approach. Fuel. 2012;99:55–63.

[8] Rousset P, Caldeira-Pires A, Sablowski A, Rodrigues T. LCA of eucalyptus wood charcoal briquettes. J Clean Prod. 2011;19(14):1647–53.

[9] Kanti BP. Biomass gasification and pyrolysis: Practical design and theory. Oxford: Elsevier Academic Press; 2010.

[10] Obeng GY, Amoah DY, Opoku R, Sekyere CK, Adjei EA, Mensah E. Coconut wastes as bioresource for sustainable energy: quantifying wastes, calorific values and emissions in Ghana. Energies. 2020;13(9):2178.

[11] Jnanesh DN. "Analysis of various characteristics of coconut leaves as a biomass briquette.," In: *Advances in Mechanical Engineering Science* (2016).

[12] Osei Bonsu B, Takase M, Mantey J. Preparation of charcoal briquette from palm kernel shells: case study in Ghana. Heliyon. 2020 Oct;6(10):e05266.

[13] Pratiwi M. “3 negara penghasil durian terbesar di dunia, nomor 2 juaranya,” https://lifestyle.sindonews.com/read/743969/156/3-negara-penghasil-durian-terbesar-di-dunia-nomor-2-juaranya-1649999093, (2022).

[14] Fretes EF, Wardana I, Sasongko MN. Karakteristik pembakaran dan sifat fisik briket ampas empulur sagu untuk berbagai bentuk dan prosentase perekat. Jurnal Rekayasa Mesin. 2013;4(2):169–76.