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The Impact of Composition and Type of Material on the Characteristics of Fuel Briquttes

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The significant energy need for alternative fuels is caused by the increasingly depleting fossil fuels. One alternative material that has the potential to be used as a substitute for fuel is agricultural waste. This research was conducted to determine the characteristics of briquettes by varying the composition of rambutan skin charcoal and coconut shell charcoal. Briquettes are made from coconut shells and rambutan skin. Molasses is used as a charcoal adhesive. Briquettes are made in the laboratory using a carbonization process using a furnace. . Variations in the composition of rambutan skin and coconut shell charcoal are 10:90, 20:80, 30:70, 40:60, 50:50, 60:40, 70:30, 80:20, and 90:10. This article was conducted to study the calorific value, water content, ash content, and fixed carbon briquettes from coconut shell charcoal and rambutan skin. The results showed that mixing coconut shell charcoal and rambutan skin increased the calorific value and ash content. The best composition is 10:90 for rambutan skin and coconut shell charcoal with a calorific value of 6297.09 cal/gram.

1. Introduction

Current energy needs continue to increase and continue to increase, while to meet demand, they still depend on fossil fuels, whose availability is starting to run out. This needs to be done alternatively to meet fuel needs, namely looking for renewable energy sources that are efficient, cheap and easy to obtain (Suttibak and Loengbudnark, 2018; Kongprasert *et al*., 2019). Biomass energy is a form of renewable energy source that is easily obtained and abundant. Biomass is fuel obtained from agricultural, forestry, or organic waste. Some examples of materials that can be made as biomass fuel are used wood, fruit peel residues, forest remnants, sawdust, rice husks, and agricultural waste residues (Brunerová *et al*., 2018).

Biomass fuel in several countries in the African continent has increased the use of charcoal. Even in Ghana, 97% of the population, 67% still depend on charcoal (Olatunji et al. 2021; Song et al. 2020). The main advantages of briquette fuel are less volume, cheap transportation costs, complete fuel combustion, not easily damaged and easy to store (Wang *et al*., 2018). In Indonesia, the availability of agricultural waste is very supportive to meet the demand for biomass fuel as a substitute for coal, which is starting to decrease (Kan *et al*., 2016).

Some examples of agricultural waste that have the potential to be used as raw material for biomass fuel are sugar cane peel (Ayuningtiyas *et al*., 2020), durian peel, bintaro peel, and sugarcane bagasse (Mirzayanti et al. 2021). The availability of this leather waste is abundant, and the calorific value obtained is above 5000 cal/gram, meaning it has a calorific value above coal. An economic feasibility analysis has been carried out for this use and shows that making briquettes from agricultural waste is economically feasible with a return on capital of 3.42 years and a net profit of 147.402 €/year (Sahoo et al. 2018). Investigation of the combination of biomass raw materials, modification, composition can also improve the quality of the briquettes produced.

One of the important parameters that influences the quality of briquettes from quality analysis is composition. The results as reported by (TT et al. 2022). reduce the water content by 1.5% and can also increase the ash content by more than 10%. Apart from that, the material used as raw material can also influence the analysis of briquette quality(Srinivasan et al. 2022). This is also directly related to the calorific value of the briquettes, so it is necessary to set the right composition and use good raw materials to produce the best quality briquettes.

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Based on the brief description above, it is necessary to study the influence of the composition of charcoal raw materials from coconut shells and rambutan skin waste. Coconut shell charcoal, which has a high calorific value, can increase the economic value of abundant rambutan shell charcoal, thereby reducing the volume of waste in the environment and also improving the quality of briquettes.

2. Method

2.1 Research Material

This study uses coconut shell and rambutan peel waste materials as raw materials for biomass, which will be used as charcoal. The adhesive used is molasses, which is a waste from the sugar manufacturing process

2.2 Equiment

The leading equipment in this research is a furnace muffle as seen in figure 1, and this tool is used for the carbonization process and a manual briquette press with the UNP (U-Channel) type.

2.3 Research Prosedure

This briquette is made using coconut shell and rambutan peel. The coconut shell and rambutan peel were dried before the pyrolysis process to reduce the water content to ±10%. The two dried skins are put into the furnace for pyrolysis processing. Coconut shells were carbonized at 450°C, and rambutan shells at 400°C. The charcoal obtained was reduced to a particle size of 100 mesh. Variations in composition between rambutan peel charcoal and coconut shell were 10:90, 20:80, 30:70, 40:60, 50:50, 60:40, 70:30, 80:20, and 90:10. Gluing is done by adding 20% molasses. The printing process uses a manual briquette press with the UNP (U-Channel) type. The resulting briquettes are 2 x 3 cm in size. The resulting briquettes are tested; the tests carried out are water content, ash content, fixed carbon, ignation time, burning rate (Fikri & Sartika, 2018), water vaporizing capacity and calorific value.

3. Result and Discussion

The composition of charcoal from coconut shells and rambutan skin dramatically influences the quality of briquettes. The results indicate that the more mass ratio of coconut shell charcoal composition can increase the calorific value. In general, the briquettes produced meet the standards of SNI 01-6235-2000. The resulting product is presented in figure 2 with a diameter of 20 cm, a thickness of 10 cm and a weight of 90 gr.

Figure 1: furnace muffle

Figure 2: briquette

3.1 Moisture content

The Moisture content in a briquette is a parameter that affects the quality and has an inverse relationship with the calorific value. This means that the moisture content is low, and the calorific value is high. In addition, the moisture content also affects the density, durability, and storage. The moisture content obtained by varying the coconut shell charcoal and rambutan peel composition is below 5%. In Figure 3. it can be seen that the high composition of rambutan charcoal can increase the moisture content in the briquettes. The lowest water content is 4.05% at a composition of 10:90 for rambutan peel charcoal: coconut shell charcoal.

3.2 Ash content

Briquettes from coconut shell charcoal and rambutan peel are higher than coal briquettes. High ash content depends on the type of biomass raw material used because of the chemical content contained, such as calcium, magnesium, sodium, iron silica, and copper. Ash content is an undesirable component in the combustion process. This is because it can cause slag deposits in combustion equipment and also reduce the calorific value of the briquettes(Mendoza Martinez et al. 2019). The ash content presented in Figure 4 was the lowest at 4.83% at 10:90 rambutan shell charcoal: coconut shell charcoal and the highest at 90:10 rambutan shell charcoal: coconut shell charcoal at 15.94%.

3.3 Fixed carbon

The content also influences high fixed carbon in the charcoal raw material used; a high value indicates good fuel quality. The fixed carbon value is directly proportional to the heating value, so high fixed carbon can cause a longer burning time (Kpalo et al. 2021). The proximate analysis results show that the highest fixed carbon value is 52.36% and the lowest is 33.97%, which can be seen in Figure 5.

3.4 Calorific value

The calorific value obtained based on Figure 6 shows that the highest calorific value of briquettes is from coconut shell charcoal and rambutan shell charcoal, which is 6297.09 cal/gram. The calorific value obtained shows that briquettes with the main ingredients from coconut shell charcoal and rambutan peel waste have the potential to be used as briquettes. A high calorific value indicates better fuel quality (Trubetskaya et al. 2019). This correlates with the content of bound carbon in the briquettes.

3.5 Ignation Time

Table 1 shows the ignition timing for the composite variations. Based on the results, the reduced content of the coconut shell can reduce the ignition time. This shows that the pores formed by the presence of rambutan peel are increasingly open, which causes air cavities to enter (Magnago *et al.*, 2020). The lowest ignition time occurred at a ratio of 90:10 coconut shell rambutan skins, namely 2 minutes, while the highest ignition timing occurred at a ratio of 10:90 coconut shell rambutan peel, namely 10 minutes.

3.6 Burning Rate

The burning rate increased with the amount of rambutan peel, as shown in Figure 7. The burning rate ranged from 5 – 13 minutes, lower than that obtained for the composite of bagasse powder and rice husk, which was 29 – 46.4 minutes. The decrease in the burning rate was caused by the increased porosity of the briquette charcoal, which occurred with the addition of rambutan peels (Islam *et al.*, 2014).

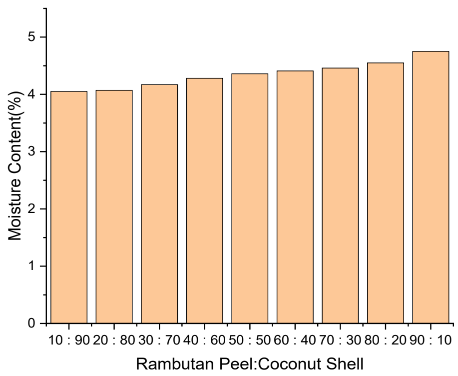


Figure 3: Graph of Comparison of Composition and Moisture Content

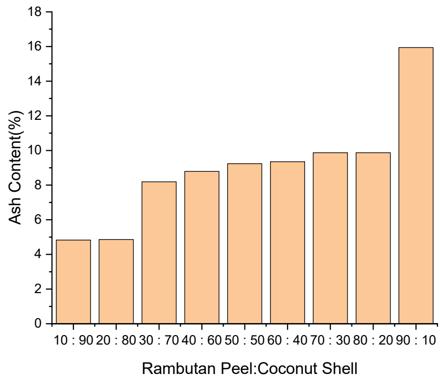
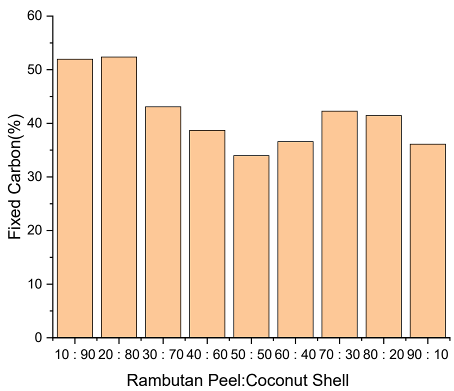


Figure 4: Graph of Comparison of Composition and Ash Content



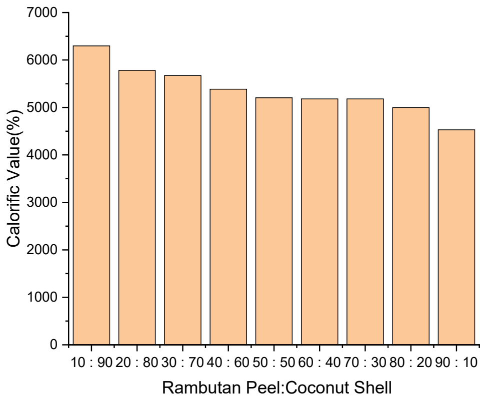


Figure 5: Graph of Comparison of Composition and Fixed Carbon

Table 1: The ignition time for the produced composite briquettes

Composition	*Ignition Time*
90:10	*2*
80:20	*3*
70:30	*4*
60:40	*5*
50:50	*6*
40:60	*7*
30:70	*8*
20:80	*9*
10:90	*10*

3.7 Water vaporizing capacity

An illustration to show the evaporation capacity of water is presented in Figure 8 (Oyelaran et al. 2018). The results showed that the highest water evaporation capacity was in the ratio 10 : 90 of coconut shell rambutan peels, namely 0.93l/kg. The lowest is 90:10 coconut shell rambutan skin, which is 0.41 l/kg. The material used can affect the water vaporizing capacity, because coconut shell charcoal contains a lot of carbon chains.

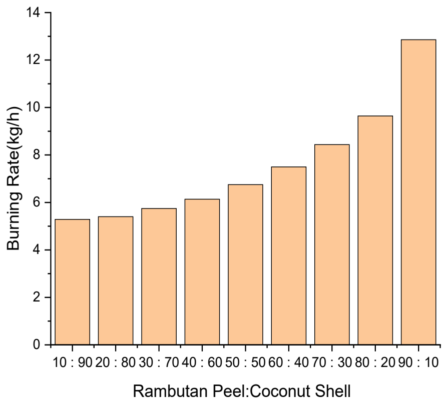


Figure 7: Graph of Comparison of Composition and Burning Rate

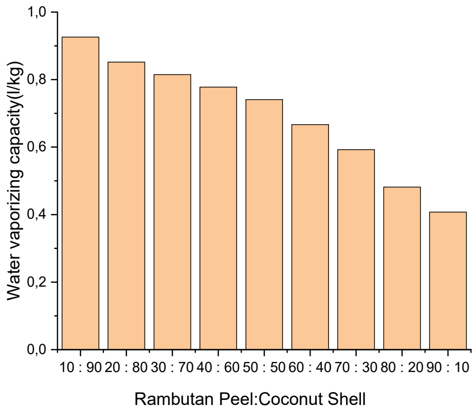


Figure 8: Graph of Comparison of Composition and Water Vaporazing Capacity

4. Conclusions

The tested coconut shell charcoal briquettes refer to the SNI standard 01-6235-2000 for water content, ash content, fixed carbon, and calorific value. For the parameters that have been tested, the ash content parameter does not meet the SNI standard. The best composition was obtained at 10:90 for rambutan skin and coconut shell. This composition has the best water content characteristics of 4.05%, Fixed carbon 52.36%, calorific value 6297.09 cal/gram, ignition time 2 minutes, burning time 13 minutes, and evaporation capacity of water 0.93l/kg. One of the steps that can be tried to improve the quality of the carbon content is to rearrange the composition of the mixture of raw materials and adhesives used. Methods and technology need to be developed to optimize the quality of briquettes**.**

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