The effect of the percentage of alaban waste and rice husk waste with tapioca adhesive on the physical properties

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Abstract. Tapuk Village, Limpasu District, Hulu Sungai Tengah Regency is one of the processing centers for alaban wood charcoal in South Kalimantan. The alaban wood charcoal produced by Tapuk Village consists of several grades, namely: grade A, grade B, Grade C, and Grade D. Grade D charcoal is small pieces of charcoal which are leftovers from large charcoal, often called alaban wood charcoal waste. Around Tapuk Village, there are also many residents' rice fields, where almost all year round there are piles of rice husks that are not used by the residents. The benefits of alaban wood charcoal and rice husk waste can be increased by making it into briquettes. The percentage of briquettes waste of alaban wood charcoal and rice husks, namely 100%: 0%, 90%: 10%, 80%: 20%, 70%: 30%, 60%: 40%, 50%: 50%, 40%: 60%, 30%: 70%, 20%: 80%, 10%: 90%, and 0%: 100%. Briquettes also use 5% tapioca starch adhesive. The briquettes are then tested for their physical properties. From testing and analysis, it is known that the moisture content, ash content, and volatile matter content increased along with the increase in the percentage of rice husks. The content of bound carbon (fixed carbon) and heating value decreased along with the increase in the percentage of rice husks.

Keywords: Charcoal Waste, Husk, Physical Properties

1. Introduction
Energy use will continue to increase with increasing numbers of the population in the world, while the source of that energy is used rapidly supplies are running low. Of the 7.63 billion world population, it is estimated as much as 40% use wood, charcoal, and coal for their daily needs. This resulted in the level of destruction of the world's forests as much as 3% annually and is likely to continue to increase. By nature non-renewable coal and time-consuming wood to be able to grow, the scarcity of resources will likely occur if no alternative method to produce energy is found.

Apart from causing energy scarcity, increasing world population as well leading to increased waste production. The increasing need for housing residents result in less and less temporary land available land for landfililing also continues to increase. To solve these two problems, briquettes are a solution that can be used. Apart from being cheap enough to produce, it is friendly environmental, saving and economical, higher heat, briquette ash can be used as fertilizer when compared to other solid fuels.

1.1 Alaban Wood and Rice Husk
One of the most familiar uses of alaban wood in the South Kalimantan area is as a raw material for making charcoal, as has been done by residents of Tapuk Village, Limpasu District, Hulu Sungai Tengah Regency. Based on the explanation of the head of the Tapuk Village, Mr. Ripansyah (Head of the Tapuk Village for the period 2015-2020), that the production of alaban wood charcoal from this village is ± 90 tons/week, which means that in 1 month this village produces approx. 360 tons of
alaban wood charcoal. Alaban wood charcoal is generally used for kitchens, restaurants, and small and medium-sized industries, among others, for grilling fish, bread, satay, and others. The composition of alaban wood charcoal in general, 85% - 95% carbon, and the rest is ash, water, nitrogen, and sulfur [4].

In the area around Tapuk Village, there are many residents' rice fields. When the harvest season arrives, there are many piles of rice husks that are not utilized and sometimes only burned by residents to be used as raw material for compost. The chemical composition of rice husks, namely moisture content (9.02%), crude protein (3.03%), fat (1.18%), crude fiber (35.68%), ash (17.71%), crude carbohydrates (33.17%), carbon (1.33%), and silica (16.98%) [5].

1.2 Briquettes
Briquettes are a source of energy derived from biomass which can be used as an alternative energy substitute, petroleum, and other energy derived from fossils. The raw material for briquettes can come from various kinds of biomass, from fruit peels [1], even to sawdust which becomes waste in frame factories [2]. Briquettes with good quality include properties such as a smooth texture, not easily broken, hard, safe for humans and the environment, and have good ignition properties. The properties of this ignition include flammability, long enough flame time, no soot, little smoke, and fast disappearance, and high calorific value. The percentage of briquette composition [3] and adhesive concentration are several factors that can affect the quality of the briquette.

1.3 Briquette Adhesives
To glue the substance particles in the raw material in the briquette-making process, a binder is needed so that a compact briquette is produced [7]. One of the ingredients commonly used as an adhesive is a starch adhesive consisting of corn starch, potato, tapioca, flour, sorghum, sweet potato, sago, and others.

Tapioca flour is made by extracting water from cassava tubers (cassava). After filtering, the liquid part is separated from the pulp. The filtered liquid is then precipitated. The precipitated part is then dried and milled to obtain fine white starch grains, which are called tapioca. Tapioca flour is often used as an ingredient in briquettes because it has several advantages, namely low cost, easy use, and can produce high dry adhesive strength and adhesives made from plants (organic) to produce relatively little ash [8].
2. Methods
This research was conducted on a laboratory scale with the main ingredients of alaban wood charcoal waste briquettes and rice husks using tapioca starch adhesive. testing using the SNI 01-6235-2000 standard. The stages of the briquette research process can be seen in Figure 2.

![Figure 2. Stages of the Research Process](image)

### Table 1. Adhesive composition

| Composition          | Tapioca Starch Adhesives |
|----------------------|--------------------------|
| Water (%)            | 12                       |
| Carbohydrate (%)     | 86.9                     |
| Protein (%)          | 0.5                      |
| Fat (%)              | 0.3                      |
| Energy (kalori)      | 362                      |

### Physical properties of briquettes:
1. Water content
2. Ash content
3. Levels of flying substances (volatile matter)
4. Carbon content is bound (fixed carbon)
5. Calorific value
Testing the physical properties of briquettes using proximate analysis, which consists of: testing the moisture content, ash content, volatile matter content, fixed carbon content, and heating value. This test was carried out at the Banjarbaru Industrial Research and Standardization Center.

3. Results and Discussion

3.1 Water content

The effect of the percentage of alaban wood charcoal waste and rice husk on the moisture content of briquettes is shown in Figure 3.

![Figure 3. Graph of Briquettes Water Content.](image)

Figure 3 shows an increase in the water content of briquettes occurs with the increase in the percentage of rice husks in briquettes. This occurs because the rice husks are still in their original condition in the form of agricultural waste and not processed into charcoal, so that the water content is still high, which is between 11.35 - 32.40 by weight% [9]. The adhesive added to the briquettes also has a role in increasing the water content of the briquettes, because the adhesive used is not dry but wet. The wet adhesive is easier to blend with the briquette raw material so that it increases the adhesion between the briquette grains but will also increase the moisture content. Apart from being influenced by raw materials and adhesives, the moisture content of briquettes is also influenced by environmental conditions, such as humidity, room temperature, sunlight intensity, and storage conditions.

Based on the quality standards of Indonesian wood charcoal briquettes, SNI 01-6235-2000, the maximum standard of water content is 8%, so the moisture content of alaban wood charcoal waste briquettes and rice husks is by SNI 01-6235-2000 standards, namely briquettes with code ABC1 - ABC11. The water content standard of the briquettes that has been made indicates that the waste briquettes of alaban wood charcoal and rice husks are suitable to be used as an alternative energy source.

3.2 Ash content

The effect of the percentage of alaban wood charcoal waste and rice husk on the ash content of briquettes is shown in Figure 4.
Figure 4 shows that the ash content of briquettes has increased as the percentage of rice husk in briquettes increases. This is because rice husks have a fairly large ash content, which is between 13.16-29.04 by weight [9]. Ash is the residual material from the combustion of briquettes that cannot burn anymore. High ash content affects the resulting calorific value, the higher the ash content, the lower the quality of the briquettes produced. Because there is silica in the ash which can reduce the heating value [1].

Based on the quality standards of Indonesian wood charcoal briquettes, SNI 01-6235-2000, the maximum standard of ash content is 8%, so the ash content of alaban wood charcoal waste and rice husk briquettes is by SNI 01-6235-2000 standards, namely briquettes with code ABC1 - ABC4. The fulfillment of the standard ash content of the briquettes that has been made indicates that the waste briquettes of alaban wood charcoal and rice husks are feasible to be used as an alternative energy source.

3.3 Levels of Flying Substances (Volatile Matter)
The effect of the percentage of alaban wood charcoal waste and rice husk on the levels of volatile matter of briquettes is shown in Figure 5.

Figure 5 shows the levels of volatile matter have increased along with the increase in the percentage of rice husks in briquettes. The level of flying substances is a substance (volatile matter)
that can evaporate as a result of the decomposition of compounds that are still present in briquettes other than water [3]. Compounds such as fiber (31.37 - 49.92% by weight), cellulose (34.34 - 43.80% by weight), and lignin (21.40 - 46.97% by weight) are mostly contained in rice husks and increasing the levels of volatile matter in the briquettes.

When processed into briquettes, briquette raw materials have not undergone a carbonization or charcoal process, it will produce high levels of volatile matter. This occurs because, during the carbonization or carbonization process, almost all levels of volatile matter from the material evaporate into the environment, leaving only most of the charcoal and other compounds that cannot be burned.

Based on the quality standards for Indonesian wood charcoal briquettes, SNI 01-6235-2000, the maximum standard of volatile matter is 15%, so the levels of volatile matter for alaban wood charcoal waste briquettes and rice husks do not exist which meets the SNI 01-6235-2000 standards. This shows the levels of the volatile matter of alaban wood charcoal waste briquettes and rice husks are still high so that further processing is needed for raw materials to reduce the levels of the volatile matter of briquettes.

3.4 Bonded Carbon Content (Fixed Carbon)

The effect of the percentage of alaban wood charcoal waste and rice husk on the fixed carbon content of briquettes is shown in Figure 6.

Figure 6 shows that the level of fixed carbon has decreased with the increase in the percentage of rice husks in briquettes. This happens because the composition of alaban wood charcoal, in general, is 85% - 95% carbon and the rest is ash, water, nitrogen, and sulfur [4]. So that if the more the percentage of rice husks in the briquette, the lower the fixed carbon content.

The content of bound carbon (fixed carbon) in briquettes is also influenced by the value of moisture content, ash content, and levels of flying substances. The levels will be of high value if the moisture content, ash content, and fly briquette content are low. The higher the carbon content bound to wood charcoal, it indicates that charcoal is good charcoal [1].

The quality standard of Indonesian wood charcoal briquettes, SNI 01-6235-2000 for the standard of fixed carbon content does not yet exist, but Figure 6 shows that the content of bound carbon (fixed carbon) briquettes of alaban wood charcoal waste and rice husks is quite high because some reach more than 50%. This indicates that briquettes are suitable for use as an alternative energy source.

3.5 Calorific Value

The effect of the percentage of alaban wood charcoal waste and rice husks on the heating value of briquettes is shown in Figure 7.
Figure 7 shows that the calorific value has decreased as the percentage of rice husk in briquettes increases. This occurs because the rice husks still have quite high water content, ash content, and volatile matter levels as shown in Figure 3 - Figure 5 which results in a decreased calorific value. The lower the water content, ash content, and volatile matter content, the higher the calorific value. Water content and volatile matter content affect because, during the briquette combustion process, the briquette heat energy will be used to evaporate water and volatile matter contained in the briquette. Ash content also affects because the ash content in the form of silica is a non-combustible impurity, causing clumping and blockage of the airflow in the fuel [10].

Table 2 shown the based on the quality standards of Indonesian wood charcoal briquettes, SNI 01-6235-2000 the minimum standard of heating value is 5000 cal / g, so the calorific value of alaban wood charcoal briquettes and rice husks is by SNI 01-6235-2000 standards, namely briquettes with code ABC1 - ABC5. The standard calorific value of the briquettes that has been made indicates that the waste briquettes of alaban wood charcoal and rice husks are suitable for use as an alternative energy source.

| Parameter                  | Wood Charcoal Quality Standards |
|----------------------------|---------------------------------|
| Water Content (%)          | Max. 8                          |
| Ash Content (%)            | Max. 8                          |
| Flying Substance Level (%) | Max. 15                         |
| Bonded Carbon Content      | Min. 77                         |
| Calorific Value (Cal / G)  | Min. 5000                       |

In Table 3, the difference between sample A and B is the type of binder that was used. Sample A was using tapioca flour while B was using sago flour. Figure 9 shows that the difference of the binder influenced the characteristics of the respected samples. The usage of tapioca flour as the binder increased the water content and volatile matter, because amylopectin in tapioca flour is higher than sago which result the former swelled more than the latter if both were heated with water [11]. Sago flour itself increased the ash content and fixed carbon which results increasing the calorific value of the briquette. Carbohydrate in sago flour is higher than tapioca, which in it contained cellulose as one of natural carbon source and is the main reason sago flour having more carbon than tapioca flour [12].
Table 3. Data of Average Results of Testing the Characteristics of Briquettes.

| Sample Code | Composition | Water Content (%) | Ash Content (%) | Volatile matter (%) | Fixed Carbon (%) | Calorific Value (Cal / G) |
|-------------|-------------|-------------------|----------------|---------------------|------------------|---------------------------|
|             | Charcoal Alaban (%) | 90 | 10 | 3.11 | 4.25 | 47.96 | 44.10 | 5.329 |
| A1          | Rice Husk (%)       | 70 | 30 | 3.20 | 6.56 | 52.00 | 38.10 | 5.094 |
| A2          | 50 | 50 | 3.38 | 10.37 | 57.22 | 29.15 | 4.542 |
| A3          | 30 | 70 | 6.19 | 13.12 | 63.48 | 17.20 | 4.185 |
| A4          | 90 | 10 | 6.25 | 16.67 | 65.70 | 11.36 | 3.635 |
| A5          | 90 | 10 | 0.54 | 4.70 | 42.02 | 52.73 | 5.828 |
| B1          | 70 | 30 | 0.60 | 7.31 | 47.50 | 44.58 | 5.218 |
| B2          | 50 | 50 | 0.72 | 11.73 | 50.75 | 36.79 | 4.809 |
| B3          | 30 | 70 | 1.16 | 14.51 | 54.69 | 29.63 | 4.264 |
| B4          | 90 | 10 | 1.14 | 16.85 | 64.03 | 17.71 | 3.710 |
| B5          | 90 | 10 | 0.54 | 4.70 | 42.02 | 52.73 | 5.828 |

4. Conclusion

Based on the results of the research and data analysis that has been carried out, it can be concluded that the moisture content, ash content, and volatile matter content increased along with the increasing value of rice husk percentage while the fixed carbon content and heating value is the opposite. The recommended composition is rice husk percentage below 40%, and the best is when using 100% alaban wood charcoal as the material based on Indonesian briquette quality standard. The composition mentioned before already qualified in all parameter except volatile matter. To reduce the high value of volatile matter, it’s recommended to carbonize the rice husk before the process starts.

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