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Analysis Of the Quality of Biobriquettes from Salak Skin with Starch Adhesive

Irving Josafat Alexander[1*], Gloria Sirait[2], Ramlan Silaban[3], Timotius Agung Soripada[4]

[1]Pendidikan Ilmu Pengetahuan Alam FKIP Universitas HKBP Nommensen
[2]Pendidikan Biologi FKIP Universitas HKBP Nommensen Pematangsiantar
[3]Jurusan Kimia Fakultas Matematika dan Ilmu Pengetahuan Alam Universitas Negeri Medan
[4]Pendidikan Kedokteran Fakultas Kedokteran Universitas Riau

e-mail: ***irving.alexander@uhn.ac.id**

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Abstract
This study aims to analyze the quality of biobriquettes made from salak skin with starch adhesive. Biobriquettes are one of the alternative fuel solutions that are environmentally friendly and can reduce organic waste. The analysis method used in this study is qualitative analysis. Salak fruit produces waste in the form of salak skin which is brownish and slightly prickly, then the salak seeds have a very hard texture which is black and brown. Salak seeds have a very hard texture so they are suitable as a basic ingredient for making briquettes The research method includes:the preparation stage of raw material for salak skin, carbonization stage of salak skin, adhesive material preparation stage and biobriquette quality analysis. From the research results, it can be concluded that both biobriquette samples, namely sample A (without adhesive) and sample B (with adhesive) have met the requirements of SNI No. 01-6235-2000 concerning charcoal biobriquettes.

Keywords: analysis, biobriquette, salak skin, starch adhesive, SNI No. 01-6235-2000

1. Introduction

Indonesia is the 4th most populous country in the world with a population of 278 million. This is directly proportional to the increasing need for energy. So that the need for fossil energy in Indonesia is increasingly confined (Iskandar et al, 2019). From the facts and data available, it shows that if the use of fossil fuels is approaching retirement, the amount of reserves will also continue to decrease, with unstable prices (Silaban et al, 2020). In addition, issues that fossil fuels are the cause of global warming and the cause of environmental damage have begun to be proven (Islamia et al, 2024). Fossil fuels are non-renewable energy and produce emissions, so if used continuously they will run out and have an impact on environmental damage (Siswanto et al, 2024). The high use of fossil fuels has significant environmental impacts, such as air pollution and global warming. Therefore, alternative energy sources that are environmentally friendly and renewable are needed

(Puspita et al, 2024). The development of alternative energy such as biobriquettes is in line with the government's efforts to diversify energy to strengthen national energy security (Silaban et al, 2021).

The need for alternative energy sources continues to rise as fossil fuel reserves dwindle and awareness grows about the environmental impacts of fossil fuel combustion (Kaur et al, 2017). One emerging solution is the use of biobriquettes, a renewable energy source made from organic biomass waste (Sinaga et al, 2024). Indonesia, as a tropical country with abundant natural resources, produces various organic wastes with potential for utilization (Sirait et al, 2023). Biomass is solid waste that can be converted into fuel. Raw materials from organic waste are one of the efforts to produce alternative energy (Silaban et al, 2021). Plantation and agricultural waste that originates from biomass, which has many alternative energy sources and has a high energy composition, can be converted into briquettes, which are solid and easy to transport alternative fuels (Abdillah et al, 2024).

Biobriquettes are defined as materials burnt in a solid, tasteful form; from remnants of organic material that has been undergo processing in a certain way (Sirait et al, 2024) . Biobriquettes have the potential to be a cheaper and more accessible alternative energy source for communities, especially in remote or developing areas (Alexander et al, 2023). The use of biobriquettes can help lower energy costs, while opening up new economic opportunities through the production and sale of biobriquettes from local waste (Silaban et al, 2024). Indonesia is known as one of the largest producers of salak in the world. However, this fruit also produces skin waste that has not been optimally utilized. The abundant salak skin waste can be an environmental problem if not managed properly (Alexander et al, 2024). Salak fruit produces waste in the form of salak skin which is brownish and slightly prickly, then the salak seeds have a very hard texture which is black and brown. Salak seeds have a very hard texture so they are suitable as a basic ingredient for making briquettes (Harahap et al, 2023).

This research offers significant novelty compared to previous research. Most prior studies on biobriquettes have focused on raw materials such as rice husks, sugarcane bagasse, and other agricultural residues (Noprianti et al, 2024). However, the utilization of salak skin waste as a raw material for biobriquettes remains underexplored, despite its abundance and frequent underutilization (Alexander et al, 2024). This study addresses the gap in the use of organic waste that has not been extensively studied, particularly regarding the physical and chemical properties of salak skin and their effects on biobriquette quality. This research also makes a specific contribution by examining the effectiveness of environmentally friendly starch-based adhesives as a sustainable alternative to synthetic adhesives, which are less eco-friendly. This addresses the need for solid fuel alternatives that not only reduce organic waste but also minimize environmental impact during production (Ariani et al, 2024). Furthermore, the analysis of product quality, including calorific value, ash content, and compressive strength, provides technical parameters that can serve as references for optimizing the production of biobriquettes from salak skin waste (Indah et al, 2024). Thus, this research contributes to the advancement of more efficient and sustainable biobriquette technology.

2. Methods

The analysis method used in this study is experimental qualitative analysis. The research method includes:the preparation stage of raw material for salak skin, carbonization stage of salak skin, adhesive material preparation stage and biobriquette quality analysis (Sirait et al, 2023).

2.1. Preparation stage of raw materials for salak skin

At this stage, the raw material for this research, namely the skin of the salak fruit, is cut into small pieces and then washed with distilled water to free it from impurity ions first, then the washed salak skin is dried in the sun for ± 5 days.

2.2. Carbonization stage of salak skin

In this carbonization stage, the raw material, namely the dried salak skin, is then burned until it becomes ash to produce biomass. From this ash, adhesive will be added for the next stage.

2.3. Adhesive material preparation stage

At the stage of making adhesive material, namely starch flour, there are various processes, namely as follows:

- Weighing 160 grams of starch flour using an analytical balance.
- Then, the weighed starch flour is poured into a beaker container that has been prepared in advance to be diluted with 200 mL of distilled water.
- Next, the mixture of starch flour and distilled water is stirred until smooth, then heated using a Bunsen heater until the mixture of starch flour and distilled water becomes thick.
- The final step, the salak skin in the form of ash from the previous carbonization is separated into 2 samples labeled "Sample A", namely the biobriquette sample without adhesive and "Sample B", namely the biobriquette sample to which adhesive has been added for further analysis.
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2.4. Biobriquette quality analysis

At this stage, an analysis test was performed on both biobriquette samples. This analysis includes ash level test, water level test, bound carbon test, and volatile matter level test. The results of the analysis were then compared with SNI No. 01-6235-2000 concerning charcoal biobriquettes. The Indonesian National Standard (SNI) No. 01-6235-2000 concerning biobrickets outlines the technical requirements for the production of biobrickets from biomass materials such as agricultural residues or other organic wastes. The theory supporting this standard focuses on the conversion of biomass energy into a form that is easy to use as an alternative fuel, reducing dependence on fossil fuels and mitigating greenhouse gas emissions. The biobrick production process also involves the compaction of materials to increase energy density, which facilitates storage and transportation and improves combustion efficiency (Alexander et al, 2024).

The design of this research can be seen in the following Figure 1.

Figure 1. Research Design Plan

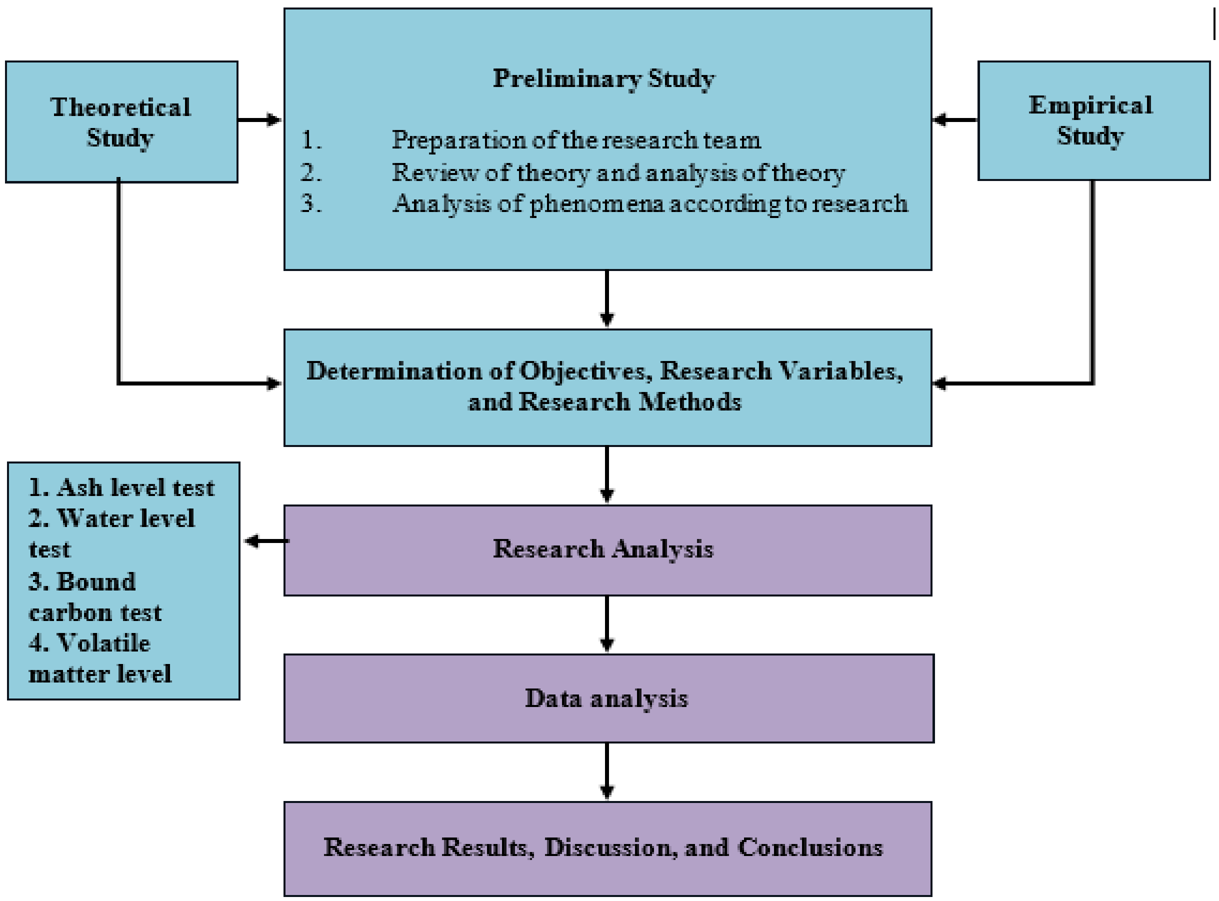


Table 1. Charcoal Briquette Standards

Properties of charcoal briquettes	Japan	England	USA	SNI
Water Level (%)	6-8	3,6	6,2	< 8
Volatile Matter (%)	15-30	16,4	19-28	< 15
Ash Level (%)	3-6	5,9	8,3	< 8

Bound carbon (%)	60-80	75,3	60	> 77
Density (g/cm^3)	1,0-1,2	0,46	1	-
Compressive density (g/cm^3)	60-65	12,7	62	-
Calorific value (cal/g)	6000-7000	7289	6230	> 5000

Reference : (Badan Penelitian dan Pengetahuan Kehutanan, 1994)

3. Result and Discussion

Biobriquette samples that have been divided into 2 samples, namely sample A (without adhesive) and sample B (with adhesive) were analyzed using ash content test, water content test, bound carbon test and volatile matter content test. The results of the analysis along with the discussion of the research are as follows with SNI No. 01-6235-2000 concerning charcoal biobriquettes.

3.1. Ash level test

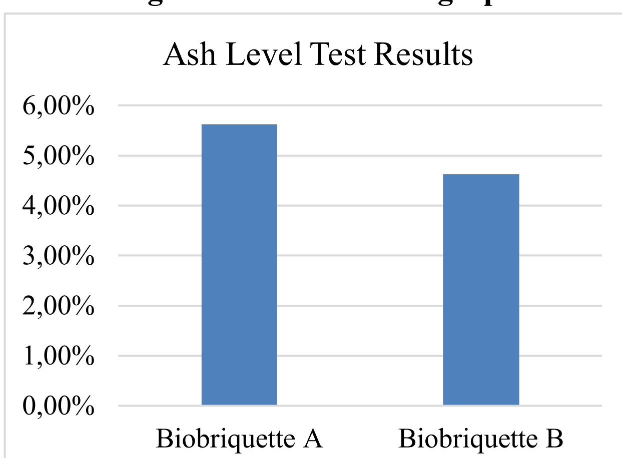
The results of the ash content analysis can be seen in the following table 2.

Table 2. Ash level test results

Sample	Ash level test results
Biobriquette A	5,91 %
Biobriquette B	4,57 %

Comparison of the analysis results of biobriquette samples A and biobriquette B can be seen in the following Figure 2.

Figure 2. Ash level test graph



From the research results, the results of the ash content test on the two biobriquette samples have met the requirements of SNI No. 01-6235-2000.

The difference in ash content between Biobriquette A (5.91%) and Biobriquette B (4.57%) can be attributed to several factors, including the raw material composition, adhesive used, and production process. Higher ash content in Biobriquette A could be due to variations in the mineral content of salak skin, which depends on environmental factors like soil quality (Putri et al, 2022). Additionally, the type of adhesive used may contribute inorganic components to the final product, as some starch-based adhesives have higher mineral content (Alexander et al, 2024). Furthermore, differences in drying, compression, or carbonization temperatures could also affect the ash content, as incomplete drying or lower temperatures might leave more residual minerals (Sari et al, 2021).

3.2. Water level test

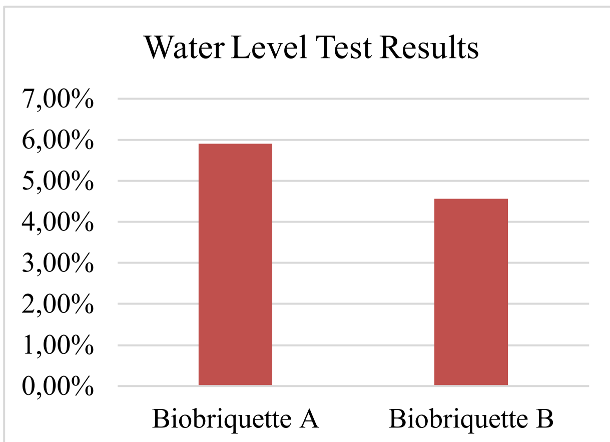
The results of the water content analysis can be seen in the following table 3.

Table 3. Water level test results

Sample	Water level test results
Biobriquette A	5,62 %
Biobriquette B	4,63 %

Comparison of the analysis results of biobriquette samples A and biobriquette B can be seen in the following Figure 3.

Figure 3. Water level test graph



From the research results, the results of the water content test on the two biobriquette samples have met the requirements of SNI No. 01-6235-2000. The difference in water content between Biobriquette A (5.62%) and Biobriquette B (4.63%) can be influenced by factors such as the moisture content of the raw materials and the drying process. If the salak skin used in Biobriquette A had higher initial moisture content or underwent less thorough drying, it would result in higher water content Additionally, the type and amount of adhesive used can absorb moisture, contributing to the water content. Inadequate drying during production can also lead to higher residual moisture, reducing combustion efficiency (Alexander et al, 2024).

The calculation of water content aims to determine the hygroscopic properties of each charcoal briquette from each type of wood. The water content of a briquette is determined by several factors. The higher the carbonization temperature, the faster the rate of water evaporation leaving the biomass (Haryono et al, 2021). The water content also affects how easy it is to burn the briquette.

The higher the water content, the more difficult it will be to ignite. Additionally, the type and concentration of adhesive used could also contribute to differences in water content. Some adhesives, especially natural starch-based ones, may absorb moisture, further increasing the water content in the final product (Kaur et al, 2017).

3.3. Bound carbon test

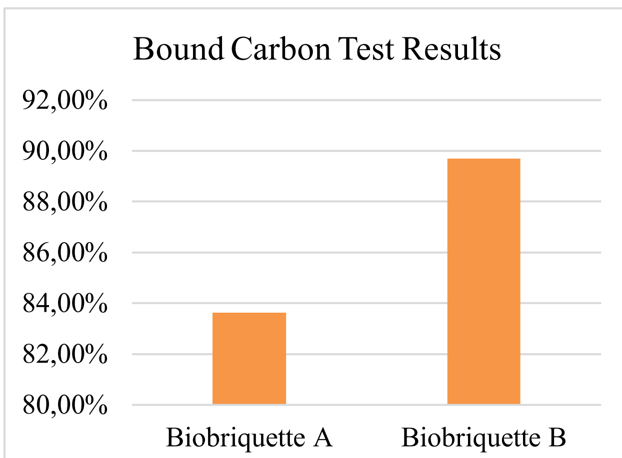
The results of bound carbon test analysis can be seen in the following table 4.

Table 4. Bound carbon test results

Sample	Bound carbon test results
Biobriquette A	83,62 %
Biobriquette B	89,71 %

Comparison of the analysis results of biobriquette samples A and biobriquette B can be seen in the following Figure 4.

Figure 4. Bound carbon test graph



From the research results, the results of the bound carbon test on the two biobriquette samples have met the requirements of SNI No. 01-6235-2000. The difference in bound carbon content between Biobriquette A (83.62%) and Biobriquette B (89.71%) can be influenced by factors such as raw material composition, production process, and adhesive used. Biobriquette B may have contained more carbon-rich salak skin or undergone better carbonization, leading to higher bound carbon. Additionally, higher compression or effective carbonization in Biobriquette B could retain more carbon, while lower-temperature processes in Biobriquette A may result in lower bound carbon The adhesive composition also plays a role, as some adhesives can reduce carbon content (Kaur et al, 2017). The adhesive used in each biobriquette may also impact bound carbon. Some adhesives,

depending on their composition, can introduce oxygenated compounds that may reduce the overall carbon content in the biobriquettes (Sari et al, 2021). Differences in adhesive composition or concentration between Biobriquette A and B could explain the variation in bound carbon levels.
High bound carbon content in biobriquettes will increase the calorific value, thus producing greater energy during combustion. In addition, bound carbon also affects the combustion time of biobriquettes, the higher the bound carbon content, the longer the combustion time, which means that biobriquettes are more efficient and produce more stable heat (Putri et al, 2024). The bound carbon content also helps reduce the amount of ash residue produced after combustion, thereby improving combustion quality and reducing pollution levels (Alexander et al, 2024).

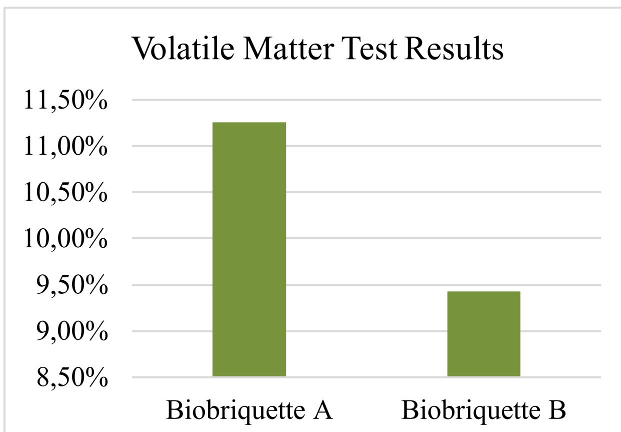
3.4. Volatile matter test

The results of bound carbon test analysis can be seen in the following table 5.

Table 5. Volatile matter test results

Sample	Volatile matter test results
Biobriquette A	11,26 %
Biobriquette B	9,43 %

Comparison of the analysis results of biobriquette samples A and biobriquette B can be seen in the following Figure 5.



From the research results, the results of the volatile matter test on the two biobriquette samples have met the requirements of SNI No. 01-6235-2000.
The differences in volatile matter content between Biobriquette A (11.26%) and Biobriquette B (9.43%) can be attributed to several factors, as reflected in the materials used and the production processes. High volatile content can increase combustion efficiency in the early stages, so that biobriquettes have a higher calorific value. However, too high volatile content can reduce combustion stability. Volatile matter also plays a role in initiating the combustion process (Agustina et al, 2024). Higher volatile content makes it easier for biobriquettes to ignite, but can cause faster and uneven combustion, reducing the combustion duration (Alexander et al, 2024).

One factor that could explain this difference is the type of adhesive used. Biobriquette A might contain a higher concentration or a different starch adhesive composition, which could increase the volatile matter. Research has shown that various organic adhesives, particularly those based on starch, can introduce additional volatile components when burned, influencing the overall volatile matter content (Pardede et al, 2024). Additionally, variations in the moisture content of the raw materials, such as salak skin, could play a role. Higher moisture content leads to higher volatile matter as the water evaporates during the combustion process (Alexander et al, 2024).
Furthermore, differences in the processing conditions, such as the drying method or compression pressure applied during biobriquette formation, could contribute to these variations. Lower compression pressures or insufficient drying might leave more residual moisture or unbound organic compounds, which would result in higher volatile matter (Sari et al, 2021). This difference in processing could affect the final structure and composition of the biobriquettes, leading to variations in their combustion characteristics.

This research holds significant relevance for both society and industry, particularly in the context of waste management and energy diversification. Salak skin waste, which is often underutilized, offers a practical solution for reducing the environmental impact of organic waste. By converting it into biobriquettes, this research provides a means to repurpose waste while supplying an affordable and eco-friendly alternative fuel source, especially for rural communities and areas with limited access to fossil fuels (Rahman et al, 2023). From an industrial perspective, the findings of this research present innovative opportunities in the renewable energy sector by utilizing abundant local raw materials. Biobriquettes made from salak skin have the potential to be developed as a sustainable energy source, reducing reliance on fossil fuels and supporting green economy initiatives (Pratama et al, 2022). Moreover, the use of natural starch-based adhesives further enhances the eco-friendly attributes of this product, making it more suitable to meet the demands of an increasingly sustainability-conscious global market (Nugroho et al, 2021),

4. Conclusion

From the analysis of the quality of biobriquettes made from salak skin with starch adhesive, it can be concluded that both biobriquette samples, namely sample A (without adhesive) and sample B (with adhesive) have met the requirements of SNI No. 01-6235-2000 concerning charcoal biobriquettes. The use of starch adhesive has also been proven to improve the quality of salak skin biobriquettes.
This research opens pathways for future research to refine and expand its findings. Further studies could optimize production parameters, such as compression pressure and adhesive concentration, to improve biobriquette quality. Investigating alternative natural adhesives like cassava starch or gum arabic may offer enhanced binding strength and sustainability. Additionally, life cycle assessments (LCA) could evaluate the environmental impact of production, while scalability and economic feasibility studies could support commercial applications. Testing biobriquettes in real-

world scenarios and exploring biomass blends with materials like sawdust could further enhance their energy efficiency and mechanical properties, advancing their role in sustainable energy development.

5. Acknowedgements

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