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Proximate Analysis of Palm Oil Waste Biobriquettes in East Kalimantan as an Alternative Energy Source in the Area Around the Nusantara Capital City-Indonesia

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ABSTRACT
Renewable energy is an alternative energy that the government is strongly promoting to support energy security in the future, one of which is biomass energy. Oil palm plantations are quite extensive plantations in Indonesia; in fact, in one plantation, 9,155,722 tons of palm oil shell waste can be obtained/per year. Large quantities of palm oil shells can be processed into bio briquettes, so they have high economic value. This research aims to determine the approximate analysis of Palm Oil Waste Biobriquettes in East Kalimantan as an Alternative Energy Source Around the IKN Area. This research was carried out using experimental methods by making bio briquettes with analysis results obtained through laboratory analysis, namely proximate analysis. From the proximate analysis carried out on two repetitions of tests carried out on palm shell bio briquettes, only the water content still does not meet the SNI 01-6235-2000 standard. Namely, it is still above 8%. Still, of the other three parameters tested, all three have met the SNI standards of each, namely ash content below 8%, volatile matter content below 15%, and the calorific value of each is in the Ministry of Energy and Mineral Resources category, namely in category 3 with a calorific value range of 4700-5600 cal/g and SNI 01-6235-2000 with minimum 5000 cal/g.

Keyword: Bio briquettes, Palm Kernel Shells, Calorific Value.

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INTRODUCTION

It is estimated that by 2035, there will be a significant increase in global energy consumption. The three primary sources of global energy are petroleum, coal, and natural gas, which collectively supply approximately 86% of the world's energy needs. Renewable energy sources, accounting for about 2%, include hydroelectric, geothermal, wind, solar, tidal, wave, and biomass energy (Sidabutar, 2018). Biomass energy refers to the energy stored in organic materials such as forests and agricultural products.

Renewable energy is an alternative energy source that is currently being heavily promoted by the government to support energy security in the future. Numerous efforts have been undertaken by the government to achieve the national goal of meeting domestic energy needs. As previously mentioned, biomass, as a renewable and sustainable energy source, has significant potential, estimated at 146.7 million tons per year. Additionally, the biomass potential derived from waste in 2020 was projected to reach 53.7 million tons. Increasing the utilization of biomass from waste can reduce global pollution levels by converting waste into a valuable energy resource.

The use of biomass is a more environmentally friendly option compared to fossil fuels, while also contributing to the reduction of total greenhouse gas emissions. Biomass resources can be found in every country across the globe. Various technologies are available to convert biomass into useful forms of energy (Tambaria & Serli, 2019). Numerous types of woody materials can serve as raw materials for charcoal briquettes, including rice husks, coconut shell waste, wood shavings, sawdust, tree leaves and branches, sugarcane bagasse, empty palm oil bunches, and others.

Briquettes are an alternative energy source that can replace traditional fuels. They are made from coal, organic waste, industrial waste, or urban waste by converting solid raw materials into a compacted form that is more effective, efficient, and easier to use. Bio-briquettes, in particular, are briquettes produced from raw materials derived from living organisms, specifically plant-based materials such as biomass (Parinduri & Parinduri, 2020).

Palm kernel shells are a type of waste that accounts for approximately 60% of palm kernel oil (PKO) production. A palm oil mill with a capacity of 100,000 tons of fresh fruit bunches per year will produce around 6,000 tons of palm kernel shells, 12,000 tons of fibers, and 23,000 tons of empty palm oil bunches. Palm kernel shells are the hardest part of the palm oil fruit, yet their utilization has not been fully optimized. They are primarily used as boiler fuel and as a material for filling potholes in palm oil plantations.

According (ANTARA News Kalimantan Timur, n.d.), palm oil plantations are widespread in Indonesia, one of which is located at P.T. TELEN in Kutai Timur Regency. This plantation processes 28,626,810 tons of fresh fruit bunches annually, resulting in 9,155,722 tons of palm kernel shell waste per year. Given this substantial amount, palm kernel shells can be processed into bio-briquettes, providing significant economic value.

Based on this perspective, the author conducted a study titled *Proximate Analysis of Bio-Briquettes from Palm Oil Waste in East Kalimantan as an Alternative Energy Source Around the Nusantara Capital City Area*. This research aims to determine the results of the proximate analysis of bio-briquettes from palm oil waste in East Kalimantan as an alternative energy source in the vicinity of the Nusantara Capital City.

METHODS

This study employs an experimental method. The research process involves the following steps:

The raw materials, consisting of palm kernel shells, were sourced from two locations near the Nusantara Capital City (IKN) area. The first sample (A1) was obtained from Long District, Paser Regency, while the second sample (A2) was collected from Muara Kembang, Kutai Kartanegara Regency. Both samples were sun-dried for approximately three days to reduce their moisture content. Sample A1 experienced a moisture reduction of approximately 0.3 kg, decreasing from an initial weight of 8.7 kg to 8.4 kg. Similarly, sample A2 showed a reduction from an initial weight of 7.9 kg to 7.7 kg, indicating a decrease of about 0.2 kg in moisture content. This demonstrates the effectiveness of the drying process in reducing the moisture content of the palm kernel shells.

The next step involves preparing an adhesive made from tapioca starch. The adhesive is created by mixing 10 g of tapioca flour with 1000 mL of water and then heating the mixture until it forms a starch glue.

Once the raw materials and adhesive are prepared, each raw material is carbonized in a furnace at a temperature of 600°C for 2 hours to produce charcoal carbon (Moeksin et al., 2017). After obtaining the charcoal carbon, the next step is to grind the material coarsely and then sieve it using a 100-mesh sieve.

The next step is mixing the charcoal carbon with a starch adhesive at a concentration of 10%, followed by molding the mixture into briquettes. After molding, the briquettes are dried in an oven at 80ºC for 48 hours (Kahariayadi et al., 2016). Once these processes are completed, proximate analysis and calorific value testing are performed on each bio-briquette sample, namely A1 and A2.

RESULTS AND DISCUSSION

The palm kernel shells that have undergone the treatment process are then subjected to analysis for each sample. Below are the results of the proximate analysis conducted on the two samples.

Table 1. Analysis Results of Palm Kernel Shells with Two Samples in the IKN Area

Samples	Output Parameters			
	Moisture Content	Ash Content	Volatile	Calorific Value
	(%)	(%)	(%)	(cal/g)
A1	10,37	6,07	13,06	4974,64
A2	8,94	5,47	11,95	5098,53
SNI*	8	8	15	5000

SNI = Indonesian National Standar (*Pdf-Sni-4931-2010-Briket-Batubara_compress*, n.d.)

Moisture Content

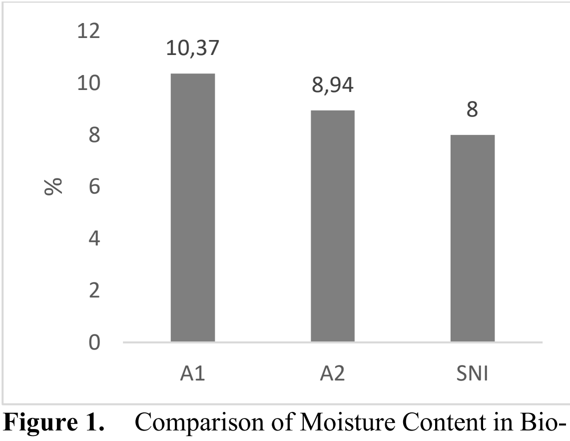

Figure 1. Comparison of Moisture Content in Bio-Briquettes

Based on Figure 1, the moisture content of the bio-briquettes does not meet the standard set by the Indonesian National Standard (SNI), which specifies a maximum value of 8%. Two tests conducted using the same raw material, palm kernel shells, showed lower moisture content in the second test, with a value of 8.94%, compared to the first test, which recorded a moisture content of 10.37%.

Moisture content significantly affects the quality of charcoal briquettes; lower moisture content leads to higher calorific value and improved combustion efficiency. During the study, the researchers used an adhesive with a relatively high water-to-starch ratio, which resulted in elevated moisture content in the produced bio-briquettes.

Charcoal has a high capacity to absorb moisture from the surrounding air. This absorption capability is influenced by the surface area and porosity of the charcoal, as well as the fixed carbon content in the briquettes. The lower the fixed carbon content in the charcoal briquettes, the greater their ability to absorb moisture from the surrounding air. This moisture content is further affected by the high moisture levels in the adhesive used during production (Kahariayadi et al., 2016).

Ash Content

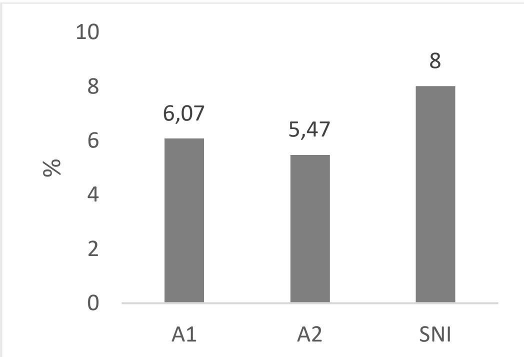

Figure 2. Comparison of Ash Content in Bio-Briquettes

Ash refers to the mineral content in solid fuels that remains non-combustible after the combustion process. Ash is the residue left when solid fuel (such as wood) is heated to a constant weight (Martynis et al., 2012). The ash content represents the amount of residue left in the briquette after heating in a furnace at a temperature of 900°C.

The ash content in briquettes affects their combustion efficiency. Higher ash content reduces the burning time of the briquettes. All briquettes contain inorganic substances, the quantity of which can be determined by the weight of the residue after complete combustion. This residue is referred to as ash. Briquette ash originates from materials such as clay, sand, soil, and various other mineral substances. Briquettes with high ash content are considered undesirable as they can form crusts during use, reducing their efficiency and usability. (Arbi et al., n.d.).

To determine the ash content in the briquettes, laboratory testing is conducted using a furnace heated to 900°C for approximately 2 hours. During this process, 1 gram of briquette is weighed and then converted into ash. The resulting ash is weighed again, and its ash content is calculated using a specific formula. This method allows for precise measurement of the ash content present in the briquettes.

According to Arbi et al. (n.d.), higher carbonization temperatures result in a greater amount of material being burned and converted to ash during the carbonization process. Additionally, the ash content is influenced by the amount of inorganic material present in the raw materials and the tapioca flour used.

In Figure 2, it can be observed that the lowest ash content in the bio-briquette tests was recorded in the second test at 5.47%, while the first test showed a higher ash content of 6.07%. Based on the above data, it is evident that in both tests, the bio-briquettes made from palm kernel shells meet the standards specified in SNI 01-6235-2000.

The standard for ash content, as specified by SNI, requires a maximum of 8%. Both sample tests have met this standard.

Volatile Matter

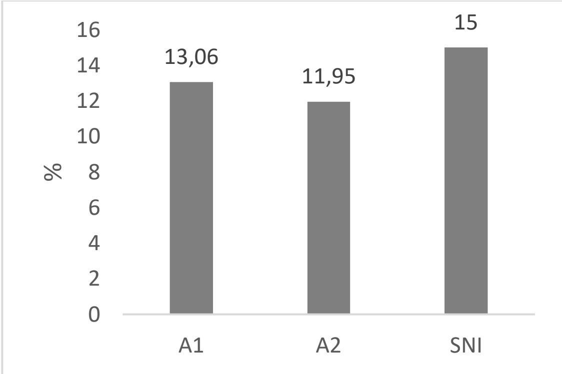

Figure 3. Comparison of Volatile Matter Content

According to Purba and Sirajuddin (2021), the volatile matter content is a key factor in determining the quality of a bio-briquette. Higher volatile matter content enhances combustion, as indicated by a longer flame. During the carbonization process, significant amounts of smoke are released due to combustion. Moreover, the volatile substances decrease as the heating process accelerates. (Tambaria & Serli, 2019).

The bio-briquettes produced in this study are expected to have low volatile matter content, minimizing the amount of smoke generated during the use of solid fuel. In the two tests conducted, both samples nearly met the standard set by the Indonesian National Standard (SNI), which specifies a maximum volatile matter content of 15%.

Volatile matter content is always expected to be low in bio-briquette quality standard tests. This is because a high volatile matter content can lead to increased emissions, which may contribute to environmental pollution (Purba & Sirajuddin, 2021).

As the combustion temperature increases, the release of volatile matter also rises. Higher pyrolysis temperatures result in a reduced amount of charcoal formation and an increased release of volatile matter (Purba & Sirajuddin, 2021). Consequently, during the quality analysis of bio-briquettes, the volatile matter content becomes lower due to its release during combustion. The carbonization process provides an opportunity to evaporate as much volatile matter as possible.

As a result, the testing yielded low volatile matter content. The two tests conducted both met the SNI 01-6235-2000 standard, which specifies a maximum of 15%.

Calorific Value

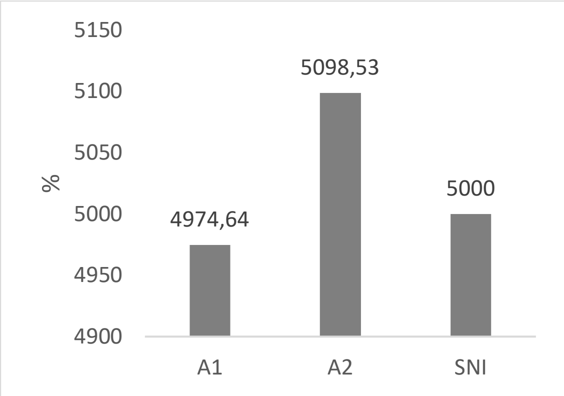

Figure 4. Comparation of calorific value

The calorific value is one of the most important parameters in the production of bio-briquettes. A higher calorific value indicates a higher quality of the bio-briquette produced. The raw material or biomass used for bio-briquette production significantly influences the calorific value. According to the Ministry of Energy and Mineral Resources of Indonesia (Kementerian ESDM RI), there are four categories of coal quality based on calorific value:

1. Quality I: Coal with a calorific value of 6,000 kcal/kg or higher.
2. Quality II: Coal with a calorific value between 5,600 kcal/kg and less than 6,000 kcal/kg.
3. Quality III: Coal with a calorific value between 4,700 kcal/kg and less than 5,600 kcal/kg.
4. Quality IV: Coal with a calorific value below 4,700 kcal/kg.

From the analysis results shown in Figure 4.4, it is evident that the calorific values obtained meet the standards set by the Ministry of Energy and Mineral Resources (ESDM) for both tests. However, for the SNI 01-6235-2000 standard, which requires a minimum calorific value of 5000 kcal/g, one of the tests did not meet the requirement. The first test recorded a calorific value of 4974.64 kcal/g, while the second test achieved 5098.53 kcal/g.

The low calorific value is partly attributed to the tapioca flour adhesive used, which still contains relatively high moisture and ash content. Lower moisture and ash content would increase the calorific value of the briquettes. This is because, during combustion, some of the briquette's heat is used to evaporate the remaining water, while the silica in the ash, being non-combustible, obstructs airflow during the burning process (Nugraha et al., n.d.). The calorific value is a critical determinant of the quality of charcoal briquettes. The higher the calorific value, the better the quality of the produced charcoal briquettes. Conversely, higher moisture and ash content in the charcoal briquettes reduce the calorific value of the briquettes produced.

CONCLUSION

The proximate analysis conducted on two repetitions of testing bio-briquettes made from palm kernel shells revealed that only the moisture content did not meet the SNI 01-6235-2000 standard, as it remained above 8%. However, the other three parameters tested met the SNI standards: ash content was below 8%, volatile matter was below 15%, and calorific value fell within the Ministry of Energy and Mineral Resources (ESDM) Category 3 range of 4700–5600 kcal/g, as well as the SNI 01-6235-2000 minimum requirement of 5000 kcal/g.

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