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Production of Biochar Briquettes from Coconut Leaves

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Abstract

Coconut leaf waste (Cocus nucifera), which contains various beneficial compounds, has not been utilized optimally by the community. Coconut leaves contain a valuable biomass of around 44,000 tonnes/ha to 67,000 tonnes/ha. This has the potential to be used as biochar. The research method used in this research is descriptive experimental research using coconut leaves as raw material for biochar briquettes using a pyrolysis carbonization process. This study used differences in the composition of starch which acts as an adhesive with 3 different variations, namely 2%, 4% and 6%. Based on the results of the ash content test and the calculation of the water content and density, the biochar briquettes in all samples complied with SNI 01/6235/2000.

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INTRODUCTION

Indonesia is being ushered in an energy crisis, which is also the result of the decreasing availability of fossil energy every year. One of the causes of the decline in energy availability is the increase in population, which is directly proportional to the amount of fossil fuel used (Sasana & Putri, 2018). According to DEN (2019), people in Indonesia consume up to 7.5 million tons of LPG, which is fulfilled by domestic LPG production of 2 million tons (26%) and imports of 5.5 million tons (74%) in 2018. The level of LPG use continues to increase due to the success of the kerosene-to-LPG conversion program. On the other hand, the supply of LPG from domestic LPG refineries and oil refineries is limited in terms of the amount of raw materials. That will indirectly impact the nation's energy availability in the future, so it is necessary to develop alternative energy to anticipate and overcome the problem of energy availability and increasing energy consumption in the future.

Alternative energy is the hope of society to be able to meet energy needs in the future. This energy is considered abundant, sustainable, and environmentally friendly, so its development is highly anticipated and will play a role in becoming the central mainstay of the national energy supply (Liun, 2011). The advantage of alternative energy is that it can be produced from various energy sources, including renewable materials, including biomass. According to Papilo et al. (2016), biomass is a term for all organic material from plants (including algae, trees and plants). Biomass has the potential to become one of the primary energy sources in the future, and the modernisation of bioenergy systems will be an essential contributor to sustainable energy development. One effort to utilise it as an alternative source is to utilise commodities that are easily found in various regions in Indonesia, namely coconut plants. To increase its economic value while stopping dependence on energy needs that still rely on oil and LPG gas for household activities, biomass from coconut plants can be processed to be more practical and economical by utilising one technology, namely briquettes derived from biochar by pressing) charcoal powder with adhesive.

Coconut trees (*Cocos nucifera L.*) are a tropical plant and commodity often found in Asia and the Pacific region, such as Indonesia (Pham, 2016). Coconut is often called the plant of life because almost all plant parts are valuable and versatile for human life. In this case, coconut plants are no exception and can be used as raw material to make alternative biochar fuel. One part of the coconut plant that can be used is the leaves. According to Adilah et al. (2014), coconut leaves have a percentage of hemicellulose content reaching 22.49%, cellulose content reaching 39.05%, and lignin content reaching 21.4%. From the value of the percentage content of hemicellulose, cellulose, and lignin in coconut leaves, coconut leaves can be used as raw materials to make alternative energy (renewable energy) in the form of biocharcoal. Coconut leaves, abundant in various regions in Indonesia, have yet to be utilised optimally. Generally, people only use coconut leaves to make traditional house roofs, various kinds of crafts, and household decorations (Sutara, 2013; Budiywono & Rahman, 2018; Ryandita et al., 2020). Using coconut leaves as biocharcoal briquettes are rarely done, and are still limited to using coconut shells and husks (Kambey et al., 2022; Haryati et al., 2021; Iskandar et al., 2019). Based on this, this research focuses on using coconut leaves which have yet to be utilized optimally as raw material for making biocharcoal briquettes.

METHOD

The research method used in this research is experimental descriptive research using coconut leaves as raw material for biocharcoal briquettes using a pyrolysis carbonization process (Figure 1). This research was conducted at the Integrated Science Laboratory, Universitas Negeri Semarang, using different starch compositions, which act as an adhesive with three different variations, namely 2%, 4%, and 6%. Data was obtained by calculating the briquettes' water content, density, specific gravity, ash content, and burning time of the charcoal briquettes.

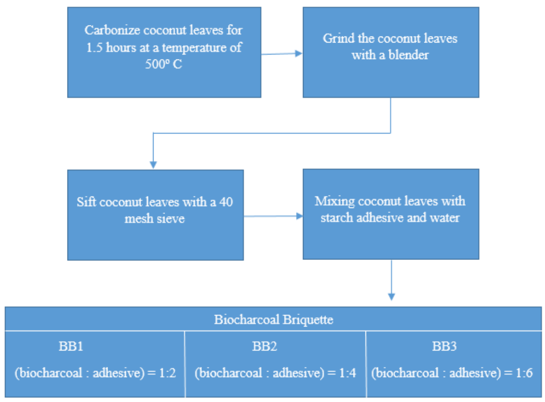

Figure 1. Research flow diagram

RESULT AND DISCUSSION

Biocharcoal briquettes are made from coconut leaves that have undergone carbonization and are treated with varying amounts of 2%, 4% and 6% starch adhesive. The starch adhesive is mixed with water in a ratio of 1:2. Three briquettes are formed and have the same charcoal mass, namely 13 grams. When the starch adhesive and charcoal have been homogenized, the briquettes need to be dried for two days to determine the moisture content, density and specific gravity of the briquettes. After the drying process is carried out, the mass of briquettes in each sample will decrease, as shown in Table 1.

Table 1. Mass Measurement of Biocharcoal Briquettes Before and After Drying

Sample	Initial Mass (gram)	Final Mass (gram)
A	15,6	15,0
B	29,3	28,0
C	32,0	30,0

Sample A is a mixture of charcoal with 2% starch adhesive, sample B is a mixture of charcoal with 4% starch adhesive, and sample C is a mixture of charcoal with 6% starch adhesive.

Water Content

The water content of the briquettes is a crucial component to know because it will significantly influence the characteristics of the biocharcoal briquettes. The water content of briquettes is greatly influenced by the adhesive used. If the adhesive mixture is higher, the value of the water content contained in the briquettes will be lower. That is because the amount of water in the briquettes comes from the adhesive used (Elfiano et al., 2014). From the data processing results, the highest briquette water content was found in sample c (Table 2).

Table 2. Briquette Water Content in Each Sample

Sample	Briquette Water Content (%)
A	4,00
B	4,64
C	6,66

Sample C has a higher water content than the other samples because the final mass produces a relatively high difference after drying. Apart from that, the final mass of sample C is two different from the reduction result from the initial mass before the drying process, and this affects the high results of the division between the reduction results and the final mass after the drying process of sample C. The result of this division is the water content of the briquettes. The mixing ratio between the starch adhesive and more water in sample C also influenced the high water content of the briquettes.

Density

The density of a briquette is the ratio between the mass and the volume of the briquette. The mass used to determine density is the mass of the briquettes after the drying process. The size and homogeneity of the briquette constituents greatly influence the briquette density value. Based on research results from Harun & Sutapa (2015), information was found that the value of the amount of adhesive will be directly proportional to the density level of the charcoal briquettes. From the results of data processing, the highest density is found in sample B (Table 3).

Table 3. Density Content in Each Sample

Sample	Volume (cm^3)	Density (g/cm^3)
A	17,27	0,87
B	29,44	0,95
C	38,86	0,77

Sample C has a lower density value than the other samples, even though the amount of adhesive added is higher than samples A and B. That can be caused by several factors, one of which is that the size of the briquettes for sample C is not uniform compared to the other samples. Sample C has a wider size than the other samples, affecting the volume and density level produced. Briquette samples that are not homogeneous in size to other briquette samples will directly decrease the density and density values of the briquettes (Susanto & Yanto, 2013). The briquettes produced in this research are cylindrical in size (Figure 2).

Figure 2. Samples of Briquettes Produced

The briquettes' shape will affect the water content and density values. Based on the results of research conducted by Iskandar and Suryanti (2015), it was found that cylindrical briquettes have a lower density level than triangular and rectangular briquettes because the different geometric shapes of the briquettes will affect the arrangement of voids between the particles in the briquettes. Even though sample B's density value is higher than sample A's, the density value of all samples meets the standards of SNI 01/6235/2000, which exceeds 0.44%.

Specific gravity

Specific gravity is one component that significantly influences the density level of a briquette. If the quantity of adhesive added to making briquettes is high, the level of density that will be produced from the briquettes will also be high. From the results of data processing, the highest specific gravity value is found in sample A (Figure 3).

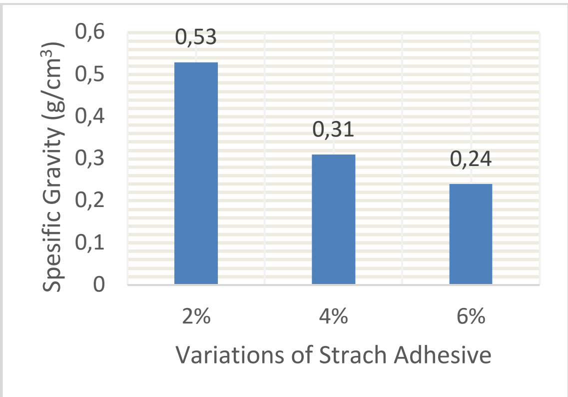

Figure 3. Relationship Between Starch Adhesive Variations and Briquette Specific Gravity

The specific gravity value in sample C, which is lower than samples A and B, can be influenced by several factors: the size of the briquettes produced from the moulding process and the density value of the briquettes. During the briquette moulding process, sample C is wider than the other samples, directly affecting the volume value. That impacts the density value that sample C briquettes will obtain because they have a wider size than samples A and B. A low-density value will have an impact on the low specific gravity of a briquette sample (Sugiyati et al., 2021).

Ash Content

Ash content is a component that is no less important in the characteristics of charcoal briquettes. That is caused by silica in the ash, which can affect the calorific value of a charcoal briquette. The ash content value will affect the quality of the briquettes as fuel, where the higher the ash content indicates the lower the quality of the briquette fuel (Mulyadi et al., 2013). The value of the ash content of briquettes can be determined by comparing the mass of ash produced from the combustion process to the mass of charcoal briquettes before burning. The data processing results produced the highest ash content in the sample a (Table 4).

Table 4. Ash Content in Each Sample

Sample	Ash Content (%)
A	6,66
B	3,57
C	3,33

Based on the data in Table 3, the value of the ash content will be smaller in samples with a more significant amount of adhesive. The low ash content value in each sample is also influenced by the high content of organic elements so that they are easily bound when burned and produce a low quantity of residue in the form of ash. That is in line with the results of research conducted by Budiawan et al. (2014), who stated that the high organic content in coffee skins can reduce the ash content of charcoal briquettes. The ash content produced from all samples of banana leaf-based charcoal briquettes meets the standards of SNI 01/6235/2000, which is less than 8%.

Burning Time

The burning time of charcoal briquettes will reflect the quality of the briquettes themselves. The longer it takes for a charcoal briquette to burn until it turns to ash, the better the quality of the charcoal briquette. The quantity of adhesive used in the briquette-making process will affect the burning time. Generally, the higher the quantity of adhesive used, the longer the burning time of the charcoal briquettes. From the observations, the longest burning time was found in sample C (Table 5).

Sample C uses a starch adhesive mixture with a more significant quantity than the other samples. That impacts how long it takes for the charcoal briquettes to burn until they become ash. The observation results align with research conducted by Sudding and Jamaluddin (2015), where mixing higher levels of starch with coconut shell charcoal will require a longer burning time. That is caused by the harder the charcoal briquettes are made, the longer it takes to burn the charcoal briquettes until they become ash.

Table 5. Times to Burn Briquette Until Turn to Ash

Sample	Burning Time (minute)
A	33
B	40
C	47

This research still has many limitations, so much development needs to be done. This research must be developed by mixing several materials, such as coconut fibre or other agricultural waste (Sanchez et al., 2022). The mixture can even use palm oil waste, which is the most strategic agricultural commodity in Indonesia (Yanti et al, 2022; Kpalo et al, 2021; Putra et al, 2023). Apart from that, the production of biorang briquettes must also be studied from financial and environmental aspects (Clasen et al, 2022). That is because studies from the financial aspect play an essential role in implementing biochar briquettes as fuel in households (Bot et al., 2022).

CONCLUSION

The contents of coconut leaf waste can be used as a primary ingredient in making biocharcoal. With the help of the carbonization method, which aims to obtain charcoal as the main product, three samples were made with different variations of starch. Sample A 2%, Sample B 4% and Sample C 6%. Variations in starch will affect the test results for several characteristics, such as briquette moisture content, ash content and the burning time of the briquettes. The highest water content for testing characteristics fell on sample C at 6.66%. For briquette density, sample B is far superior to the other samples. Sample B has a density of 0.95 g/cm^3 with a volume of 29.44 cm^3. Sample A was superior in testing the characteristics of ash content resulting from burning briquettes; the ash content of sample A was 6.66%. The final characteristic test is the length of time the briquettes burn. In testing this characteristic, it was outperformed by sample C with a burning time of 47 minutes. Several characteristics that have been tested, such as water content, ash content and other test characteristics, have met SNI 01/6235/2000 standards.

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