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Evaluation of waste composition for biochar production as a sustainable waste management approach

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ABSTRACT
Background: To meet human life needs, fuel energy is obtained from fossil sources, such as coal, found in the Earth's crust. However, non-renewable energy sources in the Earth's crust will eventually run out. One alternative fuel is the production of biobriquettes from various types of waste. **Methods:** Using a literature review method, this study aims to determine which waste is most suitable for use in the production of biobriquettes. The samples taken are journals sourced from Google Scholar ranging from 2017 to 2022 that align with the discussion topic. **Findings:** Among various raw materials, the best waste for biobriquette production is found to be a mixture of dacron waste and corn cob, with a moisture content of 3.45% and a carbon value of 7986.45 cal/g. **Conclusion:** The results of the above study indicate that the production of biobriquettes from dakron waste and corn cobs is the best option because it yields the highest calorific value and the lowest moisture content, in accordance with SNI 01/6235/2000. **Novelty/Originality of this article:** This study presents a novel approach by identifying a specific combination of dacron waste and corn cob for biobriquette production, showcasing its superior calorific value and low moisture content, thus contributing to sustainable energy solutions and waste management practices.

KEYWORDS: biobriquettes; waste utilization; sustainable energy.

1. Introduction

Indonesia's energy demand continues to increase every year, but this increase is not proportional to the amount of available energy. This increase is caused by economic growth, a rising population, inefficient energy usage, and a lack of human resources capable of processing and utilizing existing resources. According to the National Energy Management Plan 2005 by the Department of Energy and Natural Resources (DESDM), Indonesia's oil reserves were estimated to be depleted within 18 years based on the reserve/production ratio in 2004. Crude oil consumption has been increasing by an average of 6% per year (Faizal et al., 2015).

Currently, biobriquettes, which are solid fuels made from a mixture of biomass available in the environment, are the most widely used alternative fuel. Biobriquettes are easy to produce and have great potential for large-scale development in a short time. Rubber seeds, palm kernel shells, water hyacinth, sludge waste, and many other biomass sources can be utilized in Indonesia (Moeksin et al., 2017).

Utilizing waste for biobriquette production will be efficient in reducing such waste, especially since some waste cannot be processed or reused. Some of the waste that can be used has relatively high calorific values (Bimantara & Hidayah, 2019). Although the main

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materials for briquette production are already quite good, it is advisable to choose a good adhesive as well, as the adhesive can affect the quality of the produced briquettes. Adhesives are divided into two categories: inorganic and organic adhesives. Each type of adhesive has its own advantages to ensure better briquette quality (Anizar et al., 2020). The objective of this research is to determine which waste raw materials are most suitable for biobriquette production.

2. Methods

The literature review method is used in this research, focusing on the results of studies that have identified the characteristics of biobriquettes. Furthermore, the characteristics of biobriquettes from various studies will be compared with the Indonesian National Standard (SNI). The literature utilized in this research is sourced from journals available on Google Scholar, concentrating on journals that discuss topics related to biobriquettes.

Several criteria have been established in selecting relevant journals, including journals written in Indonesian that are published in Indonesia, with a publication period from 2017 to 2022. Additionally, only complete text articles that align with the research context are chosen. All journals or articles selected must correspond to the topic of this research (Wulandari, 2020).

3. Results and Discussion

From several journals reviewed, there are a number of studies that use various waste materials as sources for biobriquettes, consisting of palm kernel shells, waste refuse, Sidoarjo sludge, water hyacinth, corn cobs, and others. The following are the results of the journal identification:

Table 1. Review results

No.	Author	Title	Method	Results
1	Arbi & Irsad (2018)	Utilization of Palm Shell Waste into Charcoal Briquettes as Alternative Fuel	Several methods used in this research to create charcoal briquettes include gravimetric to measure moisture and ash content, and bomb calorimeter to measure calorific value. The research included three variations of composition mixtures: 95%:5%, 90%:10%, and 85%:15%, with a mixture of palm shell charcoal and starch flour.	Laboratory test results showed that briquettes made with the three variations of composition yielded the best results with a mixture composition of 90% palm kernel and 10% starch flour. The analysis results indicated a moisture content of 3.86%, ash content of 5.28%, and calorific value of 5896.8 kcal per gram.
2	Putri & Andasuryani (2017)	Quality Study of Charcoal Briquettes from	To produce briquettes with high calorific	Since the characteristics of the briquettes closely matched the SNI parameter values, all the

		Biomass Waste Materials	value, this study used coconut shell charcoal as the raw material composition. The research consisted of three stages: briquette press fabrication, briquette production, and briquette testing.	briquettes produced were found to comply with SNI standards. Testing results included moisture content, compressive strength, density, ash content, carbon content, and calorific value. The results showed moisture content of 5.625%, ash content of 4.11%, carbon content of 95.89%, and calorific value of 6160.38 Kal/gr.
3	Fitri (2017)	Production of Briquettes from a Mixture of Coffee Husks (Coffea Arabica) and Sawdust Using Pine Resin as a Binder	The carbonization process of the sawdust and coffee husk samples (carbonization). The powdered charcoal was mixed with pine resin binder in an amount of 60%. The ratios of sawdust to coffee husks used were 90:10, 10:90, 50:50, 70:30, 30:70, and 30:70.	The research showed that the briquette composition affected the amount of calorific value produced from mixing coffee husks and sawdust. The best calorific value was found at a ratio of 70:30, yielding a calorific value of 6124.0695 kcal/gr. The lowest calorific value was from the 10:90 ratio, which produced a calorific value of 5532.8981 kcal/gr.
4	Setiawan & Praswanto (2022)	Utilization of Dakron Waste and Corn Cobs as Briquette Materials with Palm Oil Mixture	The briquette contained a mixture of 2:0, 2:1, 1:1, 1:2, and 0:2 of corn cobs and dakron waste. The experimental process included material preparation, carbonization, mixing, pressing, drying, and quality inspection of the briquettes.	In the fourth specimen, the mixture with a ratio of 1:2 had a relatively high calorific value of 7986.46480 kcal/gr and a relatively low moisture content of 3.45%, which is the ideal ratio between corn cobs and dakron waste with botanical flour binder and palm oil mixture. The combustion temperatures were 498°C, 476°C, 441°C, 437°C, 388°C, and 350°C over five minutes, with a combustion rate of 0.166 grams per square meter.
5	Amanu (2022)	Utilization of Water Hyacinth (Eichhornia Crassipes) and High-Density Polyethylene (HDPE) Plastic Waste as Briquette Raw Materials	A mixture of polyethylene (HDPE) 100 EG:25, 100 EG:50, and 100 EG:75 was used in the production of briquettes. A pyrolysis process without oxygen was used to process biomass	Proximate analysis results showed that the percentage of tar in HDPE mixtures increased moisture content, volatile content, calorific value, and combustion rate. Ash content for the 100 EG:25 HDPE variation was 35.79%, while for the 100 EG:75 HDPE variation, it was 25.19%. Conversely, a higher percentage of tar in HDPE

			into char for four hours at a temperature of 450°C and for HDPE waste at 500°C. During ten minutes, briquettes with a diameter of 5 cm and height of 10 cm were pressed with a pressure of 150 kilograms per square centimeter.	mixtures resulted in lower ash and bound carbon contents. The calorific value for the 100 EG:25 HDPE variation was 6243.08 calories/gram, while for the 100 EG:75 HDPE variation, it increased to 7430.08 calories/gram.
6	Sugiharto & Lestari (2021)	Briquette from a Mixture of Sugarcane Pulp and Rice Husk Using Conventional Carbonization as Alternative Energy	In a 100-milliliter beaker, mix 1 gram of tapioca flour with 17 milliliters of water. The rice husks and sugarcane pulp charcoal were mixed in mass ratios of 2:3, 2.5:2.5, and 3:2 before mixing with the binder. Place in an oven to dry the briquettes; they are dried for thirty minutes at 100 degrees Celsius. After drying, the briquettes were weighed to determine their final weight.	The mass composition of 2:3 of the briquettes had 8.31% moisture content, 30.41% ash content, 37.10% volatile matter, 32.49% bound carbon content, and the highest calorific value of 6844.396 kcal per gram.

For this test, the SNI 01/6235/2000 standard for charcoal briquettes was used. This standard sets quality requirements for charcoal briquettes as follows:

Table 2. Quality of charcoal briquettes

No.	Test type	Unit	Requirements
1	Moisture content	%	Maximum 8
2	Ash content	%	Maximum 8
3	Caloric value	Kcal/g	Minimum 5000

The hygroscopic properties of charcoal briquettes are very high, meaning they easily absorb water from their environment. The purpose of measuring moisture content is to understand the hygroscopic properties of the charcoal briquettes produced from the research. The quality of the briquettes is greatly influenced by moisture content; as the moisture content of the briquettes decreases, the calorific value and burn rate also increase. Briquettes are difficult to ignite if the moisture content is high and produce a lot of smoke, which reduces ignition temperature and burn rate (Hutasoit, 2012).

Ash content is the part of the residue left after combustion; in this case, the ash refers to the ash produced from the combustion of the briquettes. Silica is one of the components of ash, which does not have a significant impact on the calorific value of the produced charcoal briquettes. The calorific value and carbon content of the briquettes are influenced by their ash content; the lower the ash content, the higher the calorific value and carbon content. The quality of the briquettes is largely determined by the calorific value; a higher calorific value corresponds to the quality of the briquettes produced. The values of moisture, ash, and carbon in the briquettes affect how high or low their calorific value is.

In the first journal, with a mixture composition of 10% starch and 90% palm shell charcoal, there is a moisture content of 3.86%, an ash content of 5.28%, and a calorific value of 5896.8 kcal/gram. The increasing amount of palm shell charcoal in the briquettes results in a lower moisture content. The starch binder sold in the market also contains moisture because it is not dried before being made into briquettes. Since palm shell contains mineral substances that can increase the ash content in the briquettes, the smaller amount of palm shell charcoal compared to other composition variations leads to higher ash content. The calorific value in this journal is also influenced by the moisture content in palm shell waste. The calorific value of palm shell charcoal briquettes increases with lower moisture levels (Arbi & Irsad, 2018).

The second journal has a moisture content of 5.625%, an ash content of 4.11%, and a calorific value of 6160.38 kcal/gram. The low moisture content is due to the lower number of pores, while the carbon and ash content of the briquettes affects the calorific value produced from the briquettes. This is because the combustion process requires carbon to react with oxygen to produce heat (Putri & Andasuryani, 2017).

According to research conducted by Fitri (2017), briquettes made from a composition of sawdust and coffee grounds in a ratio of 70:30 and produced a moisture content of 3.59% are the best. This is due to the fact that sawdust and coffee grounds have a lower moisture concentration, resulting in a higher ratio compared to other materials with higher moisture concentrations. Thus, the calorific value produced, 6124.07 kcal/gram, indicates that the charcoal from sawdust and coffee grounds has a lower moisture concentration (Fitri, 2017).

In the fourth journal study, briquettes with a composition of corn cobs and dakron waste in a ratio of 2:0 have the highest calorific value, which is 8131.70 kcal/gram, and the lowest moisture content, which is 3.03%. The differences in the amounts of the corn cobs and dakron waste mixtures and moisture content in each briquette affect the calorific value of each specimen. External factors during the briquette-making process influence the moisture content of the dakron waste briquettes. Temperature and storage methods are two factors affecting moisture content as they both influence absorption (Setiawan & Praswanto, 2022).

In the fifth study, briquettes with a mixture of water hyacinth and polyethylene (HDPE) in a ratio of 100:75 have a moisture content of 6.66%, with an ash content of 25.19%. This indicates that the moisture content of the briquettes increases with the addition of HDPE tar, with a lower ash content of 25.19%. The addition of HDPE tar decreases the ash content of the briquettes, while a smaller amount of tar reduces the ash content. The moisture content of the briquettes affects the calorific value; if the moisture content of the briquettes is lower, less energy is required to evaporate the contained water, resulting in a lower calorific value detected in the test. Conversely, if the moisture content of the briquettes is high, the calorific value or energy detected in the test will be lower (Amanu, 2022).

With a mass composition of 2:3, briquettes made from a mixture of sugarcane bagasse and rice husk have a moisture content of 8.31%, ash content of 30.41%, volatile matter content of 37.10%, fixed carbon content of 32.49%, and a calorific value of 6844.396 cal/gram, which is best used in variations of mass (Amanu, 2022).

4. Conclusions

Based on the reviewed journals, various waste materials have shown promising potential as sources for biobriquettes, with significant variations in their calorific values, moisture content, and ash content. Among the studies, the mixture of dakron waste and corn cobs yielded the highest calorific value (7986.46 kcal/gram) and the lowest moisture content (3.45%), making it the best option for biobriquette production and in accordance with SNI 01/6235/2000.

Other effective combinations included palm kernel shells, coffee husks, and sugarcane pulp, each demonstrating favorable characteristics in terms of combustion efficiency. The results indicate that selecting the appropriate waste materials and their compositions is crucial in optimizing the quality and performance of biobriquettes, which can serve as a sustainable alternative energy source.

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Author Contribution

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References

Amanu, N. (2022). Pemanfaatan Eceng Gondok (Eichornia Crassipes) Dan Sampah Plastik High Density Polyethylene (Hdpe) Sebagai Bahan Baku Briket. https://dspace.uii.ac.id/handle/123456789/37879

Anizar, H., Sribudiani, E., & Somadona, S. (2020). Pengaruh bahan perekat tapioka dan sagu terhadap kualitas briket arang kulit buah nipah. *Perennial*, *16*(1), 11-17.

https://doi.org/10.24259/perennial.v16i1.9159
Arbi, Y., & Irsad, M. (2018). Pemanfaatan Limbah Cangkang Kelapa Sawit Menjadi Briket ArangSebagai Bahan Bakar Alternatif. *CIVED*, *5*(4).
Bimantara, S. E., & Hidayah, E. N. (2019). Pemanfaatan limbah lumpur ipal kawasan industri dan serbuk gergaji kayu menjadi briket. *Jukung (Jurnal Teknik Lingkungan), 5*(1). http://dx.doi.org/10.20527/jukung.v5i1.6192
Faizal, M., Saputra, M., & Zainal, F. A. (2015). Pembuatan briket bioarang dari campuran batubaradan biomassa sekam padi dan eceng gondok. *Jurnal Teknik Kimia*, *21*(4), 28-39. http://ejournal.ft.unsri.ac.id/index.php/JTK/article/view/548
Fitri, N. (2017). Pembuatan Briket dari Campuran Kulit Kopi (coffea arabica) dan Serbuk Gergaji dengan Menggunakan Getah Pinus Sebagai Perekat (Doctoral dissertation, Universitas Islam Negeri Alauddin Makassar).
Hutasoit, A. (2012). Briket Arang dari Pelepah Salak. [Skripsi]. Padang: Fakultas Teknologi Pertanian. Universitas Andalas.
Moeksin, R., Pratama, K. A. A., & Tyani, D. R. (2017). Pembuatan briket biorang dari campuran limbah tempurung kelapa sawit dan cangkang biji karet. *Jurnal Teknik Kimia*, *23*(3), 146-156. http://ejournal.ft.unsri.ac.id/index.php/JTK/article/view/754
Putri, R. E., & Andasuryani, A. (2017). Studi mutu briket arang dengan bahan baku limbah biomassa. *Jurnal Teknologi Pertanian Andalas, 21*(2), 143-151. https://doi.org/10.25077/jtpa.21.2.143-151.2017
Setiawan, A. B., & Praswanto, D. H. (2022). Pemanfaatan Limbah Dakron dan Tongkol Jagung Sebagai Bahan Briket dengan Campuran Minyak Sawit. *Prosiding SENIATI, 6*(2), 259-266. https://doi.org/10.36040/seniati.v6i2.4984
Wulandari, S. (2020). Pengaruh Aroma Terapi Terhadap Kualitas Tidur AnakYang Menjalani Hospitalisasi:(Literatur Review). *PIN-LITAMAS, 2*(1), 258-266. https://ejournal.stikesjayc.id/index.php/PLT/article/view/45

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