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CHARACTERISTICS OF COCONUT HUSK BRIQUETTES USING TAPIOCA AND RICE FLOUR BINDERS AT VARIOUS CONCENTRATIONS

Ahmad Akromul Huda[1*], Syarif Hidayatullah[1]
[1]Jurusan Teknik Mesin, Fakultas Teknik, universitas Mataram, Indonesia
*Co-author: akromulh13@gmail.com

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Abstract: *This study aimed to evaluate the effects of binder type and concentration on the quality of coconut husk charcoal briquettes and to assess the potential of rice flour as an alternative binder to tapioca flour. A two factorial Completely Randomized Design (CRD) with three replications was employed. The first factor was binder type (tapioca flour and rice flour), while the second factor was binder concentration (10%, 15%, and 20%). The quality parameters evaluated were moisture content, ash content, and calorific value. Data were analyzed using two-way Analysis of Variance (ANOVA) followed by Duncan's Multiple Range Test (DMRT) at a 5% significance level. The results showed that binder type and concentration significantly affected the quality characteristics of the briquettes ($p < 0.05$). Moisture content and ash content increased with increasing binder concentration, whereas calorific value decreased. Moisture content ranged from 6.6% to 7.7%, while ash content ranged from 6.5% to 7.9%. The highest calorific value was obtained from briquettes produced with 10% tapioca flour binder (5405 cal/g), whereas the lowest value was observed in briquettes produced with 20% rice flour binder (4780 cal/g).. All treatments met the moisture and ash content requirements of SNI 01-6235-2000, while only briquettes containing 10–15% binder satisfied the minimum calorific value standard. Overall, 10% tapioca flour binder produced the best briquette quality, although rice flour showed potential as an alternative binder at appropriate concentrations.*

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A. INTRODUCTION

The extensive use of fossil energy has significantly increased greenhouse gas emissions, contributing to global climate change. Therefore, the development of sustainable and environmentally friendly alternative energy sources is urgently needed (REN21, 2021). One potential alternative energy source is biomass derived from agricultural waste, as it is renewable and abundantly available in agrarian countries such as Indonesia (IRENA, 2021). However, the utilization of this biomass waste remains suboptimal, as it is often burned directly or left to decompose, leading to environmental pollution. Thus, innovation is required to convert biomass waste into higher-value alternative fuels such as briquettes (Brunerová et al., 2017).

One promising biomass waste is coconut husk. The province of West Nusa Tenggara (NTB) is one of the major coconut-producing regions in Indonesia, resulting in a substantial amount of coconut husk waste. According to data from BPS NTB (2025), coconut production from smallholder plantations in NTB reached 49.7 thousand tons in 2024, which is relatively stable compared to 50.2 thousand tons in 2023 (BPS NTB, 2024). The main production areas are located in Lombok Island, particularly West Lombok Regency (15.28 thousand tons) and North Lombok Regency (12.27 thousand tons). Despite its abundance, coconut husk utilization at the community level is still limited, commonly used only as traditional fuel or even discarded. In fact, coconut husk contains high lignocellulosic components that play an important role in producing calorific value and combustion stability (Onukak et al., 2017).

Previous studies have shown that coconut husk charcoal has good characteristics as a briquette raw material. Nurhilal (2018) reported that coconut husk-based briquettes have a relatively high calorific value of 5,819 cal/g without any binder addition. Annisa (2025) found that coconut husk briquettes using tapioca flour binder achieved calorific values ranging from 4,915 to 5,130 cal/g, meeting national standards. Other studies by Waluyo (2023) and Lubwama (2024) indicated that briquette quality is strongly influenced by the type of material and binder composition, particularly in terms of calorific value, moisture content, and ash content.

Binders play a crucial role in briquette production as they enhance mechanical strength and maintain the structural integrity of briquettes during storage and use (Borowski et al., 2017). Without binders, charcoal particles cannot bind effectively, resulting in fragile briquettes. Therefore, selecting an appropriate binder is essential in determining briquette quality (Mousa et al., 2022).

The most commonly used binder in briquette production is tapioca flour due to its high starch content, which provides strong binding properties (Aulia et al., 2024). Studies by Abineno (2025) and Olugbade (2019) showed that starch-based binders such as tapioca can improve briquette strength and combustion performance. However, the use of tapioca may face limitations in terms of availability and cost in certain regions.

As an alternative, rice flour can be used as a binder because it contains a high starch content (approximately 70–80%), composed of amylose and amylopectin that contribute to particle binding (Rashwan et al., 2024). High amylose content provides strength and rigidity, while amylopectin contributes to elasticity, thereby improving briquette compactness (Dwijayanti, 2019). In addition, rice flour is more readily available in local communities, particularly in NTB, making it a potentially more economical and sustainable binder.

However, studies on the use of rice flour as a binder in charcoal briquettes, especially those made from coconut husk, are still limited. Furthermore, there is a lack of direct comparison between rice flour and conventional binders such as tapioca in producing briquettes that meet quality standards.

Based on these considerations, this study aims to analyze and compare the quality of coconut husk charcoal briquettes using rice flour as a binder, based on calorific value, moisture content, and ash content. This research is expected to determine the potential of rice flour as an effective alternative binder that meets fuel quality standards.

B. METHODOLOGY

1. Time and Location of the Study

This research was conducted from February to August 2024. The experimental activities were carried out at the Chemistry Laboratory, Faculty of Agriculture, University of Muhammadiyah Mataram.

2. Materials and Equipment

The main material used in this study was coconut husk as the raw material for briquette production. Two types of binders were used, namely rice flour and tapioca flour, for comparison purposes.

The equipment used included a carbonization drum, briquette mold with a diameter of 40 mm, analytical balance, oven, furnace, bomb calorimeter, desiccator, porcelain crucible, mortar, 40-mesh sieve, stove, stopwatch, and other supporting tools.

3. Experimental Design

This study employed a 2 × 3 factorial Completely Randomized Design (CRD) with three replications. The first factor was the binder type, consisting of:

A1 = Tapioca flour
A2 = Rice flour

The second factor was the binder concentration, consisting of:

B1 = 10%
B2 = 15%
B3 = 20%.

The treatment combinations were as follows in Table 1:

Table 1. Treatment Combinations of Binder Type and Binder Concentration

Treatment	Binder Type	Concentration
A1B1	Tapioca flour	10%
A1B2	Tapioca flour	15%
A1B3	Tapioca flour	20%
A2B1	Rice flour	10%
A2B2	Rice flour	15%
A2B3	Rice flour	20%

Factor A: Binder type (A1 = Tapioca flour, A2 = Rice flour); Factor B: Binder concentration (B1 = 10%, B2 = 15%, B3 = 20%).

4. Research Procedure

a. Raw Material Preparation

Coconut husks were collected, cleaned, and air-dried for approximately 3 days. Carbonization was then carried out using a pyrolysis drum for approximately 5 hours until charcoal was produced. The resulting charcoal was ground and sieved using a 40-mesh sieve to obtain uniform particle size.

b. Binder Preparation

The binders were prepared from rice flour and tapioca flour with a ratio of 1:10 (flour:water). Hot water was used to produce the binder. This starch-based adhesive exhibits good binding properties for briquette production.

c. Briquette Production

Coconut husk charcoal powder was mixed with the binder according to the treatment combinations until homogeneous. The mixture was then molded using a cylindrical mold with a diameter of 40 mm and compacted. The formed briquettes were dried under sunlight for approximately 4 days until low moisture content was achieved.

d. Briquette Characteristic Testing

To evaluate the feasibility of the produced briquettes, quality testing was conducted based on SNI 01-6235-2000 (National Standardization Agency, 2000). The parameters analyzed included moisture content, ash content, and calorific value, which are the main indicators of solid biomass fuel quality.

Moisture Content

$$\text{Moisture content } = \frac{a-b}{a} \times 100\% \quad (1)$$

Where:

a = mass of sample before drying (g)

b = mass of sample after drying (g)

(Putra & Hidayat, 2022)

Ash Content

$$\textit{Ash content} = \frac{wo}{wd} \times 100\% \quad (2)$$

Where:

wo = mass of sample after ashing (g)

wd = mass of sample before ashing (g)

(Dewi et al., 2022)

5. Statistical Analysis

The experimental data were analyzed using two-way Analysis of Variance (ANOVA) to determine the effects of binder type, binder concentration, and their interaction on moisture content, ash content, and calorific value. When significant differences were observed at the 5% significance level ($p < 0.05$), treatment means were further compared using Duncan's Multiple Range Test (DMRT). Statistical analyses were performed using SPSS software.

C. RESULTS AND DISCUSSION

1. Moisture Content

The moisture content of coconut husk charcoal briquettes at various concentrations of rice flour and tapioca binders is presented in **Figure 1.**

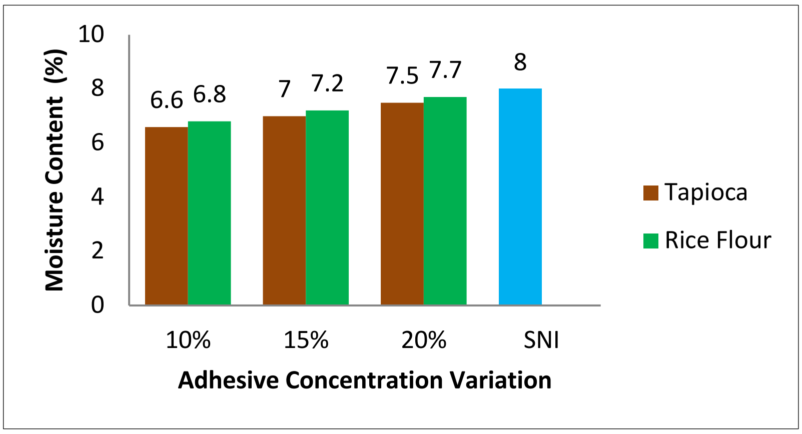

Figure 1. Moisture content of briquettes

Figure 1 illustrates the effect of binder type and binder concentration on the moisture content of coconut husk briquettes. In general, moisture content increased with increasing binder concentration for both rice flour and tapioca flour binders. The highest moisture content was observed at a 20% binder concentration, reaching 7.7% for rice flour and 7.5% for tapioca flour, whereas the lowest values were recorded at a 10% concentration, namely 6.8% and 6.6%, respectively.

The results of the two-way ANOVA indicated that both binder type and binder concentration significantly affected the moisture content of the briquettes ($p < 0.05$). Binder type showed a significant effect ($F = 18.000$; $p = 0.001$), while binder concentration exhibited a stronger influence ($F = 122.000$; $p < 0.001$). However, the interaction between binder type and concentration was not significant ($F = 0.000$; $p = 1.000$), indicating that the effect of concentration on moisture content was consistent regardless of the binder type used.

The increase in moisture content with increasing binder concentration can be attributed to the hygroscopic nature of starch-based binders such as rice flour and tapioca flour, which absorb and retain water during briquette production (Aransiola et al., 2019). Higher binder concentrations increase water retention within the briquette matrix, thereby resulting in higher moisture content.

When comparing binder types, briquettes produced using rice flour generally exhibited slightly higher moisture content than those produced using tapioca flour at the same concentration level. This difference may be related to variations in amylose and amylopectin composition, which influence water absorption and retention behavior (Imanningsih, 2012).

Moisture content is an important quality parameter because it directly affects combustion efficiency. High moisture content requires additional energy for water evaporation before combustion can occur, thereby reducing thermal efficiency and calorific value. Conversely, lower moisture content facilitates ignition and improves combustion stability (Huda et al., 2025).

According to SNI 01-6235-2000, the maximum allowable moisture content for charcoal briquettes is ≤ 8% (National Standardization Agency, 2000). All treatments in this study met this standard. However, the optimal condition was observed at a 10% binder concentration, which produced the lowest moisture content and supported more efficient combustion.

2. Ash content

The ash content of briquettes at various binder concentrations is shown in **Figure 2.**

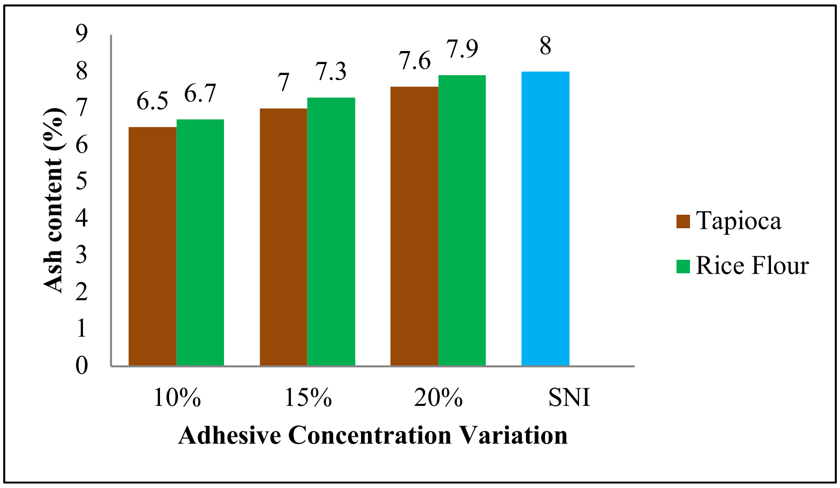

Figure 2. Ash content of coconut husk briquettes

Figure 2 shows the effect of binder type and binder concentration on the ash content of coconut husk briquettes. In general, ash content increased as binder concentration increased from 10% to 20% for both rice flour and tapioca flour binders. The lowest ash content was observed at a 10% binder concentration, reaching 6.5% for tapioca flour and 6.7% for rice flour. Conversely, the highest ash content was obtained at a 20% concentration, reaching 7.6% and 7.9%, respectively.

The results of the two-way ANOVA indicated that both binder type and binder concentration significantly affected ash content ($p < 0.05$). Binder concentration exhibited the strongest effect on ash content ($F = 198.500$; $p < 0.001$), while binder type also significantly influenced ash content ($F = 32.000$; $p < 0.001$). However, the interaction between binder type and binder concentration was not significant ($F = 0.500$; $p = 0.619$), indicating that the effect of binder concentration on ash content was consistent regardless of the binder type used.

The increase in ash content with increasing binder concentration suggests that higher amounts of starch-based binders contribute greater quantities of inorganic materials that remain as combustion residues. Rice flour and tapioca flour contain mineral components that are not completely combusted and therefore remain in the form of ash after combustion (Imanningsih, 2012). As binder concentration increases, the proportion of fixed carbon decreases, resulting in a greater amount of ash residue.

Furthermore, the increase in ash content is also influenced by the reduction in the proportion of fixed carbon in the briquettes due to the addition of binders. A lower fixed carbon content results in a higher amount of combustion residue in the form of ash (Nwabue et al., 2017). This finding is consistent with previous studies reported by Adeleke (2021), which stated that the addition of non-carbon materials, such as binders, can increase ash content and consequently reduce the overall quality of solid fuels.

When comparing binder types, briquettes produced using tapioca flour consistently exhibited lower ash content than those produced using rice flour at all concentration levels. For example, at a 10% binder concentration, the ash content of tapioca flour briquettes was 6.5%, compared to 6.7% for rice flour briquettes. Similar trends were observed at 15% and 20% concentrations. These results suggest that tapioca flour contains lower mineral content and therefore generates less ash residue during combustion. Ash content is an important parameter affecting combustion efficiency. High ash levels can obstruct airflow, reduce combustion temperature, and lead to slag formation in combustion equipment. Therefore, low ash content is desirable for solid fuel quality (Dinesha et al., 2019).

Based on SNI 01-6235-2000, the maximum allowable ash content is ≤ 8% (National Standardization Agency, 2000). All treatments complied with this standard, although rice flour at 20% (7.9%) approached the upper limit. This suggests that excessive binder use should be controlled to maintain briquette quality. Overall, binder concentrations of 10–15% produced more favorable ash content values while still satisfying the SNI requirements. Among the evaluated treatments, briquettes produced using 10% tapioca flour binder exhibited the lowest ash content and therefore showed better potential for producing high-quality solid fuel.

3. Calorific value

The calorific value of briquettes at different binder concentrations is presented in **Figure 3.**

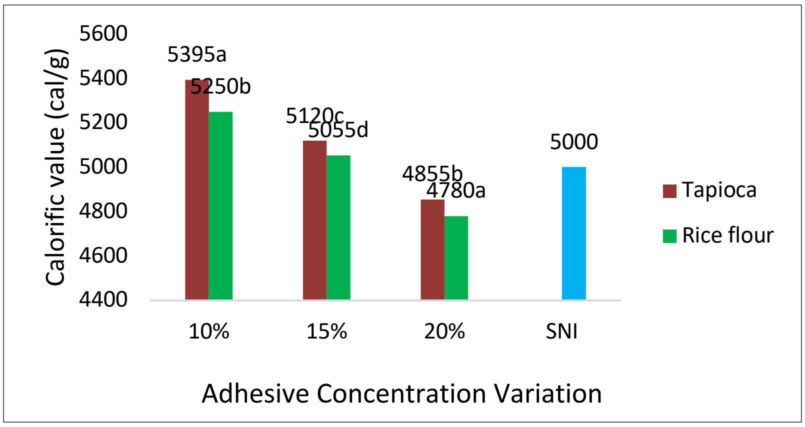

Figure 3. Calorific value of coconut husk briquettes

Figure 3 demonstrates that binder type and binder concentration significantly influenced the calorific value of coconut husk briquettes. In general, the calorific value decreased as binder concentration increased from 10% to 20% for both binder types. The highest calorific value was obtained from briquettes produced using 10% tapioca flour binder, reaching 5405 cal/g, whereas the lowest calorific value was recorded in briquettes produced using 20% rice flour binder, at 4780 cal/g.).

Two-way ANOVA revealed that binder type, binder concentration, and their interaction significantly affected calorific value ($p < 0.05$). Binder concentration had the strongest effect on calorific value ($F = 3906.000$; $p < 0.001$), followed by binder type ($F = 435.125$; $p < 0.001$). Furthermore, a significant interaction between binder type and concentration was observed ($F = 36.500$; $p < 0.001$), indicating that the effect of binder concentration on calorific value depended on the type of binder used.

The decrease in calorific value with increasing binder concentration can be attributed to the increasing proportion of non-carbon components introduced by the binders. Higher binder concentrations contribute to increased moisture and ash contents while simultaneously reducing fixed carbon content, which is the primary contributor to heat generation during combustion (Velusamy et al., 2023). Consequently, briquettes with higher binder concentrations release less energy during combustion.

At the same concentration level, briquettes produced using tapioca flour consistently exhibited higher calorific values than those produced using rice flour. At a concentration of 10%, the calorific value reached 5405 cal/g for tapioca flour compared to 5250 cal/g for rice flour. Similar trends were observed at concentrations of 15% and 20%. These results suggest that tapioca flour provides more favorable fuel characteristics, likely due to its lower mineral content and better combustion properties (Rofiq & Hardjono, 2023).

According to SNI 01-6235-2000, the minimum calorific value for charcoal briquettes is ≥ 5000 cal/g (National Standardization Agency, 2000)**.** In this study, briquettes with binder concentrations of 10% and 15% for both types met the SNI standard, whereas those with 20% concentration fell below the required threshold. This finding suggests that excessive binder addition is not recommended, as it can reduce the energy quality of the briquettes.

Overall, binder concentrations of 10–15% provided the most favorable balance between moisture content, ash content, and calorific value. Among all treatments evaluated, briquettes produced using 10% tapioca flour binder demonstrated the best fuel characteristics, as indicated by the highest calorific value combined with acceptable moisture and ash contents in accordance with SNI standards..

D. CONCLUSION

The results showed that both binder type and binder concentration significantly affected the moisture content, ash content, and calorific value of coconut husk charcoal briquettes ($p < 0.05$). Increasing binder concentration increased moisture and ash contents while reducing the calorific value. Among the treatments, 10% tapioca flour binder produced the best briquette quality, with a calorific value of 5405 cal/g, moisture content of 6.6%, and ash content of 6.5%. Overall, binder concentrations of 10–15% provided the most favorable balance of briquette quality parameters and complied with the requirements of SNI 01-6235-2000.

Future studies should evaluate additional briquette quality parameters, such as compressive strength, density, durability, and combustion emissions, to obtain a more comprehensive assessment of briquette performance. The use of alternative binders with lower mineral content should also be explored to further improve briquette quality.

REFERENCES

Abineno, J. C., Dethan, J. J. S., Bunga, F. J. H., & Haba Bunga, E. Z. (2025). Characterization and performance analysis of Kesambi branch biomass briquettes: A study on particle size effects. *Journal of Ecological Engineering*. https://doi.org/10.12911/22998993/195643

Adeleke, A., Odusote, J., Ikubanni, P., Lasode, O., Malathi, M., & Pasawan, D. (2021). Physical and mechanical characteristics of composite briquette from coal and pretreated wood fines. *International Journal of Coal Science and Technology*. https://doi.org/10.1007/s40789-021-00438-0

Ahmad Akromul Huda, Tawaqqal, A., Hidayatullah, S., & Juniardi, N. (2025). The Effect of Variations in the Composition of Cocoa Shell Charcoal and Peanut Shell Charcoal on Briquette Characteristics. *R.E.M. (Rekayasa Energi Manufaktur) Jurnal*. https://doi.org/10.21070/r.e.m.v10i2.1777

Aransiola, E. F., Oyewusi, T. F., Osunbitan, J. A., & Ogunjimi, L. A. O. (2019). Effect of binder type, binder concentration and compacting pressure on some physical properties of carbonized corncob briquette. *Energy Reports*. https://doi.org/10.1016/j.egyr.2019.07.011

Aulia, Y., & Huda, A. A. (2024). *Karakteristik Briket Campuran Arang Kulit Kakao dan Arang Sekam Padi Terhadap Mutu Briket*. *9*(2).

Badan Standardisasi Nasional. (2000). Standar Nasional Indonesia Briket Arang Kayu. *Badan Standardisasi Nasional Indonesia*, 1–4.

Borowski, G., Stępniewski, W., & Wójcik-Oliveira, K. (2017). Effect of starch binder on charcoal briquette properties. *International Agrophysics*. https://doi.org/10.1515/intag-2016-0077

BPS NTB, B. P. S. N. T. Ba. (2024). *Produksi Perkebunan Rakyat Menurut Jenis Tanaman di Provinsi Nusa Tenggara Barat (ribu ton), 2023*. Badan Pusat Statistik Provinsi Nusa Tenggara Barat. Produksi Perkebunan Rakyat Menurut Jenis Tanaman di Provinsi Nusa Tenggara Barat (ribu ton), 2023

BPS NTB, B. P. S. N. T. Ba. (2025). *Produksi Perkebunan Menurut Kabupaten/Kota dan Jenis Tanaman di Provinsi Nusa Tenggara Barat (ribu ton), 2024*. Badan Pusat Statistik Provinsi Nusa Tenggara Barat. https://ntb.bps.go.id/id/statistics-table/3/ZWxKek1URkRaV0kwYlM5T2NHcHRNVkZXTkVkaGR6MDkjMw==/produksi-perkebunan-menurut-kabupaten-kota-dan-jenis-tanaman-di-provinsi-nusa-tenggara-barat--2018.html

Brunerová, A., Roubík, H., Brožek, M., Herák, D., Šleger, V., & Mazancová, J. (2017). Potential of tropical fruit waste biomass for production of bio-briquette fuel: Using Indonesia as an example. *Energies*. https://doi.org/10.3390/en10122119

Dewi, R. P., Saputra, T. J., & Purnomo, S. J. (2022). *Analisis karakteristik briket arang serbuk gergaji dan tempurung kelapa*. *17*(1), 1–5.

Dinesha, P., Kumar, S., & Rosen, M. A. (2019). Biomass Briquettes as an Alternative Fuel: A Comprehensive Review. In *Energy Technology*. https://doi.org/10.1002/ente.201801011

Dwijayanti, S. (2019). Pengaruh Substitusi Tepung Tapioka Dengan Tepung Talas Terhadap Karakteristik Sifat Fisik, Kimia Dan Organoleptik Bakso Babi (Effect of Tapioca Flour Substitution with Taro meal On Physical, Chemical and Organoleptic Characteristics of Pork Meatballs). *Jurnal Peternakan Lahan Kering*, *1*(4), 648–656.

Imanningsih, N. (2012). Profil Gelatinisasi Beberapa Formulasi Tepung-tepungan untuk Pendugaan Sifat Pemasakan. *Penel Gizi Makan*, *35*(1), 13–22.

IRENA. (2021). *World Energy Transitions Outlook 2021*.

Lubwama, M., Birungi, A., Nuwamanya, A., & Yiga, V. A. (2024). Characteristics of rice husk biochar briquettes with municipal solid waste cassava, sweet potato and matooke peelings as binders. *Materials for Renewable and Sustainable Energy*. https://doi.org/10.1007/s40243-024-00262-x

Mousa, E., Ahmed, H., & Söderström, D. (2022). Potential of Alternative Organic Binders in Briquetting and Enhancing Residue Recycling in the Steel Industry. *Recycling*, *7*(2), 1–17. https://doi.org/10.3390/recycling7020021

Nurhilal, O. (2018). Pengaruh Komposisi Campuran Sabut dan Tempurung Kelapa terhadap Nilai Kalor Biobriket dengan Perekat Molase. *Jurnal Ilmu Dan Inovasi Fisika*. https://doi.org/10.24198/jiif.v2i1.15606

Nwabue, F. I., Unah, U., & Itumoh, E. J. (2017). Production and characterization of smokeless bio-coal briquettes incorporating plastic waste materials. *Environmental Technology and Innovation*. https://doi.org/10.1016/j.eti.2017.02.008

Olugbade, T., Ojo, O., & Mohammed, T. (2019). Influence of Binders on Combustion Properties of Biomass Briquettes: A Recent Review. *Bioenergy Research*. https://doi.org/10.1007/s12155-019-09973-w

Onukak, I. E., Mohammed-Dabo, I. A., Ameh, A. O., Okoduwa, S. I. R., & Fasanya, O. O. (2017). Production and characterization of biomass briquettes from tannery solid waste. *Recycling*. https://doi.org/10.3390/recycling2040017

Putra, B. S., & Hidayat, A. A. (2022). BRIKET DARI CANGKANG KELAPA SAWIT MENGGUNAKAN PEREKAT DAUN BELIMBING WULUH. *J-TETA (Jurnal Teknik Terapan)*, *1*(1), 1–6.

Rashwan, A. K., Younis, H. A., Abdelshafy, A. M., Osman, A. I., Eletmany, M. R., Hafouda, M. A., & Chen, W. (2024). Plant starch extraction, modification, and green applications: a review. In *Environmental Chemistry Letters*. https://doi.org/10.1007/s10311-024-01753-z

Renewable Energy Policy Network. (2021). Renewables in Cities 2021 Global Status Report Case Studies. *(Paris: REN21 Secretariat)*.

Rofiq, M. A., & Hardjono, H. (2023). PENGARUH RASIO PEREKAT TEPUNG TAPIOKA TERHADAP KARAKTERISTIK FISIK DAN PEMBAKARAN BRIKET SABUT KELAPA DAN SERBUK GERGAJI KAYU CAMPURAN. *DISTILAT: Jurnal Teknologi Separasi*. https://doi.org/10.33795/distilat.v9i4.4208

Seriani Annisa, Lukman Hakim, Suryati, Zainuddin Ginting, & Novi Sylvia. (2025). Pembuatan Biobriket dari Sabut Kelapa (Cocos Nucifera) Menggunakan Perekat Tepung Kanji. *Chemical Engineering Journal Storage (CEJS)*, *5*(05), 912–923. https://doi.org/10.29103/cejs.v5i05.23915

Velusamy, S., Subbaiyan, A., Shanmugamoorthy, M., & Thirumoorthy, P. (2023). Characterization of solid biomass briquette biofuel from the wastes of Senna auriculata and Ricinus communis using Tapioca starch for sustainable environment. *Environmental Science and Pollution Research*. https://doi.org/10.1007/s11356-022-22823-1

Waluyo, J., Setianto, M. M., Safitri, N. R., Pranolo, S. H., Susanti, A. D., Margono, & Paryanto. (2023). Characterization of Biochar Briquettes from Coconut Shell with the Effect of Binder: Molasses, Cow Manure and Horse Manure. *Evergreen*. https://doi.org/10.5109/6782158