International Journal of Advance Tropical Food (IJATF)
Vol. 3, No. 1, Mei 2021, pp. 44-56
E-ISSN: 2715-5889, DOI: http://dx.doi.org/10.26877/ijatf.v3i1.9302

Characteristics of Charcoal Briquwttes from Palm Oil Midrib and Coconut Midrib with Tapioka Glue

Bayu Nugroho, Faizah Hamzah, Raswen Efendi, Angga Pramana
[1]Fakultas Pertanian Universitas Riau, Kampus Bina Widya Km 12,5, Simpang baru Pekanbaru, (0761)63271
e-mail: pramana.angga@lecturer.unri.ac.id

Abstract

The purpose of this study aims to get the best combination of palm oil midrib and coconut midrib in making charcoal briquettes. The study was conducted experimentally using a complete randomized design method consisting of 5 treatments and 3 replications. The treatments in this study were the ratio of palm oil midrib and coconut midrib charcoal as follows: KSK_1 (100:0), KSK_2 (75:25), KSK_3 (50:50), KSK_4 (25:75) and KSK_5 (0:100). The parameters observed were density, water content, ash content, vapour content, bound carbon content and heating value. The result of palm oil midrib and coconut midrib shells had a significant effect on density, water content, ash content, vapour content, bound carbon content and heating value. Based on the results of the analysis, the best treatment in this study were KSK_4 of palm oil midrib and coconut midrib (25:75) with a density of 0,58 g/cm^3, water content 5,82%, ash content 5,87%, evaporating content 15,01%, bound carbon content 79,12%, and heating value content 6596,65 cal/g.

Keywords: palm oil midrib, coconut midrib, briquettes, tapioca glue

How to Cite: Nugroho, B., Hamzah, F., Efendi, R., & Pramana, A. (2021). Characteristics of Charcoal Briquwttes from Palm Oil Midrib and Coconut Midrib with Tapioka Glue. *International Journal of Advance Tropical Food*, 3(1), 44-56. http://dx.doi.org/10.26877/ijatf.v3i1.9302

INTRODUCTION

Indonesia is an agrarian country with huge agricultural and plantation areas such as palm oil plantations and coconut plantations. Indonesia, especially the province of Riau, is one of the regions with potential for palm oil plantations and coconut plantations. According to the Central Statistics Agency, the area of palm oil plantations in Riau in 2019 was 2.53 million hectares with a total production of 7.46 million tons per year, while the area of high coconut plantations in Riau was 421,002 hectares with a total production of 417,172 tons per year (Central Bureau of Statistics, 2019).

The area of plantations and the high productivity of palm oil and coconut make this palm frond and coconut frond a significant problem in palm oil plantations and coconut plantations because they have not been utilized optimally. The wider the area of palm oil plantations and coconut plantations, the more midrib waste produced. Technological innovation is needed to overcome this problem by making alternative fuels using readily available raw materials by utilizing plantation waste (Pramana et al., 2021).

Palm oil fronds and coconut fronds are solid waste from plantations that are generally just thrown away or piled up to rot as one of the leading wastes of palm oil plantations and coconut plantations, so many energy sources are thrown away. One of the uses of solid waste from palm oil fronds and coconut fronds is to use them as renewable energy sources or as alternative fuels such as briquette processing (Faiz et al., 2015).

Briquette is an alternative fuel in the form of charcoal and has a higher density. Briquettes as a simple fuel, both in the manufacturing process and in terms of the raw materials used, so that briquettes have considerable potential to be developed. The quality of briquettes can be seen from properties such as being environmentally friendly, not easily broken, smooth texture, flammable, slight smoke and high calorific value (Jamilatun, 2008).

The manufacture of briquettes requires an adhesive to hold the charcoal together so that it is easy to shape and does not crumble during compression. Shiami & Mitarlis (2014) stated that briquettes have specific characteristics that determine their quality. These characteristics are influenced by several factors, including raw materials, time, carbonization temperature and the type and amount of adhesive material.

Previous research on the manufacture of briquettes with various raw materials, among others, Kurnia (2018), characteristics of charcoal briquettes from a mixture of empty bunches and palm leaves, the best treatment with a combination of 30%: 70% using 5% tapioca adhesive resulted in a calorific value of 4,541cal/g. Papilo (2012), with the title of palm frond briquettes as an alternative energy source that has economic value and is environmentally friendly with a calorific value of 3,477 cal/g. Tapioca flour is an adhesive that is easy to obtain and cheap. Wiranata et al. (2017), conducted a study entitled the use of palm oil shells in the manufacture of briquettes with the addition of palm oil fronds, the best treatment with a combination of 80%:20% in this study resulted in a calorific value of 5,940 cal/g. Rahman (2009), with the research title of a mixture of cocoa husk charcoal and coconut shell charcoal using tapioca adhesive, the best result is a 25%:75% combination treatment with a calorific value of 5,823cal/g. This study aims to obtain the best treatment of charcoal briquettes with a combination of palm oil and coconut midrib charcoal briquettes, and according to SNI No. 01-6235-2000

RESEARCH METHOD

Materials and tools

The materials used in this study are coconut fronds, oil palm, and coconut fronds obtained from own plantations located in Bunga Raya area, Kemuning Muda Village, Bunga Raya District, Siak, and tapioca received at Pasar Baru Panam Pekanbaru.

The tools used in this study are a set of tools briquette press, drum as a carbonization tool, analytical balance, oxygen bomb calorimeter as a tool to measure calorific value, hydraulic press to press briquettes in a mold, sieve 60 mesh, paralon with a diameter of 1.5 inches and 5cm high, oven, kiln, porcelain dish, spatula, desiccator, stationery and camera.

Experimental design

The research was conducted experimentally using a completely randomized design (CRD) method with five treatments with three replications to obtain 15 experimental units. The treatment in this study refers to previous research by Wiranata et al. (2017), which uses 5% tapioca adhesive, as for the research formulation for making briquettes of palm oil and coconut shell charcoal briquettes can be seen as follows:

KSK1 = 100% palm frond charcoal and 0% coconut frond charcoal.
KSK2 = 75% palm oil frond charcoal and 25% coconut frond charcoal.
KSK3 = 50% palm frond charcoal and 50% coconut frond charcoal.
KSK4 = 25% palm oil frond charcoal and 75% coconut frond charcoal.
KSK5= 0% palm frond charcoal and 100% coconut frond charcoal.

The adhesive is made by mixing tapioca and water with 1:10 ratio. Tapioca was weighed as much as 10 g and added 100 ml of water, then cooked over low heat while stirring until evenly distributed, then obtained tapioca starch adhesive.

Parameters

Parameters that will be observed in briquettes with concentrations of corncob charcoal and areca nutshell charcoal are: density, water content, volatile matter content, ash content, bound carbon content, and calorific value according to SNI 01-6235-2000 (National Standards Agency, 2000).

Density

The density of briquettes refers to the Iranda (2020) step of density testing, namely preparing the equipment used, including samples, weighing the samples, measuring the volume of the sample and then calculating the density of the briquettes. The density of briquettes can be calculated by the formula:

$$\rho = \frac{m}{V}$$

Information:
ρ = Density (g/cm^3)
m = Weight of briquettes (g)
v = volume (cm^3)

Water content

Determination of water content refers to Darmanto et al. (2012), clean porcelain cup is carried out drying in an horizontal drying oven at a temperature of 100°C for 10 minutes. The porcelain cup was then placed in a desiccator for 30 minutes and then weighed. As much as 2 g sample is weighed and then put in a porcelain dish and dried in an oven at 105°C for 2 hours. The sample was then put into a desiccator for 30 minutes and then weighed. This drying was repeated until the final weight of the material obtained a constant weight (the difference between weighing before and after ± 0.02 g). Water content can be calculated by the formula:

$$\text{Water content} = \frac{W_1 - W_2}{W_1} \times 100\%$$

Description:
W1=Weight of the initial sample
W2=Weight of the final sample

Ash content

Observation of ash content refers to Darmanto et al. (2012), clean porcelain dishes were dried in a horizontal drying oven at 100°C for 10 minutes. The porcelain cup was then placed in a desiccator for 30 minutes and then weighed. The sample was weighed as much as 2 g, then put into a porcelain dish, then burned in furnace at a temperature of 600°C for 3 hours to obtain ash. The sample was then put into a desiccator for 30 minutes, then weighed to get the weight of the ash. Ash content can be calculated by the formula:

$$\text{Ash content} = \frac{X_2}{X_1} \times 100\%$$

Description:
X1= Weight of sample
X2= Weight of ash

Evaporative content

The determination of the volatile substance content refers to Iranda (2020). The cup containing the sample from the water content determination is inserted into the furnace at a temperature of 950ºC for 6 minutes. After evaporation is complete, the cup is placed in a desiccator for 30 minutes, then weighed to obtain the sample weight after heating. The evaporative contentcan be calculated by the formula:

$$\text{Evaporative content} = \frac{X_1 - X_2}{W} \times 100\%$$

Description:
W = weight of the initial sample to the analysis of water content
X1 = weight of the sample after the determination of water content
X2 = weight of the sample after heating at 950°C

Bound carbon content

Observation of bound carbon content refers to SNI 01-6235-2000, calculating the carbon fraction by calculating the results of water content, volatile matter content and ash content obtained from each sample according to the bound carbon content formula. Bonded carbon content can be calculated using the formula:
Bonded carbon content= 100%- (Water content+ash content+volatile content) %

Calorific value

Observation of the calorific value level refers to using a bomb calorimeter PARR 1261. The test is carried out by weighing 1 g and put into a cup crucible. The water jacket vessel is prepared and filled with 2 litres of distilled water. Micro mire 6 cm long is placed on both arms of the bomb vessel, and in the middle, the Micro mire is tied with 10 cm cotton thread. The sample is then placed into the bomb vessel until the cotton thread touches the sample. The bomb vessel is filled with pure oxygen with a pressure of 25 bar, then inserted into the vessel calorimeter. The temperature gauge and stirrer are inserted into the calorimeter vessel. The bomb calorie meter is ready to use by pressing the switch. A bomb calorimeter is calibrated with set 0, then pressed fire. The temperature display screen is observed until it reaches the highest increase rate. The calorific value can be calculated using the formula (Mulia, 2007):

$$Q14 = \frac{(\in \times \theta) - \text{Qign} - \text{Qfuse}}{\text{mf}}$$

Description:
Qign = Correction: 7.1011 J
0.14 = Constant 1 J: .24 cal
Qfuse = Correction micro mire 174.966 J
mf = mass of the sample (g)
∈ = Energy during combustion: 11,214,340 J/K
θ = Increase in temperature: K

Data Analysis

Observational data obtained were analyzed statistically, using variance (ANOVA) with software SPSS version 2.5. If the data shows the calculated F_{table}, then further tests are carried out with the Duncan New Multiple Range (DNMR) test at a level of 5% to determine the difference in each treatment.

RESULTS AND DISCUSSION

The results of the analysis of briquettes, including density, water content, volatile matter content, ash content, bound carbon content and calorific value.

Density

The results of the variance test showed that the mixture of ingredients in the manufacture of palm frond charcoal briquettes and coconut frond charcoal had a significant effect (P>0.05) on the density of briquettes. The average density of charcoal briquettes after further testing with DNMRT level 5% can be seen in Table 1.

Table 1. The average value of briquette density

Treatment	Density(g/cm^3)
KSK_1 = 100% palm oil midrib charcoal and 0% coconut midrib charcoal	0.49±0.006^a
KSK_2 = 75% palm oil midrib charcoal and 25% coconut midrib charcoal	0.52±0.006^b
KSK_3 = 50% palm oil midrib charcoal and 50% coconut midrib charcoal	0.53±0.006^b
KSK_4 = 25% palm oil midrib charcoal and 75% coconut midrib charcoal	0.58±0.015^d
KSK_5 = 0% palm oil midrib charcoal and 100% coconut midrib charcoal	0.56±0.012^c

The lowest density value was obtained in the treatment of KSK1, namely with a combination of palm midrib charcoal and coconut midrib charcoal (100:0). This treatment KSK1 with a density value of 0.49 g/cm3. In contrast, the highest density value of charcoal briquettes was obtained in the treatment of KSK4, namely with a combination of palm frond charcoal and coconut frond charcoal (25:75) with a density value of 0.58 g/cm3. Charcoal briquettes with high density can increase the compactness and strength of briquettes, so they are not easily crushed. The higher the density value, the better the compactness (Saragih, 2007).

The density is influenced by the specific gravity of the charcoal briquettes used. The density of the charcoal briquettes is influenced by the specific gravity of the raw materials, namely palm oil fronds and coconut fronds. Table 5 shows that mixing palm oil frond charcoal and coconut frond charcoal can increase the density value of charcoal briquettes. This is because the density of the palm frond is lower than the density of the coconut frond. Palm oil midrib fibre has a specific gravity of 0.36 g/cm3 (Intara et al., 2012), while the specific gravity of coconut frond particles that have been sifted is 4.50 g/cm3 (Darmanto et al., 2007). The density value of charcoal briquettes in this study ranged from 0.49 g/cm3-0.58 g/cm3. According to Hendra (2007), the different types of raw materials affect the size of the density value of the briquettes produced. Raw materials with high specific gravity will produce briquettes with high density.

The density in KSK5 was lower than KSK4, and this was because KSK5 did not add palm frond charcoal (0:100). Density is influenced by the specific gravity of the material used, the addition of palm oil midrib charcoal and coconut midrib charcoal in KSK4 (25:75) affects the density in the treatment, palm oil midrib charcoal has a density that tends to be high at 0.36 g/cm3 and added coconut frond charcoal which has a higher specific gravity of 4.50 g/cm3 so that the specific gravity in KSK4 is higher than KSK5. The results of this study are by Hendra (2007), which states that different types of raw materials affect the density value of the briquettes produced.

Water content

The variance results showed that the mixture of ingredients in the manufacture of palm oil frond charcoal briquettes and coconut frond charcoal had a significant effect (P>0.05) on the water content of the briquettes. The average water content of briquettes after further testing with DNMRT level 5% can be seen in Table 2.

Table 2. The average value of water content briquette

Treatment	Water content(%)
KSK_1 = 100% palm oil midrib charcoal and 0% coconut midrib charcoal	7.76±0.08[d]
KSK_2 = 75% palm oil midrib charcoal and 25% coconut midrib charcoal	6.40±0.2[c]
KSK_3 = 50% palm oil midrib charcoal and 50% coconut midrib charcoal	6.39±0.09[c]
KSK_4 = 25% palm oil midrib charcoal and 75% coconut midrib charcoal	5.82±0.12[a]
KSK_5 = 0% palm oil midrib charcoal and 100% coconut midrib charcoal	6.17±0.03[b]

Table 2 shows the highest water content was obtained in the treatment of KSK1 with a combination of palm oil midrib charcoal and coconut midrib charcoal (100:0) with a value of 7.76%. In comparison, the lowest water content was obtained in the treatment of KSK4 with a combination of palm oil midrib charcoal and coconut midrib charcoal (25:75) with a water content value of 5.82%.

Table 2 shows that the more use of palm frond charcoal and the less use of coconut frond charcoal, the higher the water content obtained. This is because palm oil frond charcoal has a low lignin of 17.4% (Ginting, 2013) compared to coconut frond charcoal, which tends to have high lignin, 45% (Darmanto et al., 2007), thus causing the midrib water content. Coconut tends to be lower. The higher the cellulose and lignin content, the lower the water content. The results of this study are by (Wiranata et al., 2017) that the more addition of palm frond charcoal causes the water content of the briquettes to tend to be higher.

The water content in KSK5 was higher than KSK4, this was because KSK5 did not add palm frond charcoal (0:100). The water content is influenced by the amount of lignin and cellulose contained in the materials used, the addition of palm oil frond charcoal and coconut frond charcoal in KSK4 (25:75) affects the water content in the treatment, palm oil frond charcoal has lignin and cellulose which tend to be high by 33.7%, 17.4% and added coconut frond charcoal which has higher cellulose and lignin by 43%, 45% so that the water content in KSK4 is lower than KSK5. The results of this study are by Iranda (2020), which states that the amount of lignin and cellulose in raw materials affects the water content produced.

The water content produced in this study ranged from 5.82%-7.76%. The water content in this study is by SNI No. 01-6235-2000 with a maximum water content of 8%. The water content of this study was higher than that of the study (Wiranata et al., 2017), from palm oil shells and palm fronds ranging from 3.24% to 4.14%. This is due to the low water content in palm oil shell briquettes, around 4-14% (Wiranatacoconut shell et al., 2017) compared to the water content charcoal briquettes in this study which was around 7.76%.

According to Hendra and Winarni (2003), the amount of lignin and cellulose in the raw material affects the level of water content produced. Faizal et al. (2014) stated that the higher the lignin and cellulose in the material, the lower the water content.

Ash Content

The variance results showed that the mixture of ingredients in the manufacture of palm frond charcoal briquettes and coconut frond charcoal had a significant effect

(P>0.05) on the ash content of the briquettes. The average ash content of briquettes after further testing with DNMRT level 5% can be seen in Table 3.

Table 3. The average value of ash content briquette

Treatment	Ash content(%)
KSK_1 = 100% palm oil midrib charcoal and 0% coconut midrib charcoal	7.84±0.07[d]
KSK_2 = 75% palm oil midrib charcoal and 25% coconut midrib charcoal	6.56±0.2[c]
KSK_3 = 50% palm oil midrib charcoal and 50% coconut midrib charcoal	6.26±0.13[c]
KSK_4 = 25% palm oil midrib charcoal and 75% coconut midrib charcoal	5.87±0.11[a]
KSK_5 = 0% palm oil midrib charcoal and 100% coconut midrib charcoal	6.49±0.04[b]

The highest ash content in this study was obtained in the treatment of KSK1 with a combination of palm oil midrib charcoal and coconut midrib charcoal (100:0) with a value of 7.84%. In contrast, the lowest ash content value was obtained in the treatment of KSK4 with a combination of palm oil midrib charcoal and coconut frond charcoal (25:75) with a value of 5.87%.

Table 3 shows that the less use of palm frond charcoal and the more use of coconut frond charcoal, the lower the ash content. This was due to the 33.7% and 17.4% of cellulose and lignin content in palm oil fronds (Ginting, 2013), which were lower than the cellulose and lignin content of coconut fronds of 43% and 45% (Darmanto et al., 2007). thus affecting the ash content of the briquettes. The higher the cellulose and lignin content, the better quality briquettes are produced, reducing the ash content. This is in accordance with Salji (2017) opinion, which states that high lignin and cellulose produce good charcoal to reduce ash content. In accordance with Triono (2006) opinion, the content of raw materials for making briquettes is closely related to the ash content produced, such as cellulose, lignin, silica, and the minerals contained therein. The ash content in KSK4 was lower due to the combination of palm oil frond charcoal and coconut frond charcoal which had high lignin.

The ash content in KSK5 was higher than KSK4, this was because KSK5 did not add other charcoal from palm fronds (0:100). The ash content is influenced by the amount of lignin and cellulose contained in the materials used, the addition of palm oil frond charcoal and coconut frond charcoal in KSK4 (25:75) affects the ash content in the treatment, palm oil frond charcoal has high lignin and cellulose of 33.7%, 17.4% and added coconut frond charcoal which has higher cellulose and lignin by 43%, 45% so that the water content in KSK4 is lower than KSK5. The results of this study are by Iranda (2020), which states that the amount of lignin and cellulose in raw materials affects the ash content produced.

The value of ash content in this study ranged from 5.87%-7.84%. The results of this study are by the SNI for charcoal briquettes no. 01-6235-2000 with a maximum ash content of 8%. The value of ash content in this study was higher than that of Wiranata et al. (2017), with ash content values ranging from 4.94%-5.23%. This is because the ash content in palm shell charcoal is 5.23% lower than the ash content in this study of 7.84%.

According to Salji (2017), high lignin and cellulose produce good charcoal so that it can reduce ash content, and ash content is also influenced by the carbonization process and chemical content in the form of silica. Silica compounds can bind inorganic compounds in the carbonization process so that the resulting high ash content. According to Kurnia (2018), a high silica content in raw material will increase the ash content. The ash content is proportional to the amount of inorganic material such as silica contained in briquettes.

Evaporative content

The variance results showed that the mixture of ingredients in the manufacture of palm oil frond charcoal briquettes and coconut frond charcoal had a significant effect ($P>0.05$) on the volatile matter content of the briquettes. The average volatile matter content of charcoal briquettes after further testing with 5% DNMRT can be seen in Table 4.

Table 4. The average value of evaporative content briquette

Treatment	Volatile subtances(%)
KSK_1 = 100% palm oil midrib charcoal and 0% coconut midrib charcoal	22.13±2.9^{b}
KSK_2 = 75% palm oil midrib charcoal and 25% coconut midrib charcoal	19.20±2.1^{ab}
KSK_3 = 50% palm oil midrib charcoal and 50% coconut midrib charcoal	16.57±0.4^{a}
KSK_4 = 25% palm oil midrib charcoal and 75% coconut midrib charcoal	15.01±2.8^{a}
KSK_5 = 0% palm oil midrib charcoal and 100% coconut midrib charcoal	15.86±1.6^{b}

The highest volatile matter content was obtained in the KSKtreatment1 with a combination of palm midrib charcoal and coconut midrib charcoal (100:0) with a value of 22.13%, while the lowest volatile matter content was obtained in the KSKtreatment4 with a combination of palm oil midrib charcoal and midrib charcoal. Coconut (25:75) with a value of 15.01%. Based on Table 8, KSK1 was significantly different from KSK3, KSK4 and KSK5, while with KSK2 the difference was not significant.

Table 4 shows that the less use of palm frond charcoal and the more use of coconut frond charcoal, the lower the volatile substances produced. This is due to the type of raw material used. Sudiro and Suroto (2014) stated that volatile substances result from the decomposition of compounds in briquettes other than water. The levels of volatile substances in this study ranged from 15.01% to 22.13%. The levels of volatile substances in this study did not meet the quality requirements of SNI No. briquettes. 01-6235-2000 with a maximum volatile substance content of 15%, so the volatile substance in this study was not good.

According to Sinurat (2011), the volatile substances in the fuel function to stabilize the flame and the rate of combustion of the charcoal briquettes produced. The lower the vapour content of a briquette produced, the better the quality of the briquette (Yuliah et al., 2017).

Bound carbon content

The variance results showed that the mixture of ingredients in the manufacture of palm frond charcoal briquettes and coconut frond charcoal had a significant effect

(P>0.05) on the bonded carbon content of briquettes. The average bonded carbon content of charcoal briquettes after further testing with DNMRT level 5% can be seen in Table 5.

Table 5. The average value of bound carbon content

Treatment	Bound carbon content (%)
KSK_1 = 100% palm oil midrib charcoal and 0% coconut midrib charcoal	70.04±2.8[a]
KSK_2 = 75% palm oil midrib charcoal and 25% coconut midrib charcoal	74.24±2.3[b]
KSK_3 = 50% palm oil midrib charcoal and 50% coconut midrib charcoal	77.17±0.4[bc]
KSK_4 = 25% palm oil midrib charcoal and 75% coconut midrib charcoal	79.12±2.9[c]
KSK_5 = 0% palm oil midrib charcoal and 100% coconut midrib charcoal	77.66±1.6[bc]

Palm oil and coconut frond charcoal (100:0) with a value of 70.04%. The highest bound carbon content in this study was obtained in the treatment of KSK4 with a combination of palm oil midrib charcoal and coconut midrib charcoal (25:75) with a value of 79.12%. In contrast, the lowest bound carbon content value was obtained in the treatment of KSK1 with a combination of midrib charcoal. Based on Table 9, the treatment of KSK4 was not significantly different from that of KSK3 and KSK5.

Table 5 shows that the less use of palm frond charcoal and the more use of coconut frond charcoal, the higher the carbon content of the briquettes obtained tends to be. This is because the volatile matter content and ash content in this study decreased with coconut frond charcoal. This is by Masturin (2002), which states that the volatile matter content and the ash content contained in the briquettes greatly affect the bound carbon content of the charcoal briquettes produced.

The bound carbon content is also influenced by chemical components such as cellulose and lignin. The higher the cellulose and lignin content, the higher the bound carbon. This is by the opinion of Wijayanti (2009), which states that carbon content is closely related to chemical content such as cellulose and lignin. When cellulose and lignin are high, it produces good carbon content. The cellulose and lignin content in palm oil fronds was 33.7% and 17.4% (Ginting, 2013) which was lower than the cellulose and lignin content in coconut fronds of 43% and 45% (Darmanto et al., 2007) thus showing a significant difference. Each treatment is actual.

The results of this study on the treatment of KSK3, KSK4 and KSK5 have met the quality requirements and the quality of briquettes according to SNI charcoal briquettes no. 01-6235-2000, namely the minimum bound carbon content of 77%. The value of the bound carbon content in this study ranged from 70.04%-79.12%. While the treatment of KSK1 and KSK2 did not meet the requirements of SNI, this was due to the water content, ash content and volatile substances in the treatment of KSK1 and KSK2, higher than the treatment of KSK3, KSK4 and KSK5.

The bound carbon content also affects the rate of briquette combustion. Briquettes that have a high bound carbon content will cause a long burning time and a relatively shorter ignition time (Fachri et al, 2010).

Calorific value

The variance results showed that the mixture of ingredients in the manufacture of palm oil and coconut shell charcoal briquettes had a significant effect (P>0.05) on the calorific value of briquettes. The average water content of briquettes after further testing with 5% DNMRT can be seen in Table 6.

Table 6. The average value of calorific value

Treatment	Calorific Value (cal/g)
KSK_1 = 100% palm oil midrib charcoal and 0% coconut midrib charcoal	5252.58±138.3[a]
KSK_2 = 75% palm oil midrib charcoal and 25% coconut midrib charcoal	5414.22±81[ab]
KSK_3 = 50% palm oil midrib charcoal and 50% coconut midrib charcoal	5736.73±260.4[ab]
KSK_4 = 25% palm oil midrib charcoal and 75% coconut midrib charcoal	6596.65±73.1[c]
KSK_5 = 0% palm oil midrib charcoal and 100% coconut midrib charcoal	6324.85±1107.3[bc]

The highest calorific value in this study was obtained in the KSKtreatment4 with a combination of palm oil midrib and midrib charcoal (25:75) with a value of 6596.65 cal/g. It was not significantly different from the KSK4. In comparison, the lowest calorific value was obtained at KSKtreatment1 with a combination of palm oil midrib charcoal and coconut midrib charcoal (100:0) with a value of 5252.58 cal/g. And not significantly different from the treatment of KSK2 and treatment of KSK3.

Table 6 shows that the less use of palm frond charcoal and the more use of coconut frond charcoal, the higher the calorific value produced. This is due to the low water content, volatile matter content, ash content, and high bound carbon content in this study. The control treatment of KSK1 and KSK5 shows that KSK1 with 100% palm frond charcoal obtained the calorific value of charcoal briquettes of 5252.58 cal/g, while KSK5 with 100% coconut frond charcoal obtained calorific value of 6324.85 cal/g. This is due to the water, volatile matter, and ash content in KSK5 being lower than KSK1.

The calorific value in this study ranged from 6241 cal/g-7815cal/g. Briquettes in this study met the quality standards and quality of charcoal briquettes according to SNI No. 01-6235-2000, which is at least 5000 cal/g. According to Purnomo et al, (2015), there are differences between treatments regarding the calorific value because the calorific value has something to do with density, particle size, specific gravity, and the materials' properties in the manufacture of briquettes. Syamsiro and Saptoadi (2007) stated that the water content, volatile matter content, low ash content and high bound carbon content, the calorific value produced will tend to be higher.

CONCLUSION

Based on the results of research on the characteristics of palm oil and coconut midrib charcoal briquettes, it can be concluded that the best combination of palm oil midrib and coconut midrib charcoal briquettes in this study was obtained in treatment KSK4 with a combination of palm oil midrib charcoal and coconut midrib charcoal (25: 75) with a density value of 0.58 g/cm3, 5.82% water content, 5.87% ash content, 15.01% volatile matter content, 79.12% bound carbon content and 6596.65% calorific value. The results of this study are by the quality standards and the quality of charcoal briquettes according to SNI No. 01-6235-2000.

REFERENCES

Badan Pusat Statistika Riau. (2019). *Produksi, Produktivitas, dan Luas Lahan Kelapa Sawit*. Badan Pusat Statistik.

Badan Standar Nasional. (2000). *Briket Arang Kayu SNI 01-6235-2000*. Badan Standarisasi Nasional Indonesia, Jakarta Pusat.

Darmanto, S., Sediono, W., Setyoko, B., & Murni, M. (2007). Kajian Pelepah Kelapa sebagai Serat Komposit (Study of Coconut Branch as Composite Fiber). *Teknik*, 28(1), 66-70. https://doi.org/10.14710/teknik.v28i1.2075

Dwisaputra, A. (2016). Pengaruh Perekat Daun Kembang Sepatu Terhadap Kualitas Biobriket dari Pelepah Kelapa Bagian Pangkal. *Skripsi*. Politeknik Negeri Sriwjaya. Palembang.

Faiz, T. A., Harahap, L. A., & Daulay, S. B. (2015). Pemanfaatan Tongkol Jagung dan Limbah Teh Sebagai Bahan Briket. *Jurnal Rekayasa Pangan Dan Pertanian*, 4(3), 427-432.

Faizal, M., Andynapratiwi, I., & Putri, P. D. A. (2014). Pengaruh komposisi arang dan perekat terhadap kualitas biobriket dari kayu karet. *Jurnal Teknik Kimia*, 20(2), 36-44.

Ginting, S. P. & Elizabeth, J. (2013). Teknologi Pakan Berbahan Dasar Hasil Sampingan Perkebunan Kelapa Sawit. *Lokakarya* Sistem Integrasi Kelapa Sawit-Sapi. Pusat Penelitian Kelapa Sawit. Medan.

Hendra, D. (2011). Pemanfaatan eceng gondok (Eichornia crassipes) untuk bahan baku briket sebagai bahan bakar alternatif. *Jurnal Penelitian Hasil Hutan*, 29(2), 189-210. https://doi.org/10.20886/jphh.2011.29.2.189-210

Hendra, D., & Winarni, I. (2003). Sifat fisis dan kimia briket arang campuran limbah kayu gergajian dan sabetan kayu. *Jurnal Penelitian Hasil Hutan*, 21(3), 211-226. https://doi.org/10.20886/jphh.2003.21.3.211-226

Hendra. D. & Pari, G. (2002). Teknologi Alternatif Pemanfaatan Limbah Industri Pengolahan Kayu. *Makalah* Falsafah Sains, Institut Pertanian Bogor, Bogor.

Intara, Y. I. (2012). Studi sifat fisik dan mekanik parenkhim pelepah daun kelapa sawit untuk pemanfaatan sebagai bahan anyaman. *Agrointek*, 6(1), 36-44. https://doi.org/10.21107/agrointek.v6i1.1952

Iranda, R. A. (2020). Karakteristik Briket Arang Tongkol dan Kelobot Jagung dengan Perekat Tapioka. *Skripsi*. Universitas Riau. Pekanbaru.

Jamilatun, S. (2008). Sifat-sifat penyalaan dan pembakaran briket biomassa, briket batubara dan arang kayu. *Jurnal Rekayasa Proses*, 2(2), 37-40. https://doi.org/10.22146/jrekpros.554

Kurnia, R. (2018). Karakteristik Briket Arang dari Campuran Tandan Kosong dan Daun Kelapa Sawit. *Skripsi*. Universitas Riau. Pekanbaru.

Kurniawan, O. & Marsono. (2008). *Superkarbon, Bahan Bakar Alternatif Pengganti Minyak Tanah dan Gas*. Penebar Swadaya, Jakarta.

Masturin, A. (2002). Sifat fisik dan kimia briket arang dari campuran arang limbah gergajian kayu. *Skripsi*. Intitut Pertanian Bogor. Bogor.

Mulia, A. (2007). Pemanfaatan Tandan Kosong dan Cangkang Kelapa Sawit sebagai Briket Arang. *Tesis*. Program Pasca Sarjana Universitas Sumatera Utara. Medan.

Ningrum, M. S. (2019). Pemanfaatan Tanaman Kelapa Oleh Etnis Masyarakat di Desa Kelambir dan Desa Kubah Sentang Kecamatan Pantai Labu Kabupaten Deli Serdang. *Skripsi* .Fakultas Biologi Universitas Medan Area. Medan.

Pramana, A., Hamzah, A., Haitami, A., & Okalia, D. 2021. Quality Analysis of KOSMOS TKKS Compose Using Selulotic Microorganism. *Jurnal Agrointek*. 15(3): 839-844. https://doi.org/10.21107/agrointek.v15i3.10149

Pratiwi, F. M., & Sutara, P. K. (2013). Etnobotani kelapa (Cocos nucifera L.) di wilayah Denpasar dan Badung. *Jurnal Simbiosis*, 1(2), 102-111.

Purwanto, D. (2011). Arang dari limbah tempurung kelapa sawit (Elaeis guineensis Jacq). *Jurnal Penelitian Hasil Hutan*, 29(1), 57-66. https://doi.org/10.20886/jphh.2011.29.1.57-66

Rahmadani. (2016). Pembuatan Briket Arang daun Kelapa Sawit (Elaeis gueneensis Jacq.) dengan Perekat Pati Sagu (Metroxylon sago Rott). *Skripsi*. Fakultas Pertanian Universitas Riau. Riau.

Rahman, A. (2009). Pengaruh Komposisi Campuran Arang Kulit Kakao dan Arang Pelepah Kelapa Terhadap Karakteristik Biobriket. *Tesis*. Universitas Gajah Mada. Yogyakarta.

Salji, A. (2017). Variasi konsentrasi bahan, molase, dan tekanan pada pembuatan briket tempurung kelapa dan sekam padi. *Skripsi*. Institut Teknologi Sepuluh Nopember. Surabaya.

Saragih, I. D (2007). Pengaruh Tekanan Pengepresan dan Jenis Perekat terhadap Mutu Briket Arang Cangkang Kelapa Sawit, *Skripsi.* Jurusan Kimia Fakultas Matematika dan Ilmu Pengetahuan Alam. Universitas Sumatera Utara.

Satmoko, M. E. A., Saputro, D. D., & Budiyono, A. (2013). Karakterisasi briket dari limbah pengolahan kayu sengon dengan metode cetak panas. *Journal of Mechanical Engineering Learning*, 2(1). 7. https://journal.unnes.ac.id/sju/index.php/jmel/article/view/1942

Shiami, M. A. (2014). Pembuatan Briket dari Campuran Blotong dan Limbah Padat Proses Sintesis Furfural Berbahan Dasar Ampas Tebu. *UNESA Journal of Chemistry*. 3(3): 104-110.

Sudarmadji, S., Haryono, B., & Suhardi. (1997). *Analisa Bahan Makanan dan Pertanian*. Liberty. Yogyakarta.

Sudiro, S. S. (2014). Pengaruh komposisi dan ukuran serbuk briket yang terbuat dari batubara dan jerami padi terhadap karakteristik pembakaran. *Jurnal Sainstech Politeknik Indonusa Surakarta.* 2(2): 1-18.

Suprapti, S., & Ramlah, S. (2013). Utilization of Cacao Pods Shells For Charcoal Briquettes. *Biopropal Industri*, 4(2): 65-72.

Syamsiro, M. & Saptoadi, H. (2007). Pembakaran briket biomassa cangkang kakao: pengaruh temperature udara preheat. *Prosiding* Seminar Nasional Teknologi 2007 (SNT 2007). Yogyakarta.

Thoha, M. Y., & Fajrin, D. E. (2010). Pembuatan briket arang dari daun jati dengan sagu aren sebagai pengikat. *Jurnal Teknik Kimia*, 17 (1): 34-43.

Triono, A. (2006). Karakteristik Briket Arang dari Campuran Serbuk Gergajian Kayu Afrika dan Sengon dengan Penambahan Tempurung Kelapa. *Skripsi*. Institut Pertanian Bogor. Bogor.

Usman, M. N. (2007). Mutu Briket Arang Kulit Buah Kakao Dengan Menggunakan Kanji Sebagai Perekat. *Jurnal Perennial*, 3(2), 55-58. https://doi.org/10.24259/perennial.v3i2.172

Wahyusi, K. N., Dewati, R., Ragilia, R. P., & Kharisma, T. (2012). Briket Arang Kulit Kacang Tanah dengan Proses Karbonisasi. *Jurnal Teknik Kimia*, 6(2): 70- 73.

Widiarti, E. S. (2010). Studi Eksperimental Briket Organik dengan Bhan Baku dari PPLH Organik. *Skripsi.* Fakultas Teknik Industri Institut Teknologi Sepuluh November. Surabaya.

Wijayanti, S. D. (2009). Karakteristik Briket Arang dari Serbuk Gergaji dengan Penambahan Arang Cangkang Kelapa Sawit. *Skripsi.* Fakultas Pertanian Universitas Sumatera Utara. Medan.

Wiranata, C. I., Hamzah, F., & Restuhadi, F. (2017). Pemanfaatan cangkang kelapa sawit dalam pembuatan briket dengan penambahan pelepah kelapa sawit. *Jurnal online mahasiswa*. 4(1): 1-8.

Yusuf, M. (2013). Pemanfaatan Pelepah Kelapa Sawit Sebagai Bahan Baku Pembuatan Briket Arang. *Skripsi*. Universitas Riau. Riau.