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Analysis of the Effect of Varying Palm Kernel Particle Sizes on the Calorific Value of Palm Kernel Briquette

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aims: This work is aimed at analysing the effect of different palm kernel particle sizes on the calorific value of the briquettes produced using this material.
Study Design: The palm kernel shell used was obtained from the local market, after which it was taken to the grinder so as to get it into powdered form of different sizes. The powered palm kernel shell was then sieved so as to get the specific particles sizes using mesh of different sizes.
Place and Duration of Study: Department of Mechanical Engineering, Federal University of Technology, Akure, Ondo State, Nigeria, between August 2014 and February 2015.
Methodology: Three different sizes of mesh were used, 4.756, 2.36, and 0.6 mm labelled A, B and C respectively. The various sizes were then mixed with starch which is the binding material and poured into the briquetting machine operated at a constant pressure of 100 Kg/cm^2. The briquette was made and dried. A e2k type combustion calorimeter was used to determine the calorific values of the briquettes.
Results: The results show that the calorific values are 18.415, 18.412 and 17.342 MJ/kg for the particle sizes 4.756, 2.36, and 0.6 mm respectively.

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Conclusion: This result shows the calorific value of the palm kernel briquette increases with the increasing particle sizes.

Keywords: Briquette; palm kernel; particle size; calorimeter; calorific value.

1. INTRODUCTION

The palm oil plants are found in most parts, especially, southern states of Nigeria. The different parts of the oil palm are utilized for different purposes. While the leaves provide brooms for tidying the environment, the kernel is a major source of red palm oil used for cooking. The seed is the source of Palm Kernel Oil (PKO) used extensively in the pharmaceutical and cosmetic industries. In the palm oil processing operations, the solid wastes are: Empty fruit Bunch, Palm fibre, and Palm Kernel Shell (PKS) [1]. Out of these solid waste, PKS is useful in making briquettes.

A briquette can be defined as a product formed by physco-mechanical conversion of dry, loose and tiny particles with or without addition of an additive into a solid state characterized by a regular shape. There are two types of briquette materials [2]. It can be homogeneous (made of the same materials) or non- homogeneous (made of different materials). Briquetting is a high-pressure process which can be done at elevated temperature or at ambient temperature depending on the technology one wants to employ [3]. During this process, fine material is compacted into regular shape and size which does not fall apart during transportation, storage or combustion.

Briquetting process is used for forming fine particles into a designed shape. It can be regarded as a waste control measure in the case of production of briquettes from agricultural wastes [4].

A lot of work have been done on palm kern shell briquette, [2] worked on the impact of Palm Kernel shell on the calorific value of composite sawdust briquette. It concluded that He made use of composite sawdust which was produced by mixing screened sawdust waste and palm kernel shell of grades 1.18, 2.00 and 2.36 mm in percentage ratios of 90:10, 80:20, 70:30, 60:40 and 50:50, respectively and starch gel was used to bind the mixtures, respectively in their ratios. Also calorific tests were carried out by him on the briquette samples using the Gallenkhamp Calorimeter to determine the energy contents. From the experiment, in respective of the percentage composition of the composite sawdust briquettes, the Percentage Heat Utilized (PHU) was found to increase from the intermediate phase through the low power phase. For other parameters like the Specific Fuel Consumption (SFC), Power Output and Burning Rate respectively, there was a sharp decrease from the intermediate phase through the low power phase.

Usman et al. [5] produced briquettes from palm kernel shell by carbonising the shell to get the charcoal followed by the pulverization of the charcoal. Starch was used as binder. The briquettes were also analysed for their combustion characteristics. The results obtained showed that the palm kernel shell briquettes had higher calorific value than the briquettes from charcoal and sawdust.

The physical and combustion properties of the briquette were determined by [2] at varying biomass-binder ratios of 100:15, 100:25, 100:35 and 100:45 using cassava starch as the binding agent. Both the physical and combustion properties of the briquette were significantly affected by the binder level ($P < 0.05$).

Also [6] worked on Fuel Developed from Rice Bran Briquettes and palm kernel shells. Three grades of cylindrical briquettes with centrally located holes were produced from a mixture of rice bran and palm kernel shells of different mixing ratios using cassava starch as binder. Palm kernel shell to rice bran ratios of 1:9, 2:8, 3:7, 4:6, and 5:5 were used. The maximum calorific values were obtained in the 3:7 ratio (palm kernel shell to rice bran).

The effects of some processing parameters on physical and densification characteristics of corncob briquettes were studied by [7]. Corncobs were collected from farm dump at a moisture content of 10.96 dry bases, granulated and sieved into three particle sizes 4.70 mm, 2.40 mm and 0.60 mm. Starch mutillage of 20, 25, and 30% by weight of the residue was added as binder. The briquettes were produced using briquetting machine at pressures of 2.1, 4.2 and 6.6 MPa. For the three processing parameters examined, binder ratio 20%, particle size 0,60 mm and pressure (6.6MPa) exhibited most positive results.

Palm kernel is one of the useful materials is frequently used in making briquette. Hence if the effect of different seizes of palm kernel shell particles on the calorific value of palm kernel briquette is known it will help in removing other particle seizes from the briquette thereby reducing material wastage during briquetting.

This research focused on the production of briquette of different particle sizes of palm kernel shell using starch as the binding element for the briquette. The effects of the sizes on the calorific value were established in this research.

2. METHODOLOGY

The palm kernel shell used was obtained from the local market, which was later taken to the grinder so as to get it into powdered form. The powered palm kernel shell was then sieved so as to get the various particles using mesh of different sizes based on previous work done on briquette. The mesh with 4.756 mm pore particle size was labelled (A), the mesh with 2.36 mm pore particle size was labelled (B) and the mesh with 0.6 which gave a fine particles size was labelled (C).

The filtrate from mesh (A) was poured into mesh (B) and filtrate from mesh (B) was poured into mesh (C). The residue from mesh (A) was now made the first particle size while the residue from mesh (B) was made the second particle size also the filtrate from mesh (C) was made the third particle size (Plate 1). The various sizes were then mixed with starch which is the binding material and then poured into the briquetting machine in which different briquette was made and dried (Plates 2 and 3).

2.1 Determination of Calorific Value

The calorific values for the dried briquettes were determined using e2k combustion calorimeter. A mass of 50 g was measured for each sample for combustion in the calorimeter. The samples were poured into the firing cotton inside the crucible separately. The sample was tied to the lead assembly and the assembly was then placed inside the calorimeter vessel. The calorimeter vessel contains oxygen up to a pressure of 1500 kpa. The vessel was placed in the bomb calorimeter for combustion. The calorimeter or total heating value of the sample briquette was displayed by the calorimeter after the combustion process.

Plate 1. The assemblage of the sieving process

Plate 2. Briquettes produced

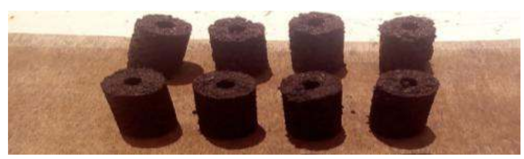

Plate 3. Sun dried briquette

Plate 4. E2k combustion calorimeter

3. RESULTS

The calorific values of the different palm kernel sizes were given in the table one (1). The briquette made from the particle size (A) had heating value of 18.415, while the briquette from the particle size (B) gave a calorific value of

18.412 MJ/kg. Also the briquette from particle size (C) has a heating value of 17.342 MJ/kg. In other to verify this trend from literature. In a previously conducted research it was reported that the calorific value of ungrounded palm kernel shell had been found as 22.94 MJ/kg [8].

4. DISCUSSION

The result (Fig. 1) showed that though the briquettes were produced at constant pressure of 100 kg/cm^2 the calorific values obtained were found to be different. The calorific value gotten from the briquette of particle size (A) (less than 4.76 mm but greater than 2.36 mm) was 18.415 MJ/Kg. The briquette from particle size (B) (less than 2.36 mm but greater than 0.6 mm) also had a calorific value of 18.412 MJ/Kg which was close to that of particle size (A) while the briquette from particle size (C) (less than 0.6 mm) had a very lower calorific value of 17.342 MJ/Kg. It was also discovered that the higher the particle sizes the higher the calorific values and the lower the particle sizes the lower the calorific value as shown in Fig. 1. This may be inferred from the fact that the air between the particle increases with increasing particle sizes and since oxygen is a necessity during combustion process this results into higher calorific value for larger particle size briquette.

Also a predictive model equation for the variation of particle size (mm) with the calorific/heating value (MJ/kg) can be generated from the curve

Table 1. Particle seizes of palm kernel shell briquette and their respective calorific values

Particle sizes	Physical appearance/ Particle texture	Calorific value (MJ/kg)	Briquetting pressure Kg/cm^2
Particle A (2.37- 4.756 mm)	Black in colour Very coarse	18.415	100
Particle B (0.6 - 2.36 mm)	Black in colour Less coarse	18.412	100
Particle C (Less than 0.6 mm)	Brownish in colour Fine particle	17.342	100
Ungrounded (greater than 5 mm) Okoroigwu et al.	black	22.94	100

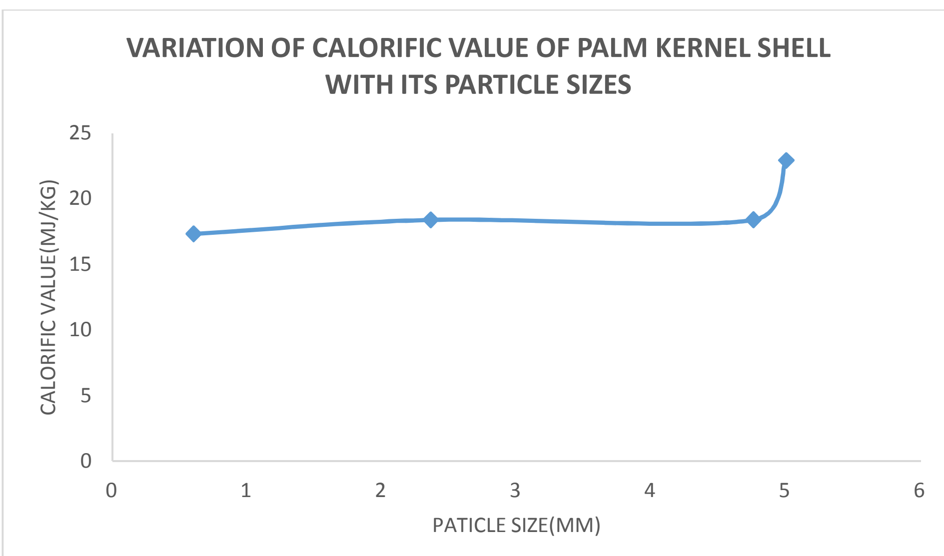

Fig. 1. Briquette particle sizes and their calorific value

above. Using matlab equation generator, based on correlation and regression analysis, the calorific value predictive equation was formulated as:

$$C = 0.21x^2 - 0.39x + 18 \quad (1)$$

Where C is the calorific value of the palm kernel shell at constant pressure of 100 kg/cm^2 and x is the particle size in millimetres.

5. CONCLUSION

The analysis of the effect of different palm kernel particle sizes on the calorific value of a palm kernel briquette shows that the calorific value increases with the increasing particle size. In this analysis it has been established that at particle size A which is less than 4.76 mm but not up to 2.36 mm in size has the highest calorific value of 18.415 MJ/kg, while palm kernel shell briquette of particle size B and size C gave lower calorific values of 18.412 MJ/Kg and 17.324 MJ/Kg respectively. Hence palm kernel shell briquette of sizes B and C are not the best particle sizes for briquetting if maximum calorific value is to be obtained. As a result, palm kernel sizes should be kept as much coarse as possible to produce higher calorific values from briquettes made up of this material.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Kuti OA. Impact of charred palm kernel shell on the calorific value of composite sawdust briquette. Journal of Engineering and Applied Science. 2007;2(1):62-65.
2. Obi OF, Akubuo CO, Okonkwo WI. Development of an appropriate briquetting machine for use in rural communities. International Journal of Engineering and Advanced Technology (IJEAT). 2013;2(5):2249–8958.
3. Ugwu KE, Agbo KE. Briquetting of palm kernel shell. Journal of Applied Science Environ. Manage. 2011;15(3):447–450.
4. Ugwu K, Agbo K. Evaluation of binders in the production of briquettes from empty fruit bunches of *Elais guinensis*. International Journal of Renewable and Sustainable Energy. 2013;2(4):176-179.
5. Usman ND, Idusuyi FI, Ojo EB, Simon B. The use of sawdust and palm kernel shell as substitute for fine and coarse aggregates in concrete construction in developing countries. Journal of Chemical, Mechanical and Engineering Practice. 2012;2(3):123–156.
6. Okoroigwe EC, Saron CM. Determination of bio-energy potential of palm kernel shell by physicochemical characterization. Nigerian Journal of Technology (NIJOTECH). 2012;31(3):329-335.
7. Olugbade TO, Mohammed TI. Fuel developed from rice bran briquettes and palm kernel shells. International Journal of Energy Engineering. 2015;5(2):9-15.
8. Oladeji JT, Enweremadu CC. The effects of some processing parameters on physical and densification characteristics of corncob briquettes. International Journal of Energy Engineering. 2012;2(1):22-27.

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