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Briquetting of Palm Kernel Shell

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ABSTRACTS: In several developing countries, briquettes from agricultural residues contribute significantly to the energy mix especially for small scale and household requirements. In this work, briquettes were produced from Palm kernel shell. This was achieved by carbonising the shell to get the charcoal followed by the pulverization of the charcoal. Starch was used as a binder. The briquettes were analyzed 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. It also had other desirable combustion characteristics. @JASEM

Key words: Briquettes, carbonizing and combustion characteristics

In spite of the vast water resources, the hot weather, the forests and the accumulated fossil fuels, most developing countries including Nigeria are plagued by energy crises arising from the inadequate availability of power for private and commercial usage. Some of the reasons for the poor energy situation in Nigeria, with its abundant petroleum resources, have been attributed to the technological inadequacy, managerial incompetence and sabotage. The prices of petroleum products which are not affordable to the majority of the populace have remained on the increase. Apart from the price, the products are not always available and just as its occurrence is finite. As long as the processed energy remains elusive, Nigeria may remain a developing economy given the importance of regular power supply in developed economies. One way of addressing the problem is to harness the available fuel resources, getting the different sources to make contribution to the energy mix. Since these resources are widely dispersed, it becomes imperative to obtain them from areas of occurrence and distribute as appropriate.

Agriculture is the main occupation of most Nigerians. It involves a lot of activities. These activities generate so many wastes which are disposed indiscriminately. It has been found out that these wastes can be reintegrated to contribute in solving the energy problem in the country. The harnessing of biomass to make significant contribution to the energy mix has been reported in several research findings (Ogbuanya, 2005). In most Nigerian rural communities, forest resources are the predominant fuel source. The trees are felled, allowed to dry and the different parts of the dried plants are used as firewood. Another way that people use to generate heat and light is by converting wood to charcoal. Other plants, apart from trees, are also used as fuel sources. The problem of felling trees for the purpose of using it as fuel source is that it impacts adversely on the environment. One way of limiting the deforestation and protecting the environment is by briquetting of flammable materials.

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Briquetting is a process of binding together pulverized carbonaceous matter, often with aid of binder (Martin*, et al*., 2008). The common forms of briquettes are the coal briquettes and the biomass briquettes. Biomass briquettes originate from mostly agricultural residues. This includes the charcoal briquettes. By converting the agricultural residues to briquettes, a gamut of advantages is derivable. These include:

- Briquettes provide an easier way of getting energy supply for cooking and ironing of clothes as the briquettes can be transported easily than the agricultural residues
- Briquettes provide cleaner emission than wood and other dried plants usually used for obtaining rural energy supply
- The raw material for making briquettes are sourced from materials that would have been chunked, and as such it converts waste to energy
- Briquettes can be used in stoves and boilers
- Briquetting increases strength, density, heat emitted per volume of the biomass (Martin, *et al*, 2008)

In this study, the plant of interest is the oil palm plant. The Oil Palm plant (*Elais Guinensis*) produces a fruit with a nut inside the fruit. The fruit is boiled in water to extract the palm oil. After the oil extraction from the fruit, the nuts are broken for the palm kernels. The broken shells are called Palm Kernel Shells (PKS). The palm oil plants are found in most parts, especially, southern states of Nigeria. The different parts of the oil palm are adapted for different useful 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 bunches, Palm fibre, and Palm kernel shell

In rural community levels, palm kernel shells are used in their crude form for heating during cooking. However it burns with a lot of smoke due to its organic content. The effect of such smoke to health cannot be over emphasized. Even in such cases most of the energy content is not used up as palm kernel shell charcoals (incomplete burnt palm kernel shells) are common sight at ash dumps. Carbonising and briquetting would remove these inadequacies and make for efficient and sustainable use of palm kernel shell. This work is to harness Palm kernel shell to make a contribution to the energy mix.

The Palm kernel shells were converted into briquettes by adopting very simple process, utilizing readily available and affordable materials. The briquettes produced from Palm kernel shell were tested for their combustion and physical characteristics.

MATERIALS AND METHOD

The raw material was Palm kernel shells which were collected at Nsukka, Nigeria, after it had been discarded by crushers of Palm kernel. The shells were converted into charcoal, pulverized and made to briquettes using cassava starch as a binder. The mixing proportion is Palm kernel shell charcoal - 59%, Water - 38% and Starch - 3%.

Making of Palm Kernel shell charcoal: The Palm kernel shells were carbonised using the simple drum method[1]. In this process, a metal container was perforated underneath. The shells filled about one-fifth of the container size. The container was placed on a stand and about 3ml of kerosene was sprinkled on the shells to facilitate ignition. This was followed by application of heat underneath the container. The shells ignited after about eight minutes and were allowed to burn until the flame became bluish and the shells turned black. The container was brought down from the stand and remained for 8 hours while being tightly covered to prevent the entry of air. After this period, the charcoal had formed with no ash.

Making of the Palm kernel briquettes: The charcoal was pulverised using a manually operated blender. The charcoal fines were screened through a 250 micron sieve. Cassava starch was used as a binder. The starch was prepared from raw cassava root which was peeled, washed and sun-dried. It was then pulverised. 50g of the cassava flour was dissolved in 100ml cold water. 400ml water was put to boil in a container. The cassava paste was added into the boiling water and mixed properly to get the starch gel. While the starch gel was still warm, 750g of the pulverized Palm kernel shell charcoal were gradually added into the gel and mixed using a stirring stick until a thick, black compound was formed. Part of the thick paste was manually pressed into cylindrical molds. Another part of the thick paste was molded with the palm of the hand. The essence of using this type of pressure was to make the briquettes as it would be in the absence of costly briquetting machines. This procedure is targeted at the rural populace who may not have access to briquetting machines. The molded thick paste was sun-dried for four days.

The following tests were conducted on the briquettes after one week sun drying from the date of molding:

Calorific value: The Calorific values of the briquettes were determined using an oxygen bomb calorimeter model XRY-1A.

Moisture content: The moisture content was determined by the use of MB35 Halogen Ohaus moisture analyser.

Ignition test: About 2ml kerosene was used for the ignition of the Palm kernel briquette.

Combustion Analysis: The combustion tests were carried out by boiling water (water boiling test), using the normal materials in a typical rural household. This was to simulate cooking condition. An open air stove was used. A known quantity of water (1.5L) was measured into a cooking pot whose weight had been noted. Some lumps of the briquettes were placed on the cooking stove after they were weighed. The briquettes were sprinkled with about 2mL of kerosene for ignition. After 8 minutes, the briquettes had ignited and the kerosene had burnt out, the pot of water was placed on the stove. This was after the initial temperature (303K) of the water had been noted. The temperature of the water was noted at intervals of five minutes until the water boiled (363K). The weight of the evaporated water was calculated from the difference between the final weight of water after cooling and the initial weight of water in the pot. The weight of the fuel burnt was calculated from the difference in the initial weight of briquettes put on the stove and the final weight after the water had boiled (Kuti, 2009).

Fig 1: Hand- molded briquettes

Fig 2: Molded palm kernel shell briquettes

RESULTS AND DISCUSSION

The results of calculations from the water boiling test and other observations are given below:

Table 1: Boil Test on Palm Kernel Shell Briquettes

Tests	Data
Total weight of briquettes at the start of test	209.7g
Total number of briquettes at the start of test	6
Average weight of each briquette	34.95g
Total weight of Briquettes after water boil	104.3g
Initial weight of water in the pot	150g
Final weight of water after boil	130g
Physical appearance of the briquettes	The colour was black. It was brittle to touch and took the cylindrical shape of the mold.
Density for a briquette	$1.65g/cm^3$
Calorific value (kJ/kg)	23603.28
Moisture content	6.67%
Ignition	The kerosene burnt out in 8 minutes and a number of the briquettes lumps turned reddish.
Smoke	It burnt with very low level of smoke. It was not confirmed whether the smoke emanated from the starch used as a binder or not
Odour	The combustion produced no odour
Spark	The briquettes burned with no sparks.
Cleanliness	The cooking pot remained very neat all through the cooking period
Percentage Heat Utilized (P.H.U)	3.2%
Power Output (P)	1.26kW
Specific Fuel Consumption	0.7kg
Burning Rate	3.2g/min

Although the briquettes did not ignite readily only a little quantity of kerosene was required. The calorific value of the briquettes was high compared to sawdust briquette (18,936kJ/kg) (Nasrin, *et al*, 2008) as shown in table 2. Furthermore it is seen that briquetting of palm kernel shell charcoal raised the calorific value by about 27% (from18611.7 kJ/kg to 23,603.28 kJ/kg). The little smoke observed during the combustion of the briquette probably may not be unconnected with the binder since the charcoal fines produced burnt without smoke. The low level of smoke underscores one of the importance gains of using palm kernel shell charcoal briquettes in cooking in homes. This is because smoke is deleterious to health and environment the effect of which is well documented (Mahanama, 2008; Bruce *et al*, 2000).

Table 2: Comparison of calorific values of oil palm parts

Fuel	Calorific value (kJ/kg)
Palm kernel Shell	18,611.7
Palm kernel oil (Ma *et al*, 2005)	38,025
Palm kernel cake (Ma *et al*, 2005)	18,884
Palm kernel charcoal	9,118.75
Palm kernel charcoal briquette	23,603.28
Empty fruit bunches (Vijaya, et al, 2004)	18,838
Saw dust (Nasrin, *et al*, 2008)	18,936

Conclusion: This study has described the convenient and adaptable method of making Palm kernel shell briquettes. The briquettes produced can be used in cooking and in ironing of clothes. The calorific value of the briquettes was high compared to sawdust briquette. The materials and method used can be adopted easily at the local communities as it does not require expertise on special training. The performance of the briquettes can be improved if the stove is appropriately designed. The smoke emission may have to be investigated to ascertain its actual source. Further analyses are required on the briquettes to ascertain their stability, stability and water resistance as improvement can be made on the production method (Grover *et al*, 1996).

REFERENCES

Bindir, U.B (2009) *Technology Acquisition and Promotion in the Power Sector*, paper presented at the International Workshop on Promotion of Coal for Power Generation at Enugu in April, 2009.

Bruce N. Perez-Padalla R and Albalak (2000): Indoor air pollution in developing countries: a major environmental and public health challenge. *Bulletin of World health Organisation 78(9) : 1078-92*

Grover, P.D and Mishra, S.K, (1996). *Biomass Briquetting: Technology and Practices*. FAO Report, United Nations, Bangkok.

Kuti, O.A (2009): *Performance of Composite Sawdust Briquette fuel in a Biomass Stove under simulated condition*. AU J.T. 12 (4) pp 284-288.

Ma A. N and Dato, Yusof Basiron. (2005). *Biomass Energy from the Palm oil industry in Malaysia.* The Ingenieur, Vol. 27 September – November, 2005 pp. 18 – 25

Mahanama K.R.R (2008). Cooking or being cooked. *Economic reviews:34(384) : 18-23*

Nasrin, A; Ma. A.N; Choo,Y.M; Mohama, S; Rohaya, M.H.; Azali, and A; Zainal, Z. 2008. *Oil Palm Biomass as Potential Substitution Raw materials for Commercial Biomass Briquettes Production*. American Journal of Applied Sciences 5 (3) 179-183

Ogbuanya, T.C. (2005): *Energy and Technology of Home Appliances*, Cheston Limited, Enugu, Nigeria, p102.

Vijaya, S.; Chow, M.C. and Ma. A.N. 2004. *Energy Database of the Oil Palm*. MPOB Palm oil Engineering Bulletin, 70: 15-22.

Walter, Emrich (1985), *Handbook of Charcoal Making: The Traditional and Industrial Methods*, D. Reidel for the Commission of the European Communities. Boston,