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SHORT COMMUNICATION

COMBUSTION PROPERTIES OF BRIQUETTES PRODUCED FROM SAWDUST OF THREE DIFFERENT INDIGENOUS WOOD SPECIES.

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Introduction

There has been an increasing trend in fuel wood consumption in Africa and about 583 million people in the continents depend on fuel wood, charcoal and other biomass for cooking, heating and raising steam in cottage industries (Arnold *et al*., 2003). In the 1970's there was much talk about rising amount of fuel being used due to the increasing population of the rural poor and that the over dependence on wood for cooking and heating would devastate forest and result in deforestation. Presently there is shortage of fuel wood in developing countries. However, with successful production of briquettes from sawdust, fuel wood users can have a cheaper alternative to fuel wood as sources of energy (Adegoke *et al*., 2014). Briquettes production has the potential to meet the additional energy demand of urban and industrial sectors thereby making significant contributions to the economic advancement of developing countries. Wood is a predominant source of fuel in rural areas of developing countries, about 200 million people in developing countries depends on wood biomass for their daily domestic energy need (FAO, 1983; FAO, 1986).

In Nigeria the indiscriminate felling of trees has led to desertification in some parts of the country especially the northern region (Fabiyi and Oyagade, 2003). Briquette is creating another option as alternative source of fuel wood in many developing countries like Nigeria. Briquettes from wood and agricultural residues are suitable for both domestic and industrial purposes. Wood briquette is regarded as high grade fuel for furnaces, restaurant and house stoves due to its high heating value (Adegoke and Fuwape, 2008).

The problems of acute scarcity or deficit supply of fuel wood for energy consumption has resulted in energy crises both in arid and semi-arid regions of developing countries (Fuwape, 1988). Briquettes could serve as an alternative to fuel wood in many developing countries. Briquettes are produced using cheap wood residues which are renewable and readily available with high volatile matter which increases its affinity to burning. These volatile matters are gases released during combustion and they include CO_2, CH_4 and SO_4.

The main objective of this study was to evaluate the combustion properties of briquettes produced from sawdust of different wood species. Specifically, the study examined the ash content and volatile matter of the briquette produced. The study also examined the wood species with the highest calorific value and the fixed carbon content of the briquettes.

Materials and Methods

The study was carried out at the Forest Product Research and Development unit of the Forestry Research Institute of Nigeria. Materials used for the briquette production were sawdust of *Berlinia spp, Funtumia elastica* and *Sarcocephalus gilleti*. Prepared gelatinous starch, water, 2mm mesh size, measuring jar, stirrer, weighing balance, fabricated briquette molder, compressor, crucibles, heat drying chamber and bomb calorimeter were used in the production and testing process.

Sawdust of different wood species namely *Berlinia spp., Funtumia elastica, Sarcocephalus gilleti* were collected from a sawmill located within Ibadan, Nigeria. The sawdust was sieved thoroughly using 2.00 mm wire mesh and sun-dried for seven days in order to reduce its moisture content. The moisture content was reduced from an initial 38% to 12% after drying and thereafter kept in polythene bags in the laboratory with temperature of 22^0C and relative humidity of 65^0C for a period of one week to attain equilibrium moisture content. 200g of sawdust was measured for each species and mixed with 50g of prepared gelatinous starch (binder); the starch was properly blended to mix with the sawdust to obtain a uniform stock. The stock was poured into the manual holding machine for pressing. Pressure was applied to the stock by continuous hammering of a metal press to compact the stock in the machine. After thirty minutes, a metal jack in the machine was used to lift the wet briquettes from the hollow cylindrical molder. The freshly formed briquettes were allowed to dry for 30 days. The sample collected was tested for Briquette density (D), Ash content (% ash), Volatile matter (% VM), Fixed carbon (% FC) and Specific heat of combustion (SHC) using standard procedures (Carre *et al.*, 1981).

Determination of briquette density: The density was determined by measuring the weight and volume of each briquette. The density was calculated using the formulae:

$$\text{Density (D)} = \frac{mass\,(g)}{Volume\,(cm^3)}$$

Ash content (% Ash): 2g of oven dried pulverized briquette was weighed into ashing crucible; this was placed in the furnace for 4 hours at 550^0 C to obtain the ash weight

$$\%\ \text{Ash} = \frac{Weight\ of\ ash}{Dry\ weight}\ x\ 100$$

Volatile Matter (% VM): percentage volatile matter was determined by placing the crucible in the furnace for 10 min at 550^0C to obtain weight (w3) after the volatile matter in it have escaped, Carre *et al.*, 1981).

$$\%VM = \frac{Dry\ weight - weight\ of\ sample\ after 10\ \text{min}\ in\ the\ furnace}{Oven\ dry\ weight}\ x\ 100$$

Fixed carbon (% FC): This was calculated by subtracting the sum of %ash content and % volatile matter from 100% (Carre *et al.*, 1981).

$$\%\ \text{FC} = 100\% - (\%Vm + \%ash)$$

Specific Heat of Combustion (HC): This was calculated using the formulae stated by Carre *et al*., (1981):

$$HC = 0.35[147.6xFc) + (144xVm) + (\%Ash)]\ kcal/kg$$

Statistical Analysis

Data collected were analyzed using analysis of variance. Where significant difference exist Duncan`s New Multiple Range Test was used to separate the mean values.

Results and Discussion

The briquettes produced from saw dust of *Berlinia spp* have the highest mean density value of 0.527g cm^{-3} followed by *Sarcocephalus gilletti* with a mean density value of 0.400g cm^{-3}. The least density was observed in briquettes produced from saw dust of *Funtumia elastica* with a mean density value of 0.267g cm^{-3}. The mean fixed values of heat of combustion for briquettes produced from three different wood species using starch as binder are presented in Table 1. *Berlinia spp* has the highest calorific value of 4526.5095kcal/kg followed by *Sarcocephalus giletti* with a calorific value of 4337.3096kcal/kg while *Funtumia elastica* has the least calorific value of 4266.3519kcal/kg. The relative high heat of combustion observed with *Berlinia spp*. may be due to the high concentration of exudates, coupled with its high lignin content and density. The findings from this study agree with results reported in literature for some selected hardwood species (Todd, 1998; Egbewole *et al*., 2009). The variations in the calorific values observed in the study species were due to the effects of density of the tree species (Todd, 1998; Bamiyo, 2004; Kerekezi *et al*., 2004; Egbewole *et a*l., 2009; Sottande *et al*., 2010). The authors reported that density is a major indicator of the strength and combustion properties of wood and it varies with tree species, sites and age. Calorific value is the most important parameters accessed in this study because it is the actual amount of energy generated during combustion. Briquettes produced from sawdust of *Funtumia elastica* has the highest percentage ash content of 17.667±0.54%, *Sarcocephalus gilletti* has percentage ash content of 16.282±0.39% while briquettes produced from *Berlinia spp* has the least percentage ash content of 13.197±0.36% as presented in Table, 1.

The percentage volatile matters of briquettes produced from the three different wood species are presented in Table 1. *Sarcocephalus gilletti* has the highest mean percentage volatile matter of *0.25*±0.05%, this was closely followed by *Funtumia elastica* with a mean percentage volatile matter of 0.175±0.04%. The least percentage volatile matter was observed in *Berlinia spp* with a mean value of 0.028±0.04%.

The results of percentage fixed carbon are presented in Table 1. Briquettes produced from *Berlinia spp* have the highest fixed carbon values of 86.775±0.36%. This was closely followed by *Sarcocephalus gilletti* with a fixed carbon value of 83.467±0.43% while *Funtumia elastica* has the least fixed carbon values of 82.147±0.58%.. This result is similar to previous findings for briquettes produced from sawdust of *Gmelinea arborea, Anogeissus leiocarpa* and *Albizia adianthifolia* (Egbewole *et al*., 2009).

Table 1: Mean values of combustion properties of briquettes produced from saw dust of different wood species

Wood species	CV(kcal/kg)	density g/cm^3	Ash content%	Volatile matter%	Fixed carbon%
B. spp	4526.5095± 78.69[a]	0.527±1.033	13.197±0.36	0.028±0.004	86.775±0.36
F. elastica	4266.3519± 26.31[a]	0.267±1.070	17.667±0.54	0.175±0.04	82.147±0.58
S. gilletti	4337.3096± 28.20[b]	0.4±0.460	16.282±0.39	0.25±0.05	83.467±0.43

Means in column with same letter are not significantly different (P>0.05)

Conclusion

Briquettes were successfully produced from the three different indigenous wood species using starch as a binder. *Berlinia spp* has the most suitable combustion properties among the three indigenous wood species used for the study. The briquettes produced have good handling properties which imply that they can be transported over a long distance without disintegrating. Briquettes produced from sawdust of *Berlinia spp* had less ash content and were of better quality than those produced from *Sarcocephalus gilletti* and *Funtumia elastica*. Sawdust are wastes from primary conversion of logs in the sawmill and should be properly utilized in briquettes production which have shown to have better calorific values when used for heating for both domestic and industrial purposes. Therefore, sawdust that are considered as wastes in the sawmill should be converted to briquettes to serve as alternative source of energy and to conserve the country`s timber resources.

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