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Production and Characterization of Hybrid Briquette from Biomass

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Authors' contributions

This work was carried out in collaboration of all authors. Author BEA collected and performed all analyses, characterization and wrote the first draft of the work. Author KOU managed the literature searches. Authors PEI and MCI designed the study, managed the analyses of the work. Authors PEI and KOU interpreted the results, corrected and prepared the final manuscript. All authors read and approved the final manuscript.

Original Research Article

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ABSTRACT

In this study, production and characterization of hybrid biomass briquettes using two major agricultural wastes was carried out. Briquettes were produced from sawdust of the specie Albiziazygia and sorghum dust using native cassava starch as binder. Five different composition of sawdust/sorghum dust hybrid briquette were produced, moisture content, compressive test, ash content, calorific test and burning efficiency tests were carried to determine the physical and mechanical properties of the hybrid briquette. Test results show that moisture content varies from 6.83% to 29.70%, compressive load at break varies from 4.94KN to 15.18KN, ash content varies from 2.85% to 17.14%, calorific value varies from 3.83MJ/kg to 10.43MJ/kg and burning efficiency varies from 1.57% to 6.63%.

Keywords: Agricultural waste; biomass; briquette; hybrid; sawdust.

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1. INTRODUCTION

Traditionally, energy in the form of firewood, twigs and charcoal has been the major source of renewable energy for many developing countries. Although Africa accounts for 12% of the global population, it consumes only 4% of global energy, with Nigeria accounting for 51% of the total energy consumption [1-3].

In all developing and industrializes countries, large amounts of waste are generated from agricultural material or by-products every year. The recycling of these materials is of increasing interest worldwide. Biomass, particularly agricultural residues, seems to be one of the most promising energy resources for developing countries [4]. Large quantities of agricultural and forestry residues produced annually in Nigeria are vastly underutilized, they are usually burnt or left to decompose resulting in environmental pollution and degradation [5]. One of the promising solutions to the problems of unutilized agricultural residues and saw dust is the application of briquetting technology. Briquettes made from materials can be an alternate source of domestic and industrial energy to charcoal, firewood, gas, coal and electricity [6].Briquette making has the potential to meet the additional energy demands of urban and industrial sectors, thereby making a significant contribution to the economic advancement of developing countries. Besides, briquettes have advantages over fuel wood in terms of greater heat intensity, cleanliness, convenience to use, and relatively smaller space requirement for storage [6,7]. However, in order to make a significant impact as a fuel source, there is the need to improve and promote its production technology [8].

Appreciable studies have been carried out on briquetting process, using agro-residues such as maize cob [9], maize cob and coal particles [10], groundnut and melon shells [11], rice husk [12,13], waste paper and admixture of coconut husk [5]and banana peel[14], among others. The objective of this research there for is to produce and characterise hybrid briquette from sawdust and sorghum dust biomass.

2. METHODOLOGY

2.1 Raw Materials Characterization

The sawdust of the wood species Albiziazygia was collected from sawmills in Bosso area of Minna Nigeria, native cassava starch was bought from the local market in Minna, while the sorghum grain dust was collected from National Food Research and Storage Agency (NFRA), also in Minna, Nigeria. The briquettes were produced and analysed at the central laboratory and mechanical engineering department of Federal University of Technology Minna Nigeria.

2.2 Briquette Production

The samples were dried for 2 days to a moisture content of 6% and crushed to smaller piece of between 100-150 microns. Five different samples of six pieces each were prepared, by using 5% native cassava starch gelas the binding agent, a hydraulically controlled press briquette machine was used to produce the sample to the require shape under pressure for 30mins, after which the sample were transfer to the oven and dried at 105ºC to constant weight. The volume relation between sawdust and sorghum dust was modified according to the following composition.

a) 100% sawdust and 0% sorghum dust.
b) 60% sawdust and40% sorghum dust.
c) 50% sawdust and 50% sorghum dust.
d) 40% sawdust and 60% sorghum dust.
e) 0% sawdust and 100% sorghum dust.

2.3 Briquettes Characterization

Equilibrium moisture content of the briquettes produced was determined in accordance with ASAES 269-4 [15],Compressive strength was determined in accordance with ASTM 1037-93 [16], Ash content was determine as describe in ASTM standard D5373-02 [17], Calorific Test or heating value of the biomass briquettes was also examined in accordance with ASTM E 711-87 [18]. Burning Efficiency was done using specific fuel consumption (SFC) method.

3. RESULTS AND DISCUSSIONS

Test results for Moisture content and Ash content are shown in Figs.1 and 2, were it was observed that as sorghum dust content increases there were increase in both moisture content and Ash Content Moisture content of sorghum dust was 29.7%, which was higher than that obtained in other biomass [19], however the hybrid sample results are within the limits of 15% recommended by Wilaipon, [10], Grover and Mishra [11], for briquetting of agro-residues.

The variations of calorific value and burning efficiency as a function of sorghum dust content are shown in Fig. 3 it was observed that as sorghum dust content increases, calorific value increases, while burning efficiency decreases. However, Calorific value, obtained from sorghum is comparable to that obtained from other biomass like cowpea- 14, 372.93 kJ/kg, and soyabeans-12,953 kJ/kg [20] groundnut shell briquette- 12,600 kJ/kg [12], rice husk [11].

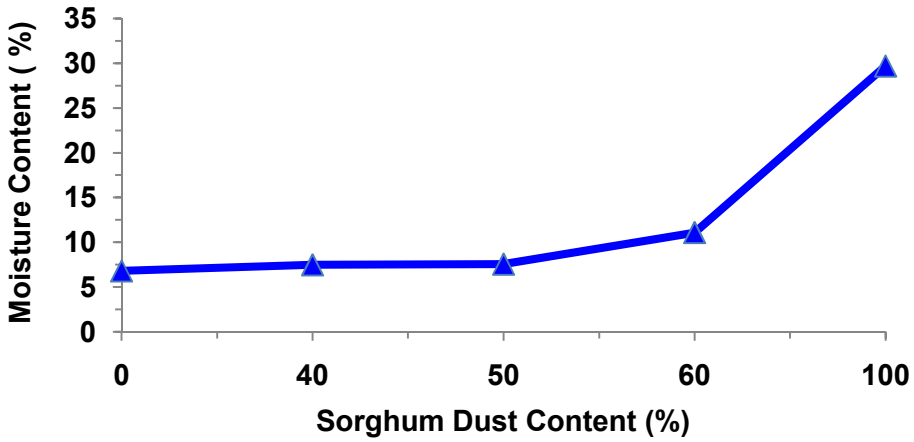

Fig. 1. Effect of sorghum content on moisture content

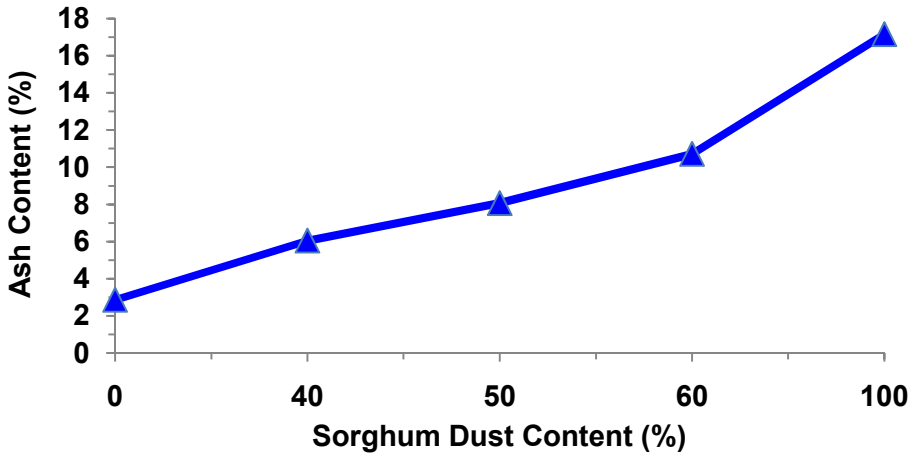

Fig. 2. Effect of sorghum content on ash content

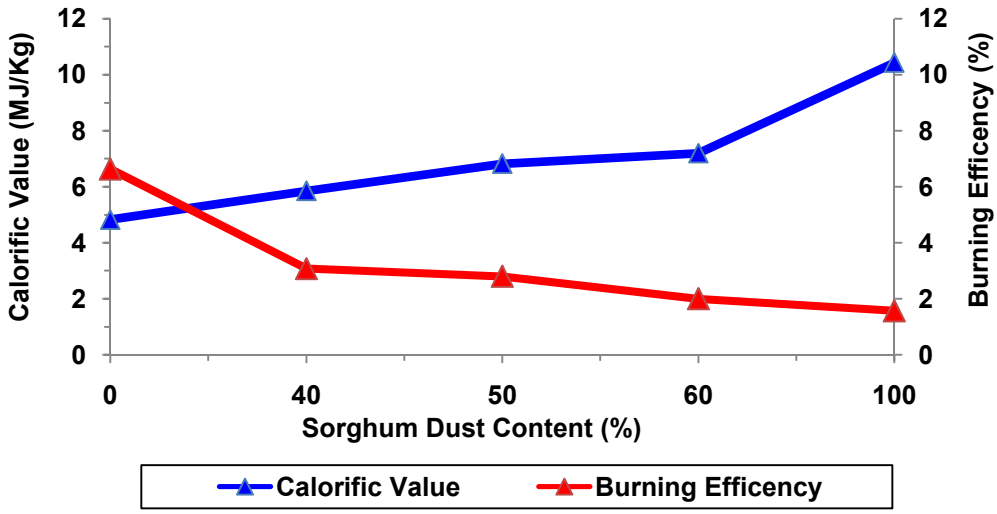

Fig. 3. Effect of sorghum content on calorific value

Compressive strength test result shown in Fig. 4 above, indicated that as sorghum content increases, compressive strength increases, which means that addition of sorghum dust increases the compressive strength of the hybrid briquette. These increases indicate that there was interfacial bonding between the sorghum dust and saw dust, which resulted in increasing compressive strength.

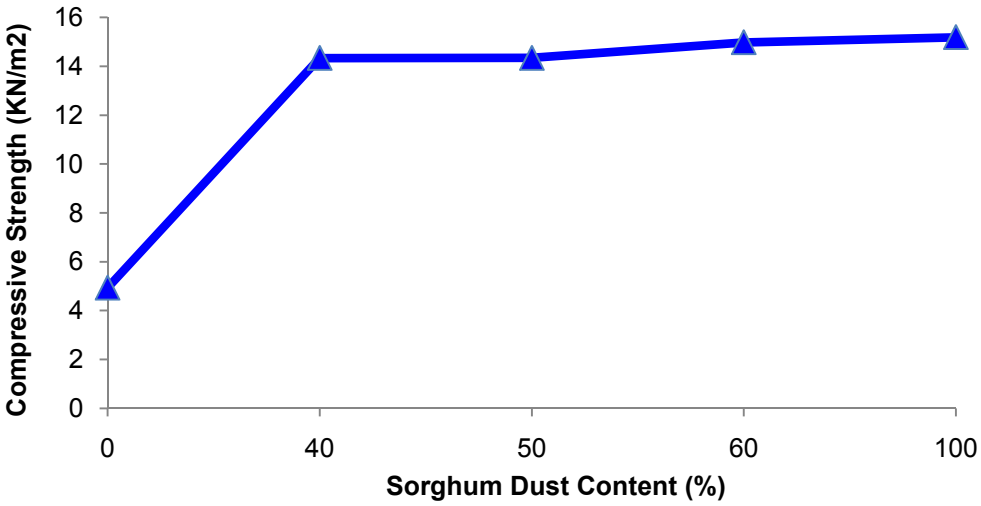

Fig. 4. Effect of sorghum content on compressive strength

4. CONCLUSION

This study has shown that the production of sawdust/sorghum dust hybrid briquette from biomass is possible. The experimental tests performed have also revealed that sawdust and sorghum dust, usually generated in large uncontrolled quantities, can be converted into good quality, highly storable and durable high-grade solid fuel briquettes, which will be suitable for both domestic and industrial energy production for energy generation.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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