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PROXIMATE AND ULTIMATE ANALYSIS OF CARBONIZED RICE HUSK BRIQUETTES

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ABSTRACT

Briquettes play significant role in the production of eco-friendly fuel and as substitutes for non-renewable sources of energy. But the selection of the right materials is essential for good briquettes, the selection of agro-wastes for domestic and industrial purposes depends on the proximate and ultimate compositions. This research focused on the proximate and ultimate analysis of briquettes produced from carbonized rice husk using a locally fabricated briquette molder. Two sets of solid fuel briquettes were produced from carbonized rice husk using starch and gum arabic as binders at varying concentration weight of 25:75, 30:70, 35:65, 40:60 and 45:55 respectively in grams. The results show that, moisture content, volatile matter, fixed carbon of the briquettes increased as the binder proportions increases for both binders, while decrease in ash content was observed as the amount of binder increases. The ultimate analysis of the carbonized rice husk briquette showed 55.10%, 3.50%, 49.70%, 1.00%, and 0.21% for carbon, hydrogen, oxygen, nitrogen, and sulphur, respectively. The amount of carbon and hydrogen content in the briquette is very satisfactory as they contribute in enhancing the combustibility of any substance in which they are found. From the overall results, 45:55 starch binder has a better positive performance. This implies that the amount of binder used has influence on the properties of briquettes.

Keywords: Briquette, Rice husk, Densification, Deforestation, Carbon sink, Cost of CO_2 reduction.

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INTRODUCTION

The availability of energy is essential for the development of any country. The use of fossil, firewood for energy has negative effect on both human health and the ecosystem by causing deforestation which results to soil erosion, desert encroachment, atmospheric pollution and global warming (Elinge *et al.*, 2011). Nigeria has abundant supply of agro- residues which are used inefficiently, causing extensive pollution to the environment.

Increasing negative effects of fossil fuels combustion on the environment, in addition to its limited stock has forced many countries to explore and change to environmental friendly alternative energy sources that are renewable to sustain the ever increasing energy demand (Mohyoub and Al Buhairi, 2006). The renewable energy sources includes bio-energy, solar, wind wave and geothermal, which are fairly abundant in Nigeria to complement the conventional energy source and provide adequate security to energy supply of the nation (Ohunakin and Olayinka, 2011)

The danger behind global warming cannot be re-emphasized, as it becomes of international concern. Global warming and other air pollution has its basis from greenhouse gases which carbon dioxide is among the major contributors. Researchers have shown that, the level of CO_2 emission increased because the rate of the deforestation is very high compared to the afforestation effort in the country (Patomsok, 2008). The application of fuel wood for cooking has its own health hazards especially on women and children who are disproportionately exposed to the smoke apart from environmental effects (Patomsok, 2008). In rural houses, women and young children carried on the back or around them while cooking, spend hours every cooking with fuel wood. In some cases, the exposure is higher especially during raining season when cooking is done in unaired kitchens and where fuel wood is used for heating of rooms to get it warmer. It was recorded that, indoor air pollution level from combustion of bio fuels in Africa are high and is above the standard set by United State Environmental Protection Agency (USEPA) for ambient level of these pollutants (Schrinding and Bruce, 2002). Exposure to biomass smoke enhances the risk of common diseases in human beings such as blindness and cataract. The smoke causes acute lower respiratory infection in children (ALRI). The most common one is pneumonia in children (Smith and Samet, 2000; Ezzati and Kammen, 2001).

MATERIALS AND METHODS

Sample Collection

Carbonized rice husk was collected from Labana rice mill industry, Birnin Kebbi, Kebbi State. Cassava starch was purchased at Zuru New Market while Gum arabic was also obtained from Zuru Local Government Area, Kebbi State, Nigeria.

Preparation of the Sample

The collected carbonized rice husk was sun-dried and sieved with a 2mm mesh to remove impurities and was kept in a polythene bag to avoid absorption of moisture until required for preparation of briquettes. In preparation of binders, boiling water was mixed with the respective percentage of starch binder to make it in gelly form; while unwarmed water was used to prepare gum arabic binder. Four briquettes samples for each binding agent were produced with varying

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weight of 25:75, 30:70, 35:65, 40:60,45:55 of the substrate. The briquettes were sun-dried for three weeks before analysis as reported by (Elinge *et al,* 2011).

Proximate Analysis of Briquettes

Determination of Moisture Content

Moisture content of the briquette samples was determined based on weight measurement before and after oven drying; 2g of the sample was measured out (initial weight of the sample before drying) the sample and the crucible were placed in a drying oven set at 105^{o}C for 24hrs. The crucible and its content were removed and placed in desiccators to cool at room temperature and re-weighed. The process was repeated until the weight after cooling is constant, and recorded as the final weight (final weight of the sample after oven drying) (Adekule *et al.,* 2015).

$$Moisture\ Content(\%) = \frac{InitialWeightofSample - FinalweightofSample}{InitialWeightofSample} \times 100$$

Determination of Volatile Matter

The briquettes percentage volatile matter content was determined using Lenton furnace. The residue of the dry sample from moisture content determination was preheated at 300^{0}C for 2hrs to drive off the volatiles, the resulting sample was further heated at 470^{0}C 2hrs,to remove volatile matter, just the before sample turned to ashes, and then cooled in desiccators (Adekunle *et al.*, 2015). The crucible with known weight and its content was weighed and as the percentage of weight loss, the percentage volatile matter was calculated using the equation below.

$$Volatile\ matter(\%) = \frac{FinalWeight}{OriginalWeight} \times 100$$

Determination of Ash Content:

Ash content of the sample briquettes was determined using a furnace residue from fixed carbon determination and was heated in a furnace ignited at 590^{0}C, for 2hrs and transferred into desiccators to cool down the material that was turn into white ash and weighed. Same process was repeated three times at 1hr interval until the weight is constant. The weight was recorded as the final weight of the ash (Adekunle *et al.*, 2015). The percentage ash content was calculated using equation below.

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$$AshContent(\%) = \frac{WeightofAsh}{InitialWeightofdrySample} \times 100$$

Determination of Fixed Carbon

The fixed carbon represents the amount of carbon that can be burnt by a primary current of air drawn through the hot bed of fuel (Moore and Johnson, 1999). The fixed carbon of the sample was determined using the following equation.

$$\boldsymbol{Fixed\ Carbon\ Content} = \mathbf{100} - [(\boldsymbol{MC}\ \%) + (\boldsymbol{VM}\ \%) + (\boldsymbol{AC}\%)]$$

Where:

MC = Moisture Content

VM = Volatile Matte

AC = Ash Content

Ultimate Analysis

This involves the determination of biomass chemical elements such as carbon, hydrogen, oxygen, nitrogen and sulphur. The method used in ultimate analysis involved burning of biomass sample in a platinum crucible, in a stream of air to produce carbon dioxide and water.

Statistical Analysis

All data was reported as mean ± standard deviation. The values were analysed using statistical package for social sciences (SPSS) Windows Programme Version 20. Statistical significant differences between means were carried out using One-way analysis of variance (ANOVA). $p<0.05$ was considered significant.

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Table:1 Result of Proximate Analysis of the Briquettes

Binder/Sample Ratio	Ash (%)		Moisture (%)		Volatile Matter (%)		Fixed Carbon (%)	
	Gum Arabic	Starch	Gum Arabic	Starch	Gum Arabic	Starch	Gum Arabic	Starch
25:75	11.00 ± 0.50^{e}	9.63 ± 0.57^{c}	6.00 ± 3.00^{a}	4.17 ± 1.28^{a}	39.32 ± 1.51^{a}	46.33 ± 0.56^{a}	41.27 ± 1.76^{a}	43.17 ± 2.75^{a}
30:70	10.67 ± 0.27^{de}	8.57 ± 0.29^{c}	6.33 ± 2.57^{a}	4.67 ± 1.15^{b}	39.76 ± 0.18^{a}	49.32 ± 0.56^{ab}	43.33 ± 1.61^{b}	46.67 ± 3.43^{b}
35:65	6.66 ± 1.00^{b}	4.33 ± 0.29^{c}	6.56 ± 0.58^{b}	5.33 ± 0.74^{bc}	41.34 ± 0.38^{a}	50.67 ± 1.16^{bc}	47.37 ± 0.29^{c}	48.67 ± 1.53^{b}
40:60	6.02 ± 1.43^{a}	4.16 ± 1.01^{b}	7.50 ± 1.33^{c}	6.73 ± 0.42^{d}	44.35 ± 0.68^{b}	56.35 ± 1.52^{c}	49.53 ± 1.51^{d}	59.17 ± 2.26^{c}
45:55	5.33 ± 0.57^{bc}	4.03 ± 1.02^{a}	9.00 ± 0.86^{d}	7.67 ± 0.57^{b}	46.67 ± 1.16^{d}	59.67 ± 1.56^{d}	55.63 ± 2.57^{e}	60.67 ± 2.31^{e}

Values are presented as mean ± SD (n = 3) of triplicate results analysed using One-way ANOVA followed by Duncan Multiple Comparisons Test using SPSS Version 20.0. Values with different superscripts are significantly different at $p<0.05$

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DISCUSSION

The ash content decreases as the binder ratio increases from 11.5% to 7.6% for gum arabic and 10.3% to 6.3% for starch binder. The cause of differences between ash content of all briquettes was as a result of the added ratios which have particles within their bonded structures, 45:100 ratio briquettes bonded with starch released less ash content. High ash content usually leads to higher dust emission and affect combustion efficiency (Akowuah *et al.*, 2012). High ash content in briquettes may block air holes and eventually lowers the oxygen supply in the combustion chamber. The results agreed with the study of Demibas and Sahin (1998), who recommended that briquettes for domestic use should be easily ignitable, but high volatile and low ash content. The moisture content of the briquettes varied from 9.0% to 6.0% for gum Arabic and 7.17% to 4.7% for starch. It can be seen that content falls within the limit of 10-15% as recommended by (Wilaipon, 2008), (Grover and Mishra, 1996), (Maciajewska, 2006) which helps in storage and combustibility. If the moisture content exceeded the range of 20% would result in the loss in energy during combustion (Idah and Mopah, 2013).

The volatile matter increased as the binder concentration increases from 38.3% to 43.6% gum arabic and 41.3% to54.6% for starch binder. High volatile matter is an indication that briquettes will ignite easily and increase in flame length (Loo and Koppejan, 2004). The amount of volatile matter attributed to the high organic matter in the material as reported by (Oloruunisola, 2007). It shows that the higher the organic matter of fuel the better the combustibility when the ash content is low (Maninder *et al.*, 2012). From the results, 45% starch binder ratio has the most outstanding result.

The results for fixed carbon content varied from 41.1% to 52.3% for gum arabic while 43% to 56.6% for starch, as the binder amount increased the fixed carbon content of the briquettes increases. The higher fixed carbon content plays an important role on the combustibility of the fuel as it corresponds to calorific energy value (FAO, 1995). The low fixed carbon content makes the fuel to prolong cooking period by releasing low heat (Onchieku *et al.*, 2012). It also decreases the calorific value of the briquette by causing what is called fuel-saving effect. The implication is that 45% starch bonded briquettes would release more heat during cooking process. Zubairu and Gana, (2014) reported in their findings that fixed carbon of briquettes made from agro-waste tend to increase with the increasing binder concentration. This trend was also reported by (Wang *et al.*, 2017).

The results of ultimate analysis of the carbonized rice husk briquette showed 55.10%, 3.50%, 49.70%, 1.00%, and 0.21% for carbon, hydrogen, oxygen, nitrogen, and sulphur, respectively. The amount of carbon and hydrogen content in the briquette is very satisfactory as they contribute in enhancing the combustibility of any substance in which they are found, (Musa, 2007). The low sulphur and nitrogen contents in the briquettes are welcomed development as there will be minimal release of sulphur and nitrogen oxides into the atmosphere and that is an indication that the burning of briquettes examined in this work will not pollute the environment, (Enweremadu, et al., 2004).

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CONCLUSION: The findings of this study showed that carbonized rice husk briquettes would serve as a good alternative source to hydrocarbons and fossil fuel. The two binders used in the research gum arabic and starch mainly because of their availability, low cost and good binding effect. Therefore, the use of carbonized rice husk to produced briquettes can be economical, sustainable and environmental eco-friendly and reduced deforestation and climate change challenge.

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