Development of Rice Husk and Saw Dust Briquettes for Use as Fuel

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Abstract
Rice husk and Saw dust, which is a large portion of biomass produced in the regions has been lying waste at the rice and saw mills in most part of this country. It was investigated as a source of solid fuel; four sets of solid fuel briquettes were produced from rice husk and saw dust separately using cassava starch and gum Arabic as binders respectively. The briquetting was carried out manually using a dead weight. Good and strong briquettes were produced. Briquettes from saw dust with cassava starch had the highest moisture content 24.36 while rice husk with cassava starch has the lowest 20.00. Also the values for dry briquette indicates that saw dust cassava starch had the highest value for density 0.6095 while rice husk gum Arabic has the lowest value of density 0.5053.The combustion performance showed that 1 litre of water was boiled in 12minutes for saw dust while it took 15 minutes for rice husk had more burning efficiency than that of rice husk. Rice husk with gum Arabic recorded the highest percentage for ash content of 21% while saw dust starch recorded the lowest percentage of 9%. During the water boiling test, the colour of the flame for the rice husk & gum Arabic briquettes was pale yellow throughout with lesser smoke and the same applies for rice husk with cassava starch briquettes only that the colour of the flame was pale yellow initially but as it stabilized, the colour became pale blue which signifies complete combustion and high heating efficiency. These indicate the superiority of briquettes by varying the binders in terms of combustion characteristics and quantity respectively.
Keywords: *Rice Husk, Saw Dust, Briquettes, Fuel, Gum Arabic and Starch*

1.0 INTRODUCTION

In most developing countries like Nigeria recycling of waste products (agricultural waste product) into useful product is rarely practice. This has led to environmental problems such as pollution resulting into refuse heap on our streets, drainage system and water ways, which has resulted to flooding on rainy days due to the blockage of the waterways. This attitude has also resulted to the outbreak of epidemic in our societies today.

The potential agro residues which do not pose collection and drying problems, normally associated with biomass are rice husk, groundnut shells, coffee husk and coir waste (obtained by drying process)(Sybil 1958). If these agricultural waste products can be properly recycled, into useful products, more goods will be made available to our society, environmental pollution and other disease attack would be greatly reduced. Solid waste can be of importance when properly used or processed, among the uses of agricultural waste are products from rice mills (rice husk) utilized as solid fuel (Grover and Mishra, 1996).

Rice husk is a typical dry or membranous outer covering of the rice. When compared to other agro residues have higher ash content (20-22.4%), higher potash content, 1.0% crude protein, 0.3% crude fat and 30% carbohydrate. However, rice husk is an exceptional biomass, it has good flow ability, normally available with 10-12% moisture and the ash contain fewer alkaline minerals. In fact, it makes an excellent fuel although its calorific value is less than wood and other agro residues (Francis and Peters, 1965). At present, loose rice mostly small-scale boilers in process industries are using husk, groundnut shells and other agro residues. Apart from being inefficient, these boilers do not have provision to capture fly ash and un-burnt carbon, which result in an extensive pollution being created. In Ludhiana, one of the industrialized cities of Punjab (India), about 2,000 tonnes of rice husk is burnt every day (Erickson and Prior, 1996).

Sawdust is a tiny piece of wood that falls as powder from wood as it is cut by a saw. In other words, sawdust is basically a waste of small particles available in saw-milling industries, pulp plant and

paper industries as well as wood processing industries particularly, in the southern part of Nigeria in a quite large volume in form of heaps and mostly burnt off resulting in the environmental pollution (Rominiyi*et al.*, 2017).

Sawdust is generally considered as a timber-industrial waste that pollutes the environment but can become a valuable commodity either as a raw material in manufacturing industries for wood boards, light construction materials such as shelves, notice boards, wall and roof sheeting for mobile houses, as an insulator in the refrigerating system and cold conservation of in energy industries as fuel burned directly or indirectly to produce wood gas, briquette, pellet, etc. Sawdust possesses characteristics similar to wood but due to the fact that it is in particles, some structural properties have been altered. It can however recover this so that it can be used again as wood.

Fuel is defined as natural or artificial organic substance used as source of energy and raw material for industries. All kinds of fuel as regards their state of aggregation are divided into solid, liquid and gaseous and as regards their origin into natural and artificial fuels (Mukhlyonov 1986). Solid fuels for which bound or compressed rice husk (Briquettes) belong to group under the natural fuel origin. Briquetting is defined as the compaction of loose combustible material for fuel making purpose. The products obtained from the process of briquetting are known as briquettes. Briquetting is a technology, which uses either a dry or a wet process to compress solid waste (rice husk) into different shapes. Briquetting of biomass can be considered for its economics, reliability and ease of operation. Hence briquetting of rice husk for solid fuel is used for domestic heating in cooking stove, fireplace and furnace. They also have the advantage of cleanliness, ease of handling and igniting, produce a small volume of smoke and its ash content is rich in potash and phosphate. This ash can be used as fertilizer on an unfertile soil. With briquetting of rice husk a new fuel source is found which will help in reducing wild dumping of rice husk in the rice growing regions of Nigeria. This will go a long way in reducing cutting of trees for fuel wood which in the long run will cause desertification (D.B. Yahaya and T.G. Ibrahim, 2012).

2.0 MATERIAL AND INSTRUMENTATION Raw Material

The raw materials used are given in the table 1 with their sources and characteristics Table 1: Raw Materials

Raw material	Source	Characteristics
Rice husk	Rice Mill at Shango, Chanchaga road in Chanchaga local government area, Minna, Niger state	Dried with 12-15% moisture content
Saw Dust	saw mill at Bosso, RandanRuwa in Bosso local government area, Minna, Niger state.	Dried with 12-15% moisture content
Starch	Locally cassava made	Fairly wet
Gum Arabic	Locally sourced (trees)	Dried in crystal like (pellets) form

3.0 EQUIPMENT USED AND THEIR MANUFACTURERS

The equipment used, their type and the manufacturers are given in table 2. Table 2. Equipment

Equipment	Model	Manufacturers
Stop watch	MT 121	Casio, Japan
Digital thermometer	0-2001 range	Comark, New York
Weighing balance	3500	Ahans Scale Corp. Florham Park, N.J U.S.A
Measuring jug	Plastic made	Nil
Mould	Nil	Locally fabricated

4.0 RICE HUSK/SAW DUST BRIQUETTING PROCEDURE Binders Selection

Current usage defined binder as substance capable of holding materials together by surface attachment. The term binder is now considered to be a general term that includes other materials such as cement, glue, starch and paste. Although all these terms are used loosely interchangeably, binder is generally becoming most widely used, and it is considered the most acceptable general term for all bonding agent. The two binders used in the cause of this research were gum Arabic and starch. The reasons were

because they are readily available, cheap, they have higher binding effect and burn effectively with less smoke.

Briquetting Process

In briquetting rice husk, the rice husk is grounded to a semi fine powder form. Rice husk briquettes are produced using 2 different binders (gum Arabic and starch) and same process was carried out for Saw dust; four sets of briquettes were produced at the ratio 6:1 (Rice husk and Saw dust: gum Arabic paste wt/wt and rice husk and Saw dust: starch paste, wt/wt). These mixtures were loaded into a fabricated mould and compressed by weight to the mould for some time and sun dried. The drying process was continued for proper drying to be achieved prior to the boiling water test.

The figure (fig 1) below shows the develop briquettes

Fig 1(a) Rice husk with Starch

Fig 1(b) Rice husk with gum

Fig 1(c) Saw dust with Starch.

Fig 1 (d) Saw dust with gum

The Water Boiling Test

The water boiling test is a well-known test, which has been used previously. It measures the time it takes a given quantity of fuel to heat and boil a given quantity of water. In this case a known quantity each of both briquettes were measured. The first sample (Rice husk - gum Arabic) was stacked in a fabricated stove while the (Rice husk – cassava starch) was stacked in a different stove. Two aluminum pots containing 1litres of water each were mounted on the stoves. The stoves were ignited and as soon as the flames were stabilized for 2 minutes, a stopwatch was activated. The initial temperatures of the water were noted and thereafter readings were obtained at 3 minutes interval using a digital thermometer. This was terminated after attaining boiling point and the weight of the residual was noted after discarding the ash. The pots were then washed to remove accumulated soot. Similarity a known quantity of the second sample (Saw Dust – Arabic gum) was then stacked in the stove while (Saw Dust – Arabic gum) was stacked in the second stove and the procedure was repeated.

5.0 RESULTS AND DISCUSSION

Nature and Appearance of the Briquettes

The briquettes obtained from the mould after drying were strong and well formed. Hair-like cracks were seen on both the rice husks - gum Arabic, rice husk – starch, saw dust- gum Arabic and saw dust – starch briquettes. This is due to low compressive force applied and it could also be due

to unequal distribution of pressure, which was restricted at the top of the mould. This can be remedied by the use of a compaction machine.

Performance on the Water Boiling Test

The result obtained from the water-boiling test for rice husk - gum Arabic, rice husk - starch and saw dust – gum Arabic, saw dust – starch are shown in the table 3 and 4 below;

Table 3. Rice husk - gum Arabic versus Rice husk – starch

Rice husk & gum Arabic	
Time (min)	**Temperature (ºC)**
0	28
3	54
6	67
9	78
12	89
15	100

Rice husk & cassava starch	
Time (min)	**Temperature (ºC)**
0	28
3	40
6	53
9	85
12	90
15	100

Table 4: Rice husk starch versus Saw dust starch

Saw dust & gum Arabic	
Time (min)	**Temperature (ºC)**
0	28
3	60
6	76
9	85
12	100

Table 5: Ash content of the fuel used

Fuel briquettes	Weight of fuel (g)	Weight of ash (g)	Percentage ash content %
Rice husk & cassava starch	500	90	18
Rice husk & gum Arabic	500	105	21
Saw dust &cassava starch	500	45	9
Saw dust & gum Arabic	500	55	11

6.0 DISCUSSION OF RESULT

From the result table 3, shows that the rice husk briquette with cassava starch attained a temperature of 40ºC in 3 minutes while rice husk briquette with gum Arabic attained a temperature of 54ºC at the same time interval. In 6 minutes, the temperature of the water for rice husk - starch briquette rose to 53ºC, followed by 85^{O}C in 9 minutes, 90^{O}C in 12 minutes and finally 100^{O}C in 15 minutes. Compared to rice husk & gum Arabic which burns from 54ºC in 6 minutes, 67ºC in 9 minutes, and 78oC in 12 minutes, and finally 100ºC in 15 minutes. From the result obtained it can be seen that the water heated with rice husk & cassava starch and rice husk with gum Arabic briquettes both took 15 minutes to boil 1 liter of water.

Similarly, table 4, shows the variation of temperature with time for both Saw dust starch and gum Arabic both from initial temperature of 28ºC, it is seen from this table that the saw dust - starch briquette attained a temperature of 58ºC in 3 minutes while saw dust gum Arabic attained a temperature of 60ºC at the same time interval. In 6 minutes, the temperature of the water for Saw dust – starch briquette rose to 70^{0}C, followed by 81ºC in 9 minutes, finally 100ºC in 12 minutes. Compared to saw dust which burns from 76ºC in 6 minutes, 85ºC in 9 minutes, and finally 100ºC in 12 minutes.

From the result obtained it can be seen that the water heated with saw dust with cassava starch and sawdust with gum Arabic briquette took 12 minutes to boil 1 liter of water compared to rice husk with cassava starch and rice husk with gum Arabic that took 15 minutes to boil the same quantity of water.

Nature of the Flame

Nature of the flame colour of a burning fuel gives an indication of the quality of heat and the cleanliness of the flame. For instance, a blue flame indicates a clean and high quality heat. On the other hand yellow flame indicates a low quality heat with soot deposits. During the water boiling test, the colour of the flame for the rice husk - gum Arabic briquette was pale yellow throughout with lesser smoke and for rice husk - starch briquette, the colour of the flame was pale yellow initially but as it stabilized, the colour became pale blue which signifies complete combustion and high heating efficiency. While for firewood, the colour of the flame was pale

yellow throughout with high smoke content. From the sample results obtained, it is a clear that for all the fuel samples, clean cooking pots emerged when used for cooking applications.

8.0 CONCLUSION

In the application of rice husk and saw dust as solid fuels, forming briquettes facilitate handling, storage and transportation. While the conservation of rice husk and saw dust into solid fuel does not only provide fuel but also keep the environment clean, helps to check deforestation by felling of trees for fuel wood. The briquettes will serve as substitute for fuel wood since it shows superior combustion characteristics over the two different the Rice husk and Saw dust and the material is readily available and the briquetting process is economically, cheap and affordable to the rural and low-income urban dwellers. Besides, the binders do not contain harmful agents.

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