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DEVELOPMENT OF RICE HUSK BRIQUETTES FOR USE AS FUEL

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ABSTRACT

Rice husk, which is a large portion of biomass produced in the rice growing regions has been lying waste at the rice mills in most part of this country. It was investigated as a source of solid fuel; two sets of solid fuel briquettes were produced from rice husk using starch and gum Arabic as binders. The briquetting was carried out manually using a dead weight. Good and strong briquettes were produced. Water boiling tests were carried out which showed that 1kg of rice husk - gum Arabic briquette and rice husk - starch briquette took 15 minutes respectively to boil 2 litres of water where as it took 1.2kg of firewood 21 minutes to boil the same quantity of water. Flame test also showed a pale yellow throughout and pale yellow to pale blue for rice husk- gum Arabic and rice husk- starch briquettes respectively. These indicate the superiority of briquettes over firewood in terms of combustion characteristics and quantity respectively and also indicate the advantage of briquette in terms of ease of handling and transportation.

KEYWORDS: Rice Husk, Briquettes, Fuel, Gum Arabic and Starch

INTRODUCTION

In most developing countries like Nigeria recycling of waste products (agricultural waste product) into useful product is rarely practice. This has lead 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).

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.

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 Bakin Dogo Market, Kaduna	Dried with 10-12% moisture content
Starch	Locally made	Fairly wet
Gum Arabic	Locally sourced (trees)	Dried in crystal like (pellets) form

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

RICE HUSK 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); two sets of briquettes were produced at the ratio 6:1 (Rice husk: gum Arabic paste wt/wt and rice husk: starch paste, wt/wt). These mixtures were loaded into a fabricated mould and compressed by weight to the mould for sometime and sun dried. The drying process was continued for proper drying to be achieved prior to the boiling water test.

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 briquette and firewood were measured. The first sample (Rice husk - gum Arabic) was stacked in a fabricated stove while the firewood was stacked in a different stove. Two aluminum pots containing 2 litres 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 (Rice husk – starch) was then stacked in the stove while firewood was stacked in the second stove and the procedure was repeated.

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 and rice husk - 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 firewood are shown in the table 3 and 4 below;

Table 3. Rice husk - gum Arabic versus firewood

Rice husk - gum Arabic		Fire wood	
Time (min.)	Temperature (^{0}C)	Time (min.)	Temperature (^{0}C)
0	27	0	27
3	42	3	38
6	44	6	43
9	88	9	49
12	93	12	65
15	100	15	79
18		18	91
21		21	100

Table 4: Rice husk starch versus firewood

Rice husk - Starch		Fire wood	
Time (min.)	Temperature (^{0}C)	Time (min.)	Temperature (^{0}C)
0	27	0	27
3	54	3	38
6	70	6	44
9	81	9	51
12	95	12	66
15	100	15	80
18	-	18	92
21	-	21	100

Table 5: Ash content of the fuel used

Fuel (Briquettes)	Weight of fuel (g)	Weight of ash (g)	Percentage ash content (%)
Rich husk -gum Arabic	1000	210	21
Rice husk - starch	1000	180	18
Firewood	1200	310	26

DISCUSSION OF RESULT

From the result, table 1 shows the variation of temperature with time for both rice husk - gum Arabic briquette and firewood. It is seen from this table that the rice husk - gum Arabic briquette attained a temperature of 42^0C in 3 minutes while fire wood attained 38^0C at the same interval of time (both from initial temperature of 27^0C). In 6 minutes the rice husk- gum Arabic briquette rose to 44^0C followed by 88^0C in 9 minutes, 93^0C in 12 minutes and finally 100^0C in 15 minutes. This shows a better combustion characteristics compared to firewood, which burns slowly from 43^0C in 6 minutes through 49^0C, 65^0C, 79^0C, 91^0C, to 100^0C in 9, 12, 15, 18, and 21 minutes. The water heated by rice husk - gum Arabic briquette took 15 minutes to boil compared with that of firewood that took 21 minutes to boil the same quantity of water. This clear difference can be observed from the graph of temperature versus time for both the rice husk - gum Arabic briquette and firewood as shown in figure 1.

Similarly, table 2 shows the variation of temperature with time for both rice husk - starch briquette and fire wood both from initial temperature of 27^0C, it is seen from this table that the rice husk starch briquette attained a temperature of 54^0C in 3 minutes while fire wood attained a temperature of 38^0C at the same time interval. In 6 minutes, the temperature of the water for rice husk starch briquette rose to 70^0C, followed by 81^0C in 9 minutes, 95^0C in 12 minutes and finally 100^0C in 15 minutes. Compared to fire wood which burns slowly from 44^0C in 6 minutes, 51^0C in 9 minutes, 66^0C in 12 minutes, 80^0C in 15 minutes, 92^0C in 18 minutes and finally 100^0C in 21 minutes.
From the result obtained it can be seen that the water heated with rice husk - starch briquette took 15 minutes to boil 2 litres of water compared to fire wood that took 21 minutes to boil the same quantity of water. This difference can also be observed from the graph of temperature versus time for both the rice husk - starch and firewood as shown in figure 2.

The rapid combustion observed could be due to porous nature of the rice husk briquettes compared to the relatively dense firewood. The porosity in the rice husk briquettes enables the volatiles to leave more readily and be consumed rapidly in the flame. This explains the sharp temperature rise within the first 6 minutes and the fact that cellulose materials often display flaming combustion (Sen 1987). From table 3 we can see the rice husk – starch gives 18% ash content, which is the list, compared to firewood, which gives 28% ash content. This indicates that rice husk – gum Arabic and rice husk – starch combust more efficiently than firewood.

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.

CONCLUSION

The following conclusions were drawn from this work.

1. In the application of rice husk as solid fuels, forming briquettes facilitate handling, storage and transportation.
2. The conservation of rice husk 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.
3. The briquettes will serve as substitute for fuel wood since it shows superior combustion characteristics over fuel wood and the material is readily available.
4. The briquetting process is economically, cheap and affordable to the rural and low-income urban dwellers. Besides, the binders do not contain harmful agents.

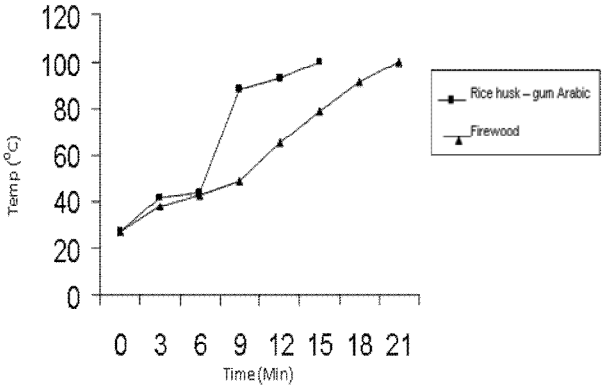

Figure 1: Rice husk - gum Arabic versus firewood

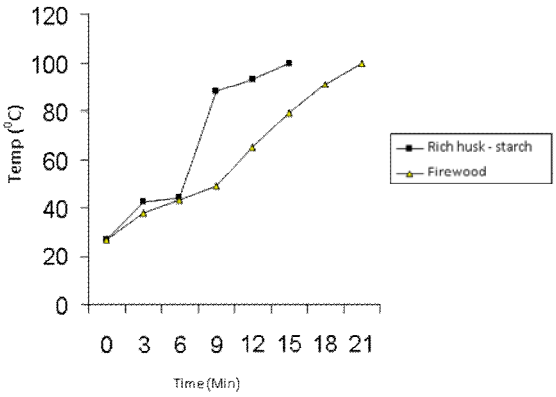

Figure 2: Rice husk - Starch versus firewood

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