Production and Analysis of Fire Characteristics of Fuel Briquettes from Corncob, Peanut Shell and Sugarcane Megasse Mixed with Tapioca Starch.

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ABSTRACT

Fuel briquettes are compressed blocks of combustible biomass materials used for fuel and kindling to start and maintain a fire. The study was carried out to determine the fire characteristics of fuel briquettes produced from corncob, peanut shell and sugarcane megasse mixed with tapioca starch. The analysis was carried out using standard procedures. The three categories of briquettes used were single briquettes, dual mixed and triple mixed briquettes. In the single briquettes, the results show that corncob has lowest ignition time (18.00 secs), highest burning length (3.00cm) and highest burning rate (0.067cm/secs). Also, corncob mixed with sugarcane megasse and peanut shell triple mix briquettes has the lowest ignition time (20.00secs), highest burning length (4.00cm) and highest burning rate (0.089cm/secs) as compared with the dual mix briquettes which has the highest ignition time (161.00 secs), lowest burning length (1.00cm) and lowest burning rate (0.022cm/secs). It can be concluded that briquettes produced from corncob is the best to replace wood burning and enhance the future energy security without jeopardizing food availability. It may be recommended that briquettes produced from biomass like corncob, sugarcane megasse and peanut shells should be used in rural villages for cooking instead of fire wood.

Keywords: Fuel, corncob, sugarcane, peanut, tapioca.

INTRODUCTION

Corn (*Zea mays*), is a cereal plant of the grass family (Poaceae) and it is an edible grain. The domesticated crop originated in the America and is one of the most widely distributed of the world's food crops. Corn is used as livestock feed, as human food, as biofuel and as raw material in industries. The corn plant is a tall annual grass with a stout, erect, solid stem. The large narrow leaves have wavy margins and are spaced alternately on opposite sides of the stem. Staminate (male) flowers are borne on the tassel terminating the main axis of the stem. The pistillate (female) inflorescences which mature to become the edible ears are spikes with a thickened axis bearing paired spikelets in longitudinal rows; each row of paired spikelets normally produces two rows of grains (Diener and Morey, 2014).

Peanut (*Arachis hypogaea*) ia a legume of the pea family (Fabaceae) grown for its edible seeds. Native to tropical South America, the peanut was at an early time introduced to the Old World tropics. The seeds are a nutritionally dense food, rich in protein and fat. Despite its several common names, the peanut is not a true nut. As with other legumes, the plant adds nitrogen to the soil by means of nitrogen-fixing bacteria and is thus particularly valuable as a soil-enriching crop (Fernarders, 2013).

Sugarcane is a giant tropical grass from the family Graminaceae, whose stalk has the particular capacity to store a crystallizable sugar, sucrose. Its main use is in industrial processing of the stalks to make rum. However, the impressive plant mass it produces can also be converted into energy-combustible material, charcoal or biofuel and also contains a wealth of molecules for the chemical industry (James, 2020).

Tapioca is a starch extracted from cassava root, a tuber native to South America. The cassava root is relatively easy to grow and a dietary staple in several countries in Africa, Asia, and South America. Tapioca is almost pure starch and has very limited nutritional value (Shafie, 2012). Fuel briquettes are compressed blocks of combustible biomass materials used for fuel and kindling to start a fire. The densification process that is concerned with increasing the density of biomass residues to nearly 100 - 1200 kg/m^3 of loose biomass reducing the volume by 8 - 10 times is known as briquetting (Fernarders, 2013). This process of briquettes making shows the potential of appropriate means of producing fuel briquettes from Agricultural wastes and other waste materials such as waste polyethene composites. For domestic and industrial heating purposes, the practice

includes the use of briquettes of biomass residues from agricultural products, food industry or combinations of different types of plant residues with other additives (Ugwu and Agbo, 2013). Agricultural residues could be used either directly as solid fuel through combustion or harnessed and transformed through densification for domestic and industrial applications (Shafie, 2012).

Developing countries and cities are indeed facing the challenges of refuse disposal and their impacts on health and environment. The most critical and immediate problems faced by developing countries and cities are impacts of urban pollution on the health of people as well as air pollution especially from particulates (Kalyan and Morey, 2010). Today, developing cities and towns are contending with the elimination of heaps of solid waste from industrial craft and domestic activities (James, 2020). The utilization of these waste materials is impended by so many factors such as moisture content of the biomass materials, poor or inadequate storage facilities, lack of efficient technology and poor management (Supatata, Ucar and Seyidbekiroglu, 2013). Biomass from Agriculture process could be utilized for production of bio-fuels in the form of briquettes to enhance the future energy security without jeopardizing food availability (Tandukar and Heijndermans, 2014). It is quite clear that most of the wastes produced in the communities around generate unpleasant odours, making the environment unsighted and can equally lead to fire outbreak. Mostly, they are of domestic, industrial and farm origins which are in great volume dumped in the open places.

Corncob is the part of the corn ear without the grains. The corncob is the by-product of the corn crop, consisting of the central fibrous rachis of the female inflorescence (the corn "ear") (Supatata, Ucar and Seyidbekiroglu, 2013). Among the broad variety of agricultural residues, corn cob represent an interesting source of biomass and their advantageous composition could allow their use for both direct combustion of dry biomass (Tandukar and Heijndermans, 2014). Corncob can be converted to fuel briquettes which can be use as source of energy for domestic and industrial purposes (Ugwu and Agbo, 2013).

Sugarcane Megasse is the waste produced when sugar is extracted from the stem of sugarcane, it is a by-product of sugarcane crop which is fibrous. It is estimated that producing one ton of sugarcane generates approximately 140 to 280kg of megasse, which is fibrous waste product of sugarcane once sugarcane is extracted (Ugwu and Agbo, 2013). Similarly, to other plants cell

walls, sugarcane megasse is mainly formed by two carbohydrates fractions (cellulose and hemicellulose) embedded in a lignin matrix (Yael *et al.*, 2006).

Peanut shells are the leftover products obtained after the removal of peanut seed from its pod. This is the abundant agro-industrial waste product which as a very slow degradation rate under natural conditions (Yumak, Ucar, and Seyidbekiroglu, 2010). However, peanut shells contain various bioactive and functional components which are beneficial for mankind (Shafie, 2012).

Commercially, it is used as a feedstock, food, and filler in fertilizer and even in bio-filter carriers (Tayade, 2009). But most of the deserted peanut shells are burnt or buried resulting in environmental pollution. Thus, new technologies need to be developed in order to attain zero waste production and direct this other waste products into meaningful used in food, feed, paper and bio-energy industries (Yael *et al*., 2006). In the search for new alternative sources of ecologically friendly energy, the utilization of corncob, peanut shells and sugarcane megasse for the production of briquettes has become good alternatives. A briquette is biochar in a particular shape, made by using pressing techniques and adhesives (Fikri and Sartika, 2018). Bagasse carbonization process is environmentally friendly, energy self-providing and a continuous flow technology. Thus, the objective of the research was to use corncob, peanut shells and sugarcane megasse for the production of energy (high caloric value briquette) and ultimately safeguard the environment from pollution.

MATERIALS AND METHODS

The corncob was collected from sellers of roasted corn in Oko, Orumba north LGA of Anambra State, Nigeria and weighed. The mass of the corn cob was 3500g. Also the sugarcane megasse and the peanut shells were collected from hawkers in Oko and weighed. Their weights were 2000g and 1500g, respectively. The samples were crushed and ground at the mill and poured into different clean dried containers and covered with airtight covers. For the purpose of this study, a cassava starch was used as a binder. Raw cassava starch was collected from a cassava processing mill.

METHODS

A volume of 270ml of boiled portable water was employed to gelatinize a thoroughly mixed 130g of starch with portable water to form a uniform jelly-like starch gel. This starch gel was used as binder for briquetting process. The briquettes were mixed with the binder until it was properly bound. The briquette was poured into moulds and sun dried for 7 days. The three briquettes were characterized to obtain their colour, physical appearance texture, ignition time, flame colour, smoke colour, odour, burning length and burning rate. The ignition time was determined by taking the time each briquette took to start burning while the burning length and burning rate were determined by the length of the briquette burnt in a specific time and the time of burning divided by the length burnt.

Table 1: Formulation of the Briquettes

Samples	Briquettes	Starch in grams	Corncob (CC) in grams	Peanut shell (PS) in grams	Sugarcane megasse (SM) in grams
Dual mix	CC & PS	20	30	30	
Dual mix	PS & SM	20		30	30
Dual mix	CC & SM	20	30		30
Triple mix	CC, PS & SM	20	20	20	20
Single mix	CC	20	60		
Single mix	PS	20		60	
Single mix	SM	20			60

RESULTS

The results of ignition time, the burning length and burning rates of the single briquettes are presented in table 2.

Table 2: The ignition time, the burning length and burning rate of the single briquettes

Parameters	CC	SM	PS
Ignition Time (Secs)	18.00	24.00	30.00
Burning Length (cm)	3.00	2.00	2.50
Burning rate at 45secs (cm/s)	0.067	0.044	0.056

The results of ignition time, the burning length and burning rates of the mixed briquettes are presented in table 3 below.

Table 3: The ignition time, the burning length and burning rate of the mixed briquettes

Parameters	CC & PS	PS & SM	CC & SM	CC, SM & PS
Ignition Time (Secs)	21.00	161.00	22.00	20.00
Burning Length (cm)	3.00	1.00	3.00	4.00
Burning rate at 45 Secs (cm/s)	0.067	0.022	0.067	0.089

The results for the analysis of colour, physical appearance, texture, odour, flame colours and smoke colours of the single and mixed briquettes are presented in table 4 below.

Table 4: The Colour, physical appearance, texture, odour, flame colours and smoke colours of the single and mixed briquettes

Parameters	CC	SM	PS	CC & PS	PS & SM	CC & SM	CC, SM & PS
Colour	Milk	Brown	Brown	Brown	Brown	Brown	Brown
Physical appearance	Solid	Solid	Solid	Solid	Solid	Solid	Solid
Texture	Hard	Hard	Hard	Hard	Hard	Hard	Hard
Odour	Biomass Odour	Biomass Odour	Biomass Odour	Biomass Odour	Biomass Odour	Biomass Odour	Biomass Odour
Flame colour	Yellow	Bluish-Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
Smoke colour	White	Gray	Gray	White	Gray	Gray	Gray

DISCUSSION

Briquetting technology plays an important role in the utilization of agro-wastes for higher calorific value and high-energy utilization. In this study, a briquetting process was aimed to investigate production of an alternate eco-friendly fuel from locally available non woody biomass such as corncob, sugarcane megasse and peanut shell. A briquette often refers to a block of highly inflammable solid material used as fuel to start and maintain a fire. The common types of briquettes are charcoal briquettes and biomass briquettes. The results indicate that briquettes produced from corncob have lowest ignition time of 18secs. Estiaty *et al*, (2018) reported ignition time of 27secs for corncob briquette which is about 9secs different. The corncob briquette has the highest burning length 3.00cm and highest burning rate 0.067cm/s. The briquette from corn cob still is suitable therefore for starting and maintaining fire for cooking and domestic heating. According to the work by Abodenyi and Yakmut (2020), groundnut shell briquette had the highest burning rate of 17.13mins. Based on the results in this research, it can be concluded that briquettes produced from corncob is the best to replace wood burning and discourage deforestation of forests. The results

also shows that corncob briquette and triple briquettes of corncob, sugarcane megasse and peanut shells are preferable than dual mix briquettes.

RECOMMENDATIONS

It is important to inform the general public of the need for a better energy alternative to firewood in order to protect the environment from pollutants that are often emitted by burning firewood.

Also, it is recommended that more people be involved in the production of better fuel briquettes as alternative energy source.

CONCLUSION

The findings showed that corncob, peanut shell and sugarcane megasse were good sources to produce briquettes and have high potentials as source of environmentally friendly energy, which reduces pollution around sugar factory and can be used as a good environment management system (EMS) to the sugar industry. Utilization of corncob, sugarcane megasse and peanut shells for the production of briquettes to produce clean energy can reduce indoor air pollution and respirator infectious disease that occurred due to the release of smoke during cooking and can also save forests from deforestation, and can be used as a climate change mitigation option. Moreover, producing briquettes from corncob, sugarcane megasse and peanut shells can generate additional income and create jobs opportunity for the local community and micro enterprise.

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