*IOSR Journal of Applied Physics (IOSR-JAP)*
*e-ISSN: 2278-4861.Volume 9, Issue 6 Ver. I (Nov. - Dec. 2017), PP 55-58*
*www.iosrjournals.org*

# Effect of Starch on Sawdust Briquettes for Domestic Energy Applications In Sokoto North-West Nigeria

[1]S. Aliyu, [2]M. M. Garbaand and [2]A.S. Bature.
*Corresponding email address; gmahmouda@hotmail.com*
*[1]Department of Physics, Faculty of Science, UDUS.*
*[2] Sokoto Energy Research Centre,Usmanu Danfodiyo University, Sokoto.*

***Abstract:*** *The effect of starch on sawdust briquettes for domestic energy applications in Sokoto state was investigated. Composite sawdust briquettes were produced using four treatments by mixing sawdust with starch in ratios 80:20 (A), 70:30 (B), 60:40 (C) and 50:50 (D). Densification of the mixture was carried out using a manually operated briquetting machine, while the starch gel was used as a binding agent. The performance of briquettes produced from each treatment was examined under controlled cooking test (CCT) together with the energy content using oxygen bomb calorimeter. The results showed that density of the briquettes produced was 0.21 Kg/cm$^3$ (A), 0.24Kg/cm$^3$ (B), 0.25Kg/cm$^3$ (C), 0.29Kg/m$^3$ (D). Treatment B had the highest energy value of 7.347cal/g and the least was treatment D with only 4.572cal/g. Treatment B was best in specific fuel consumption (SFC) with least value of 0.47gwhile the highest consumption was recorded in treatment A with 0.89g. Similarly, least time taken to cook (TTC) was recorded in treatment B with 44min/kg. It is inferred from the results that SFC and TTC are best with briquettes and that increase in starch results in higher density of the briquettes produced. It is recommended that the public should adopt the use of briquettes in domestic energy applications as a silent panacea for forest conservation and environmental sanitation.*

***Keywords:*** *Briquette, calorimeter, densification, calorie*

---

Date of Submission: 25-10-2017 Date of acceptance: 18-11-2017

---

## I. Introduction

Wood is a predominant source of fuel in rural areas of the developing countries. About 200 million people in developing countries depend on the wood biomass for their daily domestic energy needs (FAO, 1986). The main problem with fuel wood utilization in Nigeria is inadequate supply in arid region of the country (Fuwape and Sobanke 1998).The production of Briquettes from agricultural and wood residue would have an appreciable impact in meeting domestic energy requirements in the country which has problems of fuel wood scarcity (FAO 1990). It was reported that the average world production of residue comprises 250 million tonnes of sawdust, 200 million tonnes of bark, and over 400 million tonnes of crooked log. It was estimated that 55% of wood biomass processed in the saw mills in Nigeria end up as a mill residue. The wood wastes generated in the country in 1998 were estimated to be 1.72 million m$^3$ (Badejo, 1990). This composes of slabs, (63%) bark (22%) and sawdust (15%). The slabs and barks are sometimes collected and used as firewood while sawdust can be converted to briquettes which will be very useful as a source of fuel for domestic cooking. The problem of acute scarcity and deficit in supply of fuel wood has resulted in energy crisis in arid and semi-arid regions of the developing countries (Fuwape, 1992). Fuel wood provides about 30% of the total energy consumption in Africa, 17% for Asiaand 16% for the Latin American countries (FAO, 1986). There has been increasing demand for fuel-wood in response to high rate of population growth in the tropical rural areas. This along with reported bush-burning and overgrazing are seriously affecting the rate of deforestation and environmental degradation. In Nigeria, such wood is still the most utilized energy for cooking (SERC, 1991).

Briquette simply refers to a block of compressed coal dust, charcoal or sawdust and wood chips used for fuel and kindling. Briquetting is the process of transforming the powdery or granular products into a more convenient solid size. This sometimes involves the use of binders (glue). These materials are compacted with the use of roller press. Production of briquette, using sawdust will provide an alternative source of fuel which will reduce the rate at which our forests and woodlands are exploited for fuel-wood, and also reduce the rate at which this sawdust pollute our environment. The broad objective of this research is to determine the effect of starch on sawdust briquettes for domestic energy applications.

## II. Materials And Methods

The research was carried out in Sokoto Energy Research Centre (SERC) of Usmanu Danfodiyo University, Sokoto. Sokoto State has a landmass of 28,232.37 $km^2$. The state is located between longitude $11^0$ 13' to $13^O$ 50 E and latitude $4^0$ to 6 N. it is bordered in the North by Niger Republic Zamfara state to the East and Kebbi state to the South and West. (Sokoto State Tourists Guide, 2010). It has a population of about 4,244,399 (census 2006).The state falls within Sudan Savannah vegetation zone of Nigeria which is characterized by few scattered trees, and grasses that cover about 30% of the ground (Baba *et al*., 2000).The predominant plant species in the area include *Adansoniadigitata*, *Balanitesaegyptica*, *Acacia nilotica*, *Cynodondactylon*, *Andropogungayanus*,etc (Aliyu, 2006).The minimum and maximum temperatures are within the range of $19^0$C and $38^0$C respectively. The relative humidity ranges from 52 – 56% (Senchi, 2005). Interestingly, Sokoto is one of the hottest cities in the world, however the maximum daytime temperature for most of the years is generally $40^0$C (104.$0^0$F) with the dryness makes the heat bearable (Anon, 2007). The warmest months are from February – April where the daytime temperature exceeds $45^0$C ($113^0$F) with highest temperature recorded at 47.$2^0$C (117.$0^0$F) which was the highest temperature recorded in Nigeria. The rainfall mostly starts in either early or late May and ends in September. The mean annual rainfall ranges from 500mm to 1300mm which is un-evenly distributed (Ojanuga, 2004). Dry season mostly comes around October and last up to September. Hammatan is windy and dusty and cold, hence, cold and dry periods are both experienced in the state.The soil is mostly Sandy to loamy with low soil fertility particularly in primary nutrients - Nitrogen, potassium, Phosphorus (Fatubarin, 2004). The people of Sokoto state are mostly Hausa and Fulani, predominantly Muslims with about 80% farmers. The economic activities in the state include farming (irrigated), rearing of animals (cattle, sheep, goats), tanning, trade, etc.

**Controlled Cooking Test (CCT)**

Controlled cooking test was carried out to cook 200g of rice which was uniform for all the samples of briquette produced at different ratio of binder. Before the test, mass of the empty pot and initial mass of the briquette was measured.

**Specific Fuel Consumption (SFC)**

Specific fuel consumption and time taken to cook 200 grams of rice was computed in line with the relationship below:

i. The Specific Fuel Consumption (SFC) for a Controlled Cooking Test (CCT) is expressed is per Danshehu *et al*., (1992):

$$SFC = \frac{(Mfo - Mft)(1-X)}{Mpc - Mp} 1.5mc$$

ii. The time spent in controlled cooking test is given as per Danshehu et al, (1992):

$$t = \frac{totaltimespentincooking}{totalmassofcookedfood}$$

$$t = \frac{t_0 - t_1}{M_{pc} - M_p}$$

Where: t = Cooking time for 1 kg of food stuff (min/kg)

$t_0$ = Initial time before cooking (min)

$t_1$ = Final time after cooking (min)

$M_{pc}$ = Mass of pot with cooked food (kg)

$M_p$ = Mass of empty pot

X = The moisture content value of fuel assumed to be zero i.e. 100% dryness.

$M_C$ = Mass of charcoal left (kg)

$M_{fo}$ = Initial mass of fuel before burning (kg)

$M_{ft}$ = Final mass of fuel after burning (kg)

The mass of charcoal $M_c$ left after the briquette were combusted will be negligible hence $M_c$ isassumed to be zero.

**Sample collection and treatment**

Sampled sawdust was collected from Kara market. The choice of binder is because of its availability and low cost coupled with its binding ability, inoffensive smell and availability in its natural form. The sawdust and starch binder were combined into four (4) treatment combinations. Thus,Treatment A=80:20 of sawdust and starch, Treatment B=70:30, Treatment C=60:40, Treatment D=50:50 respectively.

**Experimental Design**

Complete randomized design was used to test the effect of additive (binder) in sawdust briquette at each level of composition or ratio of sawdust to additive which has four treatments, replicated three times.

**Data Collection**

Sampled sawdust and binder were simultaneously measured using electronic weighting balance before the mixture. Data were collected from compressed briquette produced before and after drying.

**Data Analysis**

The data obtained was subjected to ANOVA to test the performance of the composite briquettes for significant difference at 5% level of significance and the best treatment was compared with firewood to test the SFC. Where significant difference exists, the data was furthered subjected to post mortem analysis using Duncan's Multiple Range Test (DMRT).

## III. Results

**Density**

The results in table 1 shows the mean density of the briquettes produced. It was observed that there was significant difference between the treatments ($p<0.05$). The highest density was recorded in treatment D =0.2900g/cm$^3$,followed by treatment C=0.2433g/cm$^3$.Treatment B had 0.2500g/cm$^3$, while the least was found to be treatment A with 0.2067g/cm$^3$. This indicate that increase in the quantity of starch leads to the increase in density of the composites produced

**Table1:** Mean Density (g/cm$^3$) of the composite briquettes

| S/no | Treatments | Mean and SD |
|---|---|---|
| **1** | A | $0.2067 \pm 0.04^{b}$ |
| **2** | B | $0.2433 \pm 0.05^{ab}$ |
| **3** | C | $0.2500 \pm 0.02^{ab}$ |
| **4** | D | $0.2900 \pm 0.04^{a}$ |

Means followed by the same letter are not statistically different according to Duncan Multiple Range Test (DMRT) at 5% level of significance.

**Energy (Caloric Value)**

Table 2 shows the mean energy of the briquettes produced, with treatment B having the highest mean (7.347cal) and the lowest mean was recorded in treatment D with value of 4.572cal. Statistically there is no significant difference between the energy content of the briquettes produced.

**Table2:** Mean Energy (cal/g) Values of Briquettes

| S/no | Treatment | Mean and SE |
|---|---|---|
| **1** | A | $6.015 \pm 6.94^{ns}$ |
| **2** | B | $7.347 \pm 3.46^{ns}$ |
| **3** | C | $6.159 \pm 6.72^{ns}$ |
| **4** | D | $4.572 \pm 3.34^{ns}$ |

Ns= No significant difference.

**Specific Fuel Consumption (SFC) and Time Spent in Cooking**

From the results, it was observed that the lowest value of fuel consumed by cooking 200g of rice was recorded in treatment B with 0.47g, followed by C with 0.64g, D with value of 0.86 and A with value of 0.89g.Time spent in cooking 200g of rice showed the following pattern - treatment B with 44min/kg, D =47min/kg, C= 48min/kg and A= 50min/kg and firewood 53min/kg.

**Table3:**MeanSpecific Fuel Consumption (SFC) and Time Spent in Cooking (TSC) 200g of rice

| S/no | Treatments | S.F.C (g) | Time (min/kg) |
|---|---|---|---|
| **1** | A | 0.89 | 50 |
| **2** | **B** | 0.47 | 44 |
| **3** | **C** | 0.64 | 48 |
| **4** | **D** | 0.86 | 47 |
| **5** | **Firewood** | 0.89 | 53 |

## IV. Discussion

**Density**:

The density of the composites produced was found to increase down the treatment with A having average density of about 0.00020kg/$cm^3$,B=0.00024kg/$cm^3$, C=0.00025g/$cm^3$, D=0.00029kg/$cm^3$ which was the highest density recorded. From the research, it was deduced that increase in the amount of starch in a treatment leads to increase in the density of the briquette that will be produced and also influence compaction of the composites.

**Energy content (caloric value)**

The energy content of the composites produced was determined using oxygen bomb calorimeter and the following values were obtained A=6015.36calories/gram for 80% sawdust and 20% starch, B which has the highest energy content was found to be 7347.6calories/gram, C=6159.55calories/gram, D=4572.26calories/gram which was the lowest C.v recorded and these varied with the findings of (Adegoke and Kuti, 2004) who said that energy content of the composite briquette was found to be 22.41mj/kg. These indicate that the energy content found in this experiment is higher than that of the above authors.

**Specific fuel consumption (S.F.C)**

SFC was found to be lowest in treatment B with 0.47g produced from the mixture of sawdust and starch at 70 and 30 percent, firewood was found to be 89g same as the value obtained in treatment A. The remaining treatments have better S.F.C than that recorded for firewood.This contradicts the findings of Adegoke and Kuti, (2004) who reported that rice has S.F.C of 0.185g, though the quality of rice was not stated. It can still be concluded that this experiment has the higher value of S.F.C in cooking than what was discovered by Adegoke and Kuti, 2004.

The results contradicts the minimum quality of cassava starch required for briquette production as reported by Olorunnisola 2003, that it was impossible to produce any cohesive and stable briquette at a cassava content of 50%, 100% and 150% as they all simply fell apart after production. It was only treatment A that had such problem where the sawdust and the starch are in mixture of 80% and 20% all the rest remain solid and this indicate that these level of binders are inefficient. Mass of charcoal left was 1.5g.

**Time spent in cooking**

Time spent in cooking 200g of rice are as follows for treatment A=50min/kg, B=44min/kg, C=48min/kg, and D=47min/kg where by the firewood was recorded with highest time spend in cooking with about 53min/kg. Adegoke and Kuti 2004, reported that briquette produced using starch only, rice about 40.38min/kg, while in my research the lowest time was 44min/kg, though foreign rice was used in the test.

## V. Conclusion

The performance of the briquettes was generally impressive as they compare well with firewood in cooking. Briquettes are therefore recommended as alternative source of energy for domestic energy needs in order to checkmate deforestation of our fragile environment.

## References


[1]. Adegoke ,CO.andKuti,O A.(2004)Investigation of Composite Sawdust Briquette As A Source of Fuel for Domestic Cooking.FUTAJEET,2004 Vol4. No 2144-150

[2]. Anonymous (2007).Brief History and Geography of Sokoto state.Retrieved 2007-04-07.

[3]. Baba, K. M. and A. H. Alhassan (2000). Impact of Animal Traction on Agricultural Production and Farm Income in Sokoto State, Nigeria Journal of Agriculture and Environment vol. 1 NO. 1 June, 2000.

[4]. Danshehu, B. G., A. S. Sambo and M. Musa (1992). Comparative Performance of Sawdust and Wood Burning stove, Nigerian Journal of Renewable Energy, vol. 3. No. 1 and 2, page 50.

[5]. FAO, (1986). Tropical Forestry Action Plan Fuel-wood Energy.Unasylva 38,pp37-63.

[6]. FAO, (1990). The Briquetting of Agricultural wastes for Fuel Environmental and Forestry, paper

[7]. Fuwape, J. A. and Sobanke (1998). Combustion Characteristics of Wood Briquette Produced from Sawdust. National Conference of Nigeria Society of Agricultural Engineering Pg 1-11, 8 – 11th September 1998.

[8]. Olorunnisola, A. O. (2003). Briquetting Rattan Furniture Waste for Domestic and Agro-Industrial Application. *Nigerian journal of Renewable Energy*, Vol.11 No 1and 2 page 130-135 Published by Sokoto Energy Research Centre, Usmanu Danfodiyo University Sokoto.

[9]. SERC, (July 1991). Report of the rural energy survey in selected local government areas of Kano, Katsina, Niger and Sokoto states as well as in the Federal Territory, Abuja.

[10]. Sokoto State Tourist guide (2010). Paper presented in Trade-pire Old Airport. Sokoto state under Ministry of Commerce Sokoto. Pp4.


1S. Aliyu Effect of Starch on Sawdust Briquettes for Domestic Energy Applications In Sokoto North-West Nigeria." IOSR Journal of Applied Physics (IOSR-JAP) , vol. 9, no. 6, 2017, pp. 55-58.