Greener Journal of Agricultural Sciences
Vol. 10(1), pp. 30-33, 2020
ISSN: 2276-7770

http://gjournals.org/GJAS

Development and Performance Evaluation of a Briquette from Agricultural by-Products

[1]Ogunrinde, E.A.; [1]Ojo, O.I.; [2]Adgidzi, D.; [3]Sanusi, B.A.; [3]Olaoye, I.O.

Department of Agricultural Engineering, Ladoke Akintola University of Technology, Ogbomoso
Department of Agricultural Engineering, Federal University of Agriculture Makurdi
Department of Agricultural and Bio-Environmental Engineering, Oke-Ogun Polytechnic, Saki

ARTICLE INFO

Article No.: *122419222*
***Type*:** *Research*

Accepted: *25/12/2019*
Published: *31/01/2020*

Corresponding Author
Ogunrinde, E.A.,
E-mail:
ogunrindeemmanuelabiola@gmail.com

Keywords: *Briquettes; crushing strength; calorific value; burning efficiency*

ABSTRACT

The current wave of energy consciousness has triggered intense efforts in the search for the alternative sources for cooking fuels, including the use of agricultural by-products like cassava peels, sawdust and shea butter cake to form briquettes which are substitutes of fuel needed for domestic cooking. The experiments were conducted using 23 full factorial design. Three factors, cassava peels (X1), sawdust (X2) and shea butter cake (X3) at two level (coded as – and +) were investigated under different variable factors. The briquettes were tested and evaluated for quality in terms of crushing strength, calorific value and burning efficiency. The model developed showed that cassava peel have higher significance difference in briquettes than interaction of these factors at 5% levels of significance. Cassava peel showed a higher significance effect than shea butter cake. Crushing strength, calorific value and burning efficiency were affected by interaction of the three main factors. The fitted model for predicting the crushing strength, calorific value and burning efficiency gave the best compromise for optimization as it produced briquettes of higher calorific value 885J/kg and considerable crushing strength of 883N respectively.

1.1 INTRODUCTION

Briquettes of Agricultural by-products like cassava peel, sawdust, rice husks e.t.c. can largely overcome some of the major problem regarding their utilization for energy because the rural peoples rely heavily on fuel from wood which is faced with the rapid depletion of forest resources resulting from excessive exploitation for fuel and timber, clearing of products for village expansion work and agricultural activities (Ajueytsi, 2002). Nigeria, even though an oil producing nation has challenges of energy crisis. According to Adegoke (2002), Nigeria is passing through an unprecedented energy crisis like non – renewable energy such as kerosene and gas are outside the reach of the common man, the supply of electricity another conventional energy source is epileptic where available or non available at all in most parts of the country.

Agricultural wastes which cause health and environmental risks are now processed into briquettes which make agricultural waste into wealth (Bernard,1985), at this present rate of deforestation, there will soon be a severe shortage of fuel from wood and its necessary to introduce other sources of cheap and available fuels, increase in agricultural productivity is associated with increase in agricultural residues supplies which can be converted into high grade energy source with the modern technology known as briquettes (Adekunle, 2004). The main domestic and household fuels Nigeria families use for cooking and business are firewood, charcoal and kerosene, a greater percentage of Nigerians are still in search of cheap and affordable fuel for use at home and business (Abdullahi, 2000).

2.1 MATERIALS AND METHODS

2.1.1 Materials

Some of the materials used for this work were cassava peel, sawdust, butter cake and cassava starch as a binder

2.1.2 Equipments

The following equipment was used in this work:

i. A stopwatch was used during the experiment to record the timing of the different stages of the test
ii. Weighing balance to measure the weight
iii. California bearing ratio testing machine for determination of the crushing strength
iv. Water bucket
v. Electric heater for boiling water
vi. Stainless pan for proper mix
vii. Hydraulic briquetting machine for compression
viii. Coal pot stoves
ix. Aluminum cooking pot

2.1.3 Working principle of the briquetting machine

A manually operated hydraulic briquetting machine fabricated in mechanical engineering department, Federal University of Technology, Minna was used for the compression of the mixtures of cassava peels, shea butter cake and sawdust sample into a solid shaped briquette fuel. The machine is equipped with a pressure gauge, hand lever with a mould that could produce 15 briquettes at the same time. The resulting mix of the agricultural by-products known as feed stock is fed into a mould and compressed at 40KN pressure, after the compaction, the mould is placed over an appropriate opening and the formed briquette is extracted by gradual application of pressure at the hydraulic jack.

2.1.4 Production of briquettes

Measured quantity of cassava starch gotten at temperature between $80^o{}_C$ and $100^o{}_C$ was added to a mixture of varying composition of cassava peels, sawdust and shea butter cake and then stirred vigorously to achieve a uniform mix. Tempering of the mix was ensured by introduction of appropriate cassava starch gel at the temperature range of $80^o{}_C$, and $100^o{}_C$. The resulting mix known as feed stock was fed into mould and compressed. After compaction, the mould was placed over an appropriate opening and the formed briquette by gradual application of pressure at the hydraulic jack. The extracted briquette was then allowed to dry in the sun, after sun drying the briquette produced and tested for burning efficiency by varying the quantity of the mix organic materials.

2.2 Experimental Design for the Briquette

i. The crushing strength was determined using the California bearing ratio (CBR) testing machine.
   Crushing strength = load x 25.5

   Where:
   25.5 is the proving ring factor or calibrating factor of the CBR testing machine

ii. The calorific value of a fuel which is the amount of energy liberated by burning a unit mass

The following must be accomplished; the heat must be balanced that is,

$$E = \frac{M + M_a}{M_F} \qquad 1$$

Where:
E = Energy released by fuel (J/kg)
M = Mass of water used (kg) = 0.9kg
Ma = Mass of equivalent apparatus = 42kg

MF = Mass of fuel used (kg)

iii. The burning test was carried out using the various briquettes replicate to test for the burning capacity and the burning efficiency. There are different methods of water boiling test to be carried out; they are percentage heat utilized (PHU). specific fuel consumption (SFC). According to Adekunle J.O (2004),

$$S.F.C = \frac{Mass\ of\ briquette\ burnt}{Mass\ of\ water\ boiled} \quad 2$$

$$\frac{M_i - M_f}{M_w - M_p} \quad 3$$

Where:

Mi = initial mass of briquette before burning (kg)
Mf = final mass of briquette after burnt (kg)
Mw = mass of pot and water (kg)
Mp = mass of pot (kg)

iv. Statistical analysis and model simulation progressing test was used for the predicted briquette mode

3.1 RESULTS AND DISCUSSIONS

The results of the effect of the three factors at two levels investigated simultaneously are given by the fitted models for predicting the quality of briquette developed from Agricultural by- products from the main experimental values of the eight experimental runs as shown in Table 1-2.

3.1.1 Crushing strength

The interaction of cassava peel and shea butter cake have higher positive influence on the crushing strength while the interaction of sawdust at a lower level have negative influence on the crushing strength at the experimental runs six as presented in Table 2. However, the Ymean of the crushing strength at runs six have Y = (833). The fitted model at the runs have Y = (797) from the predicted regression coefficient equation.

$$\ddot{Y} = 644.94+41.44X_1+64.81X_{13} – 45.69X_{123}$$

3.1.2 Calorific value

The interaction of cassava peel and shea butter cake have lower negative influence on the calorific value while the interaction of sawdust has a higher positive influence on the calorific value of the experimental runs. However, the Ymean of the calorific value at run three have $\ddot{Y}$ = (867) as shown in the Table 2 and the fitted model at the same runs have $\ddot{Y}$ = (885) from the predicted regression coefficient.

$$\ddot{Y} = 726.92 – 62.22X_3 + 95.41X_{13}$$

3.1.3 Burning efficiency

The interaction of cassava peel and sawdust have higher influence on the burning efficiency while the interaction of the shea butter cake have lower negative influence on the burning efficiency at the experimental runs four. However, the Ymean of the burning efficiency model at the runs have $\ddot{Y}$ = (0.007875) from the predicted regression coefficient.

$$\ddot{Y} = 0.06825 + 0.004625X_1 – 0.005875X_{13}$$

Table 1: The mass of briquette before burning and mass of briquette after burning

Runs No	Mass of briquette before burning (kg)				Mass of briquette after burning (kg)			
	Y_1	Y_2	Y_3	$\ddot{Y}$	Y_1	Y_2	Y_3	$\ddot{Y}$
1	0.15132	0.1644	0.1482	0.15464	0.100	0.090	0.100	0.096
2	0.18528	0.1944	0.1836	0.18774	0.110	0.130	0.120	0.120
3	0.12732	0.1236	0.1320	0.12764	0.080	0.060	0.090	0.076
4	0.15120	0.1392	0.1560	0.14880	0.090	0.065	0.085	0.080
5	0.11250	0.1176	0.1080	0.11270	0.060	0.057	0.070	0.062
6	0.1740	0.1168	0.10872	0.13320	0.120	0.100	0.120	0.113
7	0.1320	0.1224	0.1386	0.1308	0.065	0.070	0.068	0.068
8	0.1305	0.1322	0.1326	0.1317	0.070	0.060	0.059	0.063

Table 2. Crushing strength, calorific values and burning efficiencies of briquette

Run	Crushing strength				Calorific value				Burning efficiency			
No	Y_1	Y_2	Y_3	$\ddot{Y}$	Y_1	Y_2	Y_3	$\ddot{Y}$	Y_1	Y_2	Y_3	$\ddot{Y}$
1	765	714	714	731	835.93	576.61	890.04	767.52	0.057	0.083	0.053	0.064
2	561	538.5	637.5	578	569.89	666.15	674.53	636.85	0.084	0.072	0.071	0.075
3	459	612	739.5	603.5	906.59	674.53	1021.43	867.51	0.053	0.071	0.047	0.057
4	688.5	739.5	561	663	817.14	707.92	1128.95	884.67	0.068	0.082	0.078	0.076
5	612	355.5	484.5	544	700.98	578.17	604.22	627.97	0.058	0.067	0.042	0.056
6	969	765	765	833	794.14	642.21	706.52	714.39	0.60	0.074	0.067	0.067
7	510	561	535.5	5335.5	640.30	818.7	612.86	680.62	0.074	0.058	0.077	0.069
8	710	663	673.5	671.5	709.09	586.06	582.88	626.01	0.067	0.081	0.082	0.076

4.0 CONCLUSION

Briquettes of several proportions of cassava peel, sawdust, butter cake and cassava starch were produced. The crushing strength and calorific value were determined, also they were burnt to determine the burning efficiency using the specific fuel consumption (S.F.C), the result obtained from the 2^3 full factorial design techniques employed in this work have shown that the briquette produced are of good quality with the following models for predicting the crushing strength, calorific value and burning efficiency at 5% level of significance.

$\ddot{Y}cs = 644.944 + 41.44X_1 + 64.81X_{13} - 45.69X_{123}$
$\ddot{Y}cv = 726.92 - 62.22X_3 + 95.41X_{13}$
$\ddot{Y}be = 0.06825 + 0.004625X_1 - 0.005875X^{13}$

Where:

$\ddot{Y}$ = fitted response
X_1 = cassava peel
X_2 = sawdust
X_3 = shea butter cake

The result of the crushing strength, calorific value and burning efficiency of the experiments and the developed models confirms that cassava peel, sawdust and shea butter cake are important for characterizing the above mentioned properties of briquettes i.e. crushing strength, calorific value and burning efficiency

REFERENCES

Abdullahi, M and Musa, B (2000). Effect of reduction of fire chamber in the performance of the “wood miser”. A paper presented during the discussion of performance test conducted on wood stores, developed at the solar energy research centre, Federal Polytechnic Bida, Polyma II Journal vol. 1 pg11

Adegoke, C.O and Mohammed, T.I (2002). Investigation of sawdust briquettes as high grade fuel, west Indian journal of Engineering 25 (1): Pp 1 – 8

Adekunle, J. O, (2004). Investigation of Briquette of different species of wood sawdust as solid fuel. M.Eng Project (Unpublished), Department of Mechanical Engineering, Federal University of Technology Akure

Ajueytsi, O.N.A (2002). Evaluation of local briquettes as a source of domestic cooking fuel. M.Eng thesis, Department of Mechanical Engineering, Federal University of Technology, Akure

Bernard, G. (1985). The use of Agriculture Residue as fuel Ambio Vol. Xiv No 4 – 5.

Cite this Article: Ogunrinde, EA; Ojo, OI; Adgidzi, D; Sanusi, BA; Olaoye, IO (2020). Development and Performance Evaluation of a Briquette from Agricultural by-Products. *Greener Journal of Agricultural Sciences* 10(1): 30-33.
.