



Appraisal of Starch-bonded Briquettes Utilization among User-respondents in Port Harcourt, Rivers State, Nigeria

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

Article Information

DOI: 10.9734/AJEE/2019/v11i330137

Editor(s):

(1) Dr. Wen-Cheng Liu, Department of Civil and Disaster Prevention Engineering, National United University, Miaoli Taiwan.

Reviewers:

(1) Yonny Martinez Lopez, Federal University of Espirito Santo, Brazil.

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(3) Ahmed Karmaoui Southern Center for Culture and Science, Morocco.

Complete Peer review History: <http://www.sdiarticle4.com/review-history/52877>

Original Research Article

Received 10 October 2019
Accepted 18 December 2019
Published 02 January 2020

ABSTRACT

The study appraised briquette users' opinions on the apparent properties and environment friendliness of the briquettes bonded by 30% and 40% starch composited saw dust collected from Marine and Illoabuchi Sawmills in Port Harcourt, Nigeria. Multistage sampling was used amongst 100 plantain (Bo-lae) roasters, meat barbecue (Suya), Garri (carbohydrate based food), and Akara (baked bean cake) respondents to elicit information on use of briquettes as an alternative source of energy on a 4-point Likert scale. The results showed that male user-respondents were 22 (88%) and 21 (84%) and female 3 (12%) from Marine and Illoabuchi sawmills, respectively. The 41-50 respondent age bracket were the most represented in both sawmills-Marine Base and Illoabuchi 12 (48%) and 11 (44%) respectively, followed by 31-40 (7: 28%) and 51-60 (4: 16%) in Illoabuchi sawmill, while the 51-60 and 31-40 age groups were 6 (24%) and 5 (20%), respectively. Amongst the businesses run by respondents, users from Marine Base, plantain roasting was highest at 7 (28%), followed by fish barbecue and akara with 6 (24%), Suya had 5(20%), while at Illoabuchi, Suya grillers had 9 (36%), followed by plantain roasters 8 (32%). Garri stewards and Akara had the same 3 (12%). Environment friendliness and physical properties showed that briquettes smoked well with cut off Mark (M =3.04 and 3.80), smelled pleasantly (M=3.03 and 2.68), stuffy and choky smoke (M=0.4 and 1.00) and irritation of eyes had M=3.25 and 4.00 at Illoabuchi and Marine Base

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sawmills, respectively. Darkening pots, burning with dark smoke and being affected by water had their cut off marks at 1.33 and 1.40 (rejected), 2.63 and 2.50 (accepted) and 2.01 and 2.12 (rejected), portable, cheap and useful had M= 2.45 and 3.00, 3.60 and 3.60 and 3.40 and 3.09 from both mills respectively. This study recommends that briquetting of sawdust from sawmills be promoted via automation to maximize its utilization status.

Keywords: Briquettes; environment friendliness user-respondents.

1. INTRODUCTION

Africa is “still” at 1.2 billion (or 16% of global population) but it grows so fast and urban planning and infrastructure so slow in comparison that challenges like overcrowding, traffic congestion, pollution, and localized resource depletion are already worrying [1]. Booming populations and urbanization, industrialization, and expansion of the middle class require more energy [1].

There are multiple dimensions to the problem of energy access in Sub-Saharan Africa, where large shares of population lack a reliable supply of electricity and affordable modern cooking fuels: from insufficient power generation capacity, to difficulties in managing energy infrastructure and attract investments in the sector, to challenges in serving low-income users [1]. The demand for the use of fuel wood have been on the increase due to rural and urban poverty, low agricultural productivity, inequalities in land holding, rapid urbanization, sharp division in the socio- economic roles of men and women in some countries; rising costs of fossil fuel, kerosene, gas and electric cookers [2].

The Energy Commission of Nigeria asserted a 92.2% consumption of fuel wood as a primary alternative energy source in the country [3]. This is corroborated by Aju and Uwalaka [4] that fuel wood is a primary energy source accounting for over 90% of the total energy used for domestic purposes in Nigeria. The demand for fuel wood is expected to rise to about 213.4×10^3 metric tonnes, while the supply is expected to decrease to about 28.4×10 metric tonnes by the year 2030 [1]. Fuel wood energy used is consumed mostly by the low and lower-middle income urban households as well as by owners of cottage and small scale industries and to augment commercial enterprises' sources such as pottery [5], hotels [5], schools [5], banks [5] and hospitals [5]. In Ogoniland and other parts of Rivers State (Nigeria), wood and even twigs and leaflets of woody species are garnered and scavenged from newly exploited and cultivated riparian and

mangrove forests as well as polluted oil sites for fuel [5]. Rural dwellers troop in groups to forests with axes, machetes, ropes and basins trekking long distances in search of these resources [5]. The high cost conventional sources of energy have changed the paradigm to wood as an energy source for livelihood sustenance and as an income source [5]. For this reason, a transition to a sustainable energy system is urgently needed in developing country like Nigeria to augment the monoculture-fossil energy source (petroleum).

One of such energy source is wood waste or sawmill residue. Sawdust constitutes one of the most abundant waste or residue in wood industries. The inefficient wood conversion and low biomass recovery from the Nigerian timber industry have led to sawdust hills around sawmills, constituting a visual blight on the local environment and a breeding ground for wood decaying organisms [6]. Sawdust hills could be compacted into briquettes as a source of fuel energy [7]. Briquettes made from sawdust can possibly reduce forest degradation and deforestation to mitigate these problems.

Briquetting, which is aggregation of micro- or minute-wood waste, costs little or no money compared to other wastes such as newspaper or partially decomposed plant waste. Sawdust can be an alternate source of domestic and industrial energy to charcoal, firewood, gas, coal and electricity. Briquettes made from charcoal and sawdust is a desirable fuel because it produces a hot, long-lasting and virtually smokeless fire, and is produced when charcoal and sawdust are combined with other materials, and it is formed into uniform chunks [6]. Thus far nothing has been stated about Starch-bonded briquettes. Starch-bonded briquettes is an organic amalgam of pulverised saw dusts in various particulate sizes and bonded by starch as binding agent natural or synthetic. Globally, the over dependence by humans on fossil fuel has led to environmental degradation. Briquette as an energy alternative to costly fossil fuel that is

cheap and readily available dotting the sawmills located near the coastal part of Port Harcourt. Wood logs are transported to these sawmills by water. Thus there is a need for a sustainable, inexpensive alternative energy source such as wood micro waste (sawdust). Therefore, this study aimed at appraising briquette users' opinion on the apparent properties and environmental friendliness of the briquettes bonded by starch after usage. The duo of rapid deforestation and environmental pollution constitute smog and polluted air inhaled by the coastal area dwellers of Port Harcourt where heaps of sawdust ubiquitous at sawmills briquetted will provide clean and alternative source to fuel wood use by these poor and low income earners.

2. METHODOLOGY

2.1 Study Area

Sawdust was sourced from Marine and Illoauchi sawmills in Port Harcourt, Rivers State, Nigeria on Latitude 4.51°N, and Longitude 7.01°E (Fig. 1).

The socio-economic conditions of the populations around Marine and Illoauchi sawmills are coastal areas of Port Harcourt where dwellers are usually low, medium income earners and some even unemployed with standard of living poor below \$1 per day and expenditure on fossil fuel is minimum in most cases none. They depended on fossil fuel alternatives like fuel wood and sawdust briquettes for cooking where heaps of sawdust ubiquitous at sawmills.

2.2 Research Design

Multistage sampling method (www.researchgate.net) was used in the identification of target respondents and their locations were purposively selected: the respondents' businesses were identified by identifying their various locations (5 at each sawmill where briquettes were produced). Fifty questionnaires (50) were administered directly amongst energy-using respondents-plantain and fisher roasting or barbecue otherwise known as bo-lae, meat barbecue (suya), garri (carbohydrate based food) and akara (baked bean cake) respondents. 10 per business

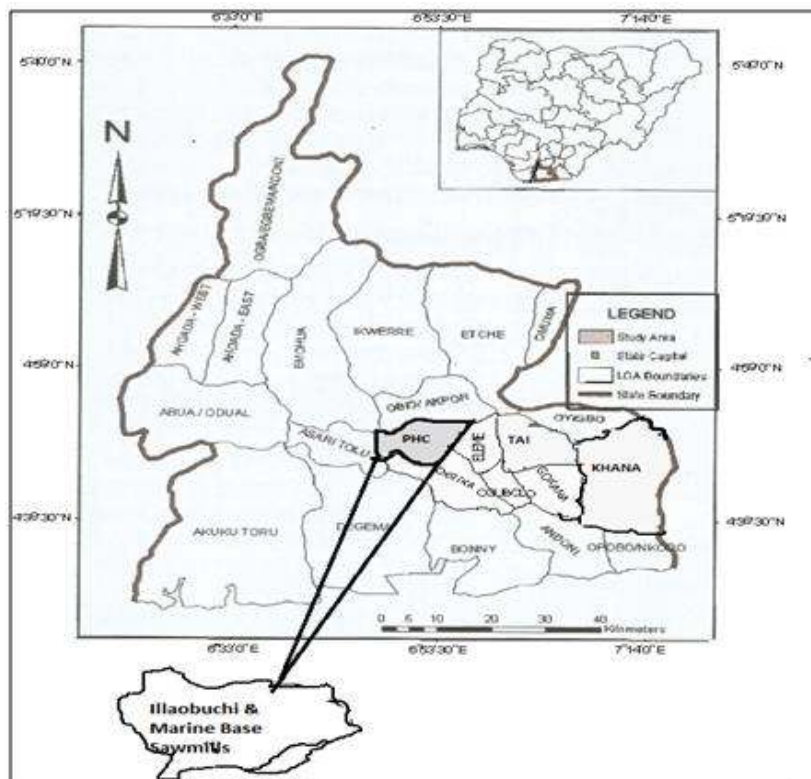


Fig. 1. Map of Rivers State indicating the study areas

Source: Rivers State Ministry of Environment, July, 2019

category in both sawmills-Marine and Illoabuchi. Sample size of 25 each at each mill-2 locations.

2.3 Data Collection

Data were collected between July, 2019 and September, 2019 using a semi-structured questionnaire designed to capture the following information: (i) biographical data of respondents, (ii) Users assessment of briquettes, and (iii) Assessment of problems associated with briquettes utilization.

2.4 Data Analysis

Environment friendliness and physical properties showed that briquettes smoked well with cut off Mark (M =3.04 and 3.80), smelled pleasantly (M=3.03 and 2.68), stuffy and choky smoke (M=0.4 and 1.00) and irritation of eyes had M=3.25, and 4.00 at Illoabuchi and Marine Base sawmills, respectively. Darkening pots, burning with dark smoke and being affected by water had their cut off marks at 1.33 and 1.40 (rejected), 2.63 and 2.50 (accepted) and 2.01 and 2.12 (rejected), portable, cheap and useful had M= 2.45 and 3.00, 3.60 and 3.60 and 3.40 and 3.09 from both mills respectively.

The product of Likert scale is divided by the sum of set of raw data: if the product of Likert scale option is 4 for strongly agreed, 3 for agreed, 2 for strongly disagreed and 1 for disagreed, then for instance outcome of an option of an opinion in the questionnaire is 10, this means $10 \times 4 = 40$. This is repeated across the column of strongly agreed. Similarly, this will be repeated for others-agreed, strongly disagreed and disagreed on the 4-point Likert scale. At the end, their sums will be added up as grand total say 79. Still on the Likert scale table, across the row total will be taken and use as the divisor say 29 therefore $M = 79/29 = 2.71$ (2 decimal places). One accepts an opinion if the cut off mark (M) is equal or above the quotient of $10/4 = 2.50$ and rejects that opinion if the quotient is below 2.50.

3. RESULTS AND DISCUSSION

3.1 Biographical Characteristics of Participants

Results showed that across different enterprises males were dominant 22 (88%) and 21 (84%) and 3(12%), male and female at Marine and Illoabuchi sawmills respectively (Table 1).

The age of respondents that used the briquettes showed that 41-50 age bracket had the highest in both sawmills-Marine Base and Illoabuchi 12 (48%) and 11 (44%) respectively followed by 31-40 (7:28%) and 51-60 (4:16%) in Illoabuchi sawmill while 51-60 and 31-40 were 6(24%) and 5 (20%) respectively (Table 1).

The businesses were dominated by the married briquettes users 11 (44%) from Marine Base sawmill but at Illoabuchi married and single users had the same frequency and percentage with 10 (40%) while separated users had the lowest (1:4% and 3: 12%, MB and IB sawmills respectively (Table 1).

The result on education status of briquettes users showed that secondary leavers were almost the same at both MB and Illoabuchi sawmills with 12 (48%) and 11 (44%) respectively, followed by those without education with 7 (28%) and 5 (20%) and lowest was primary school leavers. Even university graduates were involved in this petty entrepreneurial business with 5 (20%) for both sawmill (Table 1).

The year of experience of respondent users matters as 11-12 years had the highest (12:48%) followed by 1-10 years with 10 (40%) at MB while 1-10 years was the highest with 9 (36%) followed by 11-20 years with 8 (32%) and 21-30 years with 4 (16%) (Table 1).

Amongst the businesses carried out by respondents, users of briquettes from Marine Base, Port Harcourt, plantain roasting was highest of 7 (28%) followed by fish barbecue and akara with 6 (24%), meat barbecue had 5(20%) while at Illoabuchi, meat barbecue had 9 (36%) followed by plantain had 8 (32%) and garri and akara had the same 3 (12%) (Table 1).

3.2 Users Assessment of Briquettes from Illoabuchi and Marine Base Sawmills

The result on the use of briquettes from both sawmills in terms their environment friendliness and physical properties showed that briquettes smoked well (M=3.04 and 3.80), smelled pleasantly (M=3.03 and 2.68) Illoabuchi and Marine Base respectively, but contrariwise the briquettes smoke was stuffy and choky smoke (M=0.4 and 1.00) and irritation of eyes had M=3.25 and 4.00 respectively (Table 2). This finding provides energy solution to user respondents which agrees with Ogunsanwo [8]

that application of briquetting technology of saw dust is promising solution to the problems of unutilized agricultural residues. The environment friendliness properties of briquettes also agrees with Yaman et al., [9] and Olorunnisola [10] reported that greater heat intensity, cleanliness, convenience in use, and relatively smaller space requirement for storage are notable merits of briquettes. The use of briquettes from sawdust ubiquitous at sawmills in urban, towns, villages and other rural dwellers living close to them may reduce the energy, time and danger trekking to the forests to harvest fuel wood which a

pragmatic paradigm shift to exploration of alternative source of energy. This agrees with Barrow et al., [11] who reported that restoration of woodland around the communities reduced the time taken to collect fuel wood by up to four hours and this has potential to free up time for women to engage in other productive activities that can improve gender empowerment, equity and sustainability of woodland. Applying this concept to availability of briquettes, the time would be less than four hours, the limitation of briquetting is the manual production method used.

Table 1. Biographical characteristics of briquette users

Socio-economic characteristics		Marine base sawmill		Iloabuchi sawmill	
		Frequency	Percentage	Frequency	Percentage
Gender	Male	22	88	21	84
	Female	3	12	3	12
Age in years	31-40	5	20	7	28
	41-50	12	48	11	44
	51-60	6	24	4	16
	61-70	2	8	3	12
Marital Status	Married	11	44	10	40
	Single	9	36	10	40
	Divorced	3	12	1	4
	Separated	1	4	3	12
Education Status	Tertiary education	5	20	5	20
	Secondary school	12	48	11	44
	Primary school	2	8	3	12
	No Education	7	28	5	20
Year of Experience	1-10	10	40	9	36
	11-20	12	48	8	32
	21-30	1	4	4	16
	31-40	2	8	2	8
	41-50	0	0	1	4
Kinds of Business	Plantain Roasting	7	28	8	32
	Meat Barbecue	5	20	9	36
	Fish Barbecue	6	24	2	8
	Garri	1	4	3	12
	Akara	6	24	3	12

Field Survey, 2019

Table 2. Assessment of environmental friendliness and physical properties of briquettes

Physical Properties	Iloabuchi		Marine Base	
	Mean		Mean	Remarks
Friability and Easily Breaks	1.78		2.00	Reject
Weighty and Heavy	1.71		2.00	Reject
Smokes well	3.04		3.80	Accept
Smell Pleasantly	3.03		2.68	Accept
Stuffy and Choky Smoke	0.4		1.00	Reject
Smoke Irritates Eyes	3.25		4.00	Accept

Cut off Marks (M): Accept if $M \geq 2.50$, Reject if $M \leq 0.05$

Table 3. Assessment of Problems associated with briquettes utilization

Problems	Illaobuchi	Marine Base	
	Mean	Mean	Remarks
Darkness or Blackens pots	1.33	1.40	Reject
Lack of other Alternatives	2.44	2.20	Reject
Burns with Smoke	2.63	2.50	Accept
It is Cheap	3.60	3.60	Accept
Affected by water	2.01	2.12	Reject
Portability	2.45	3.00	Accept
Smokes well	3.01	4.00	Accept
It is Useful	3.40	3.09	Accept

Cut off Marks (M): Accept if $M \geq 2.50$, Reject if $M \leq 0.05$

3.3 Assessment of Problems Associated with Briquettes Utilization

The results of respondents users problems like darkening pots, burning with dark smoke and being affected by water had their cut off mark (M) ranged from 1.33 and 1.40 (rejected), 2.63 and 2.50 (accepted) and 2.01 and 2.12 (rejected) from Illaobuchi and Marine Base respectively (Table 3). The briquettes were portable, cheap and useful had $M = 2.45$ and 3.00 , 3.60 and 3.60 and 3.40 and 3.09 from Illaobuchi and Marine Base sawmills respectively (Table 3). In terms of cost and ease of use, it agrees with Hafner, et al., (2018) that greater heat intensity, cleanliness, convenience in use, and relatively smaller space requirement for storage are notable merits of briquettes. According to Hafner, et al., (2018) scenario of universal access to clean cooking, efficient and advanced cook stoves (biomass improved) plays a major role in Sub Sahara Africa and likely remain the only feasible upgrading from the status quo for many—especially in rural areas—and, in terms of fuel, charcoal will play an increasingly important role compared to fuel wood and other solid biomass (e.g. agricultural residues).

Wood briquette use provides alternative to fuel wood utilization that impinges on deforestation and forest degradation which corroborates with Hafner, et al., (2018) that benefits of achieving universal access to clean cooking would be immense and would include improvement of health conditions, local job creation, gender empowerment, and reduced forest degradation (and in turn improved climate mitigation at global level).

4. CONCLUSION

The properties of briquettes analyzed and appraised by product users showed that the

produce briquettes had positive environment qualities, though some properties were not all that useful and friendly but the overall use of the briquettes were promising as an alternative to conventional fossil energy sources. Briquetting of sawdust from sawmills is recommended in order to reduce deforestation, degradation and environmental hazards caused by the use of other sources of energies especially petroleum products. There should be automation of production of briquettes in order to maximize its utilization status.

CONSENT

The participants of the research were duly informed and consulted orally before the questionnaires copies were administered on them with an appeal of consent letter (See appendix 1) from me. The letter introduced the intent of the Researcher and the reason of the research, in all no antagonistic response was received.

ACKNOWLEDGEMENT

This is to acknowledge and to thank Tertiary Education Trust fund (Tetfund), Nigeria, the sole sponsor of this research due to the grant given to the researcher.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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APPENDIX 1

Department of Forestry & Environment
Faculty of Agriculture Rivers State University,
Nkpolu-Oroworukwo, Port Harcourt, Nigeria. P.M.B. 5080
20th July, 2019

Dear Respondent,

This questionnaire is designed to extract information from you (respondent) on the utilization and environmental friendliness of produced briquettes. The information required shall be used solely and mainly for academic purposes of which the result of this survey shall assist the policy makers in the wood energy sectors to formulate sustainable ways in providing alternatives to conventional energy by use of wood based briquettes. You are therefore asked to provide me with the real information as possible as this shall be strictly treated with confidence.

Please, tick the appropriate option that matches with your original opinion about each of the following question.

Thanks for your co-operation.

Yours sincerely,

Dr. David-Sarogoro, N.

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Peer-review history:
The peer review history for this paper can be accessed here:
<http://www.sdiarticle4.com/review-history/52877>