

Appraisal of Starch-Bonded Briquettes Utilization among User-Respondents in Port Harcourt, Rivers State, Nigeria

Comment [YML1]: I believe that the title must appear so that the briquettes will be used, the part of the respondents can be declared in the methodology

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 plantain (Bo-lae) roasters, meat barbecue (Suya), Garri and Akara-baking respondents (1000) to elicit information on use of briquettes as 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 & Illoabuchi Sawmills respectively. The 41-50 respondent 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 Illaboachi sawmill while 51-60 and 31-40 were 6(24%) and 5 (20%) respectively. 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 Beans cake (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 Illaobuchi and Marine Base sawmills respectively while darkening pots, burning with dark smoke and being affected by water had their cut off marks (M) had 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. Briquetting of sawdust from sawmills is recommended and its automation to maximize its utilization status.

Comment [YML2]: Under what concept were accepted or rejected, that should be described in the summary methodology

Comment [YML3]: It is recommended to describe in abstract how the briquettes were made, If they were made for use as energy because their mechanical properties were not analyzed, what were the physical properties that were evaluated in them.

I believe that the study would be more important if not only informal aspects based on surveys were considered, the physical-mechanical properties of briquettes can contribute to determining or influencing the amount of energy that they could produce in cooking food.

Comment [YML4]: In keywords should avoid placing words contained in the title of the article

Keywords: Briquettes, user-respondents, environment friendliness

Introduction

There is high and rapid demand for wood fuel consumption is considered as a major contributing factor to the fuel wood crisis in Nigeria (Himraj, 1993). Africa accounts for 12% of the global population, it consumes only 4% of global energy (Ardayfio-Schandorf, 1996). FAO (2008) predication is that fuel wood is likely to remain an important energy source in Africa in the coming decades while forecasts made 2001 even suggested a 34% increase in wood fuel consumption from 2000 to 2020. The Energy Commission of Nigeria (ECN) asserted that 92.2% consumption of fuelwood as primary alternative in the country, this is corroborated by Aju & Uwalaka (2010) that fuel wood is primary source of energy accounting for over 90% of the total

38 energy used for domestic purposes in Nigeria. Thies and Pfeil (2007) estimated that fuel wood
39 collection in Africa by 80%. The demand for fuel wood is expected to have risen to about 213.4
40 $\times 10^3$ metric tonnes, while the supply would have decreased to about 28.4 $\times 10$ metric tonnes by
41 the year 2030. Over 90% of the rural/peri-urban populations depend on fuel wood to meet their
42 domestic energy requirements Federal Department of Forestry (FDF) and Federal Ministry of
43 Environment (1999). Fuel wood energy used is consumed mostly by the low income and lower
44 middle income amongst the urban households as well as by operates of cottage and small scale
45 industries and commercial enterprises such as pottery, hotels, schools, banks and hospitals. In
46 Ogoni land and other part of Rivers State, fuel wood and even twigs and leaflets of woody
47 species are garnered and scavenged from newly exploited and cultivated primary, secondary and
48 even riparian and mangrove forests and polluted oil sites. Rural dwellers troop in groups to
49 forests with axes, machetes, ropes and basins trekking long distances in search of this resource.
50 The high cost conventional sources of energy has change the paradigm to wood as fuel wood and
51 a source of livelihood as many sell firewood in stacks and heaps depending on the sizes of
52 firewood. For this reason, a transition to a sustainable energy system is urgently needed in the
53 developing countries such as Nigeria (Stout & Best, 2001). One of such energy source is wood
54 waste or sawmill residue. Sawdust constitutes one of the most abundant waste or residue in wood
55 industries. It was estimated that wood waste generated in the country in 1998 was 1.72million/m³
56 out of which sawdust was 15% (Badejo, 1990). However, inefficient wood conversion and low
57 biomass recovery from the timber process in Nigerian forest industry have led to the prevalence
58 of sawdust hills around sawmills, thereby constituting a visual blight to the local environment
59 and a breeding ground for wood decaying organisms (Emerhi, 2011). Sawdust hills could be
60 compacted into briquette for fuel energy supply (Wilaipon, 2007). Briquettes made from
61 sawdust can reduce forest degradation and deforestation to mitigate these problems.

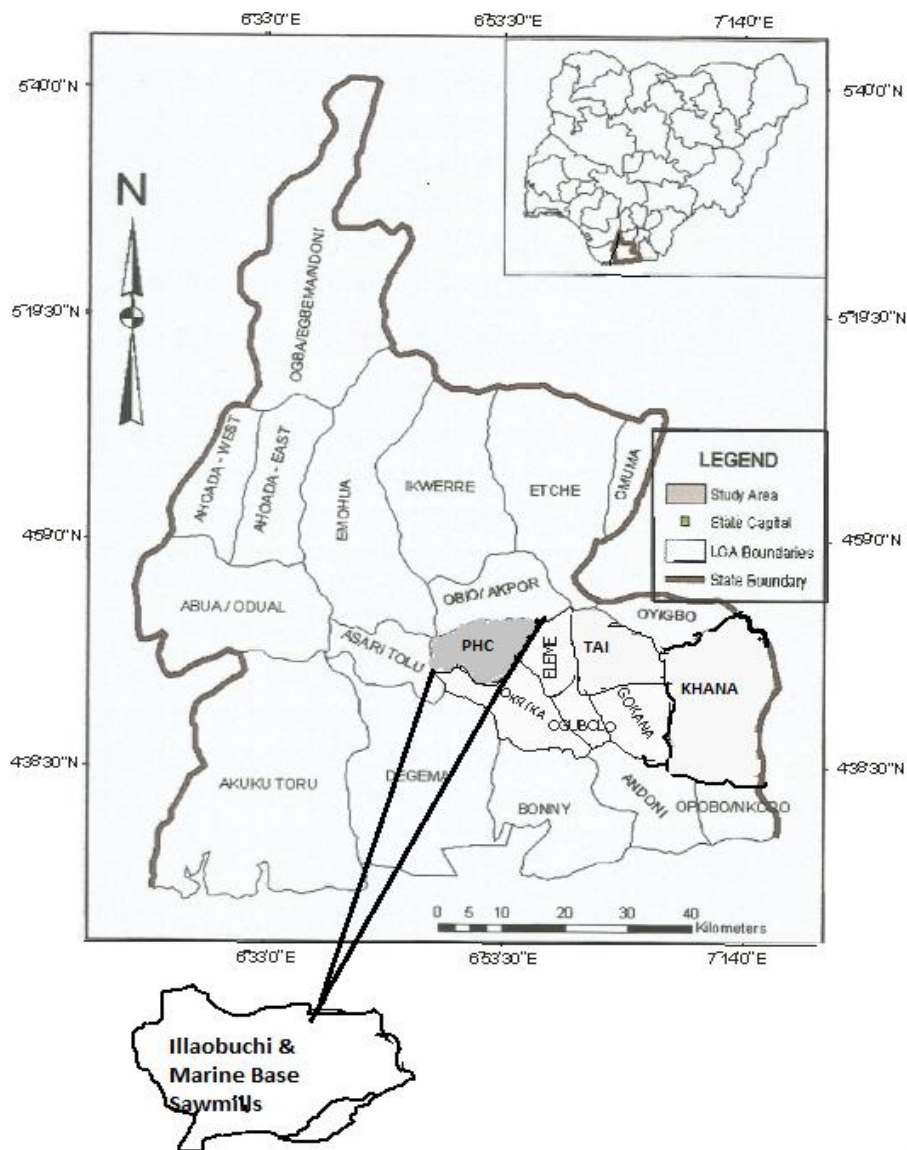
62 Briquetting which is aggregation of micro or minute wood waste costs little or no money like
63 other wastes such as newspaper, partially decomposed plant waste or sawdust can be an alternate
64 source of domestic and industrial energy to charcoal, firewood, gas, coal and electricity.
65 Briquettes made from charcoal and sawdust is a desirable fuel because it produces a hot, long-
66 lasting and virtually smokeless fire and are produced when charcoal and sawdust are combined
67 with other materials and it is formed into uniform chunks (Emerhi, 2011). Globally, the
68 overdependence of fossil fuel has environmental hazards and not enough, expensive, there is
69 need for cheap alternative from wood micro waste (sawdust). Therefore, this study aimed at
70 appraise briquette users' opinion on the apparent properties and environmental friendliness of the
71 briquettes bonded by 30% and 40% starch.

72 Methodology

73 The saw dust was sourced from Marine and Illoauchi sawmills in Port Harcourt, Rivers State on
74 Latitude 4.51°N, and longitude 7.01°E (Plate 1) and average rainfall of above 2000mm at altitude
75 above the sea level (Tariah *et al.*, 1991).

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Comment [YML5]: This information is not necessary, at this point the characteristics of the sawmill should be explained, such as: most commonly used species, type of particles, moisture content, processing of larger particles because not all particles have adequate dimensions to be used in briquette manufacturing....



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78 **Plate 1:** Map of Rivers State indicating the study areas

79 **Source:** Rivers State Ministry of Environment

80 **Research Design**

Comment [YML6]: Very large figure, could reduce it and take advantage of the spaces of the pages to better explain the methodology used

81 Multistage sampling was used by identification of target respondents and their locations: the
82 respondents were identified by spotting their various locations (5 at each sawmill where
83 briquettes were produced) purposively to assess the business they do. Questionnaires were
84 administered amongst energy-using respondents-plantain and fisher roasting or barbecue
85 otherwise known as bo-lae, meat barbecue (suya), garri and akara baking respondents (100) to
86 elicit information on the produced briquettes use as source of energy.

Comment [YML7]: Sawmills despite generating waste, produces briquettes ???

Comment [YML8]: You should describe to whom those surveys were directed, and what were the questions asked in that survey.

87 **Sampling Procedure and Sampling Size**

88 The number of respondents for the study was one thousand (1000) respondents, hundred (100)
89 copies for each locations.

Comment [YML9]: This item can be part of the previous one, you should avoid items with a paragraph.

90 **Experimental Design/Data Analysis**

91 Multistage sampling method was employed and obtained data were subjected to descriptive
92 statistics and a 4-point Likert scale which ranged from strongly agreed=4, agree=3, disagree=2
93 and strongly disagree=1.

Comment [YML10]: It is important that the experimental conditions of the waste used are described, that is: what was the treatment performed to obtain the briquettes, how the starch was added to them, how the briquettes were produced, what were the physical properties, and evaluate the properties mechanical, and if possible evaluate the caloric power of the briquettes.

96 **Results and Discussion**

97 **Socio-economic Characteristics of Briquette Users from Marine and Illoabuchi, Port 98 Harcourt**

99 The result of the socio-economic characteristics of briquettes user-respondents showed that
100 males were more involved than the females: 22 (88%) and 21(84%) and 3 (12%), male and
101 female at Marine & Illoabuchi Sawmills respectively (Figure 1).

102 The age of respondents that used the briquettes showed that 41-50 age bracket had the highest in
103 both sawmills-Marine Base and Illoabuchi 12 (48%) and 11 (44%) respectively followed by 31-
104 40 (7:28%) and 51-60 (4:16%) in Illoabuchi sawmill while 51-60 and 31-40 were 6(24%) and 5
105 (20%) respectively (Figure 1).

Comment [YML11]: What is the relationship of evaluating the properties of briquettes to produce energy used for cooking food with the demographic study of the region?

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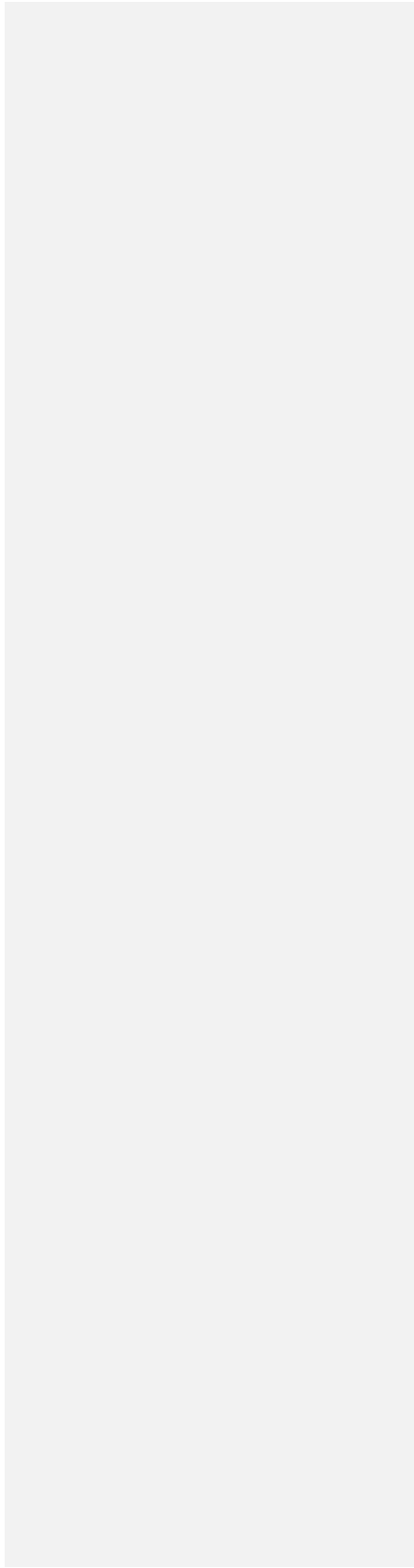
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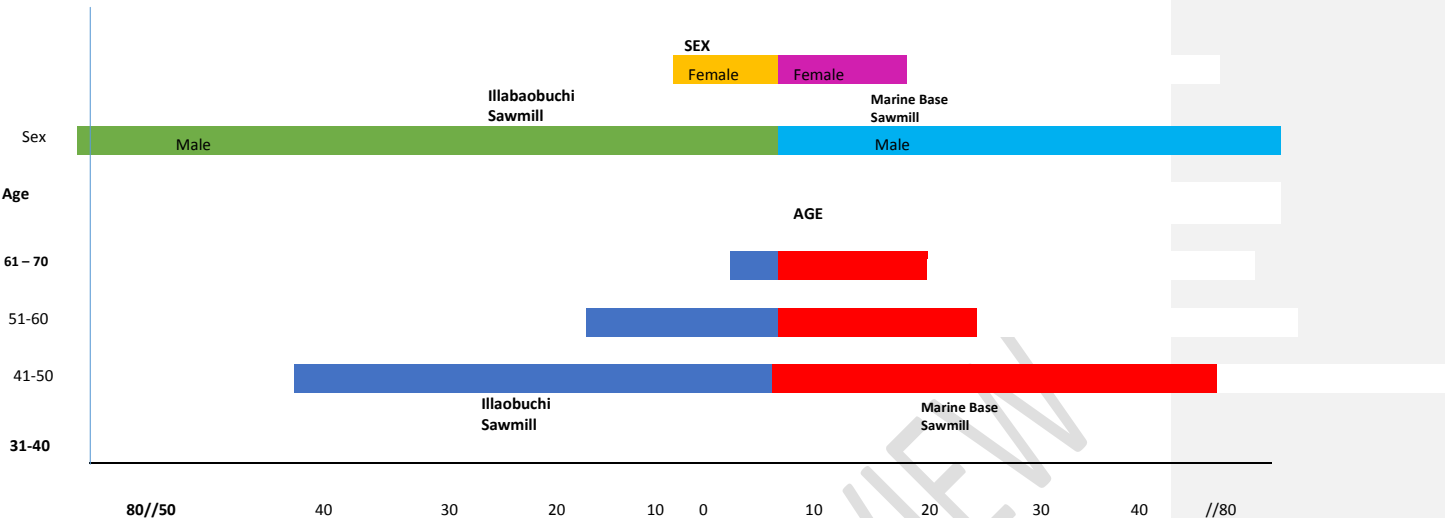
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127 **Figure 1: Percentage distribution of sex & age of user respondents in Port Harcourt**
128 **Sawmills**
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130 The businesses were dominated by the married briquettes users 11 (44%) from Marine Base
131 sawmill but at Illoabuchi married and single users had the same frequency and percentage with
132 10 (40%) while separated users had the lowest (1:4% and 3: 12%, MB and IB sawmills
133 respectively (Table 1).

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

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

142 Amongst the businesses carried out by respondents, users of briquettes from Marine Base, Port
143 Harcourt, plantain roasting was highest of 7 (28%) followed by fish barbecue and akara with 6
144 (24%), meat barbecue had 5(20%) while at Illoabuchi, meat barbecue had 9 (36%) followed by
145 plantain had 8 (32%) and garri and akara had the same 3 (12%) (Table 1).

146 **Table 1: Socio-economic Characteristics of Briquette Users from Marine and Illoabuchi,**
147 **Port Harcourt**

Socio-economic Characteristics		Marine Base Sawmill		Illoabuchi Sawmill	
		Frequency	Percentage	Frequency	Percentage
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
	Beans Cake (Akara)	6	24	3	12

148 **Field Survey, 2019**

149 **Users Assessment of Briquettes from Illaobuchi and Marine Base Sawmills**

150 The result on the use of briquettes from both sawmills in terms their environment friendliness
 151 and physical properties showed that briquettes smoked well (M=3.04 and 3.80), smelled
 152 pleasantly (M=3.03 and 2.68) Illaobuchi and Marine Base respectively, but contrariwise the
 153 briquettes smoke was stuffy and choky smoke (M=0.4 and 1.00) and irritation of eyes had
 154 M=3.25 and 4.00 respectively (Table 2). This finding provides energy solution to user
 155 respondents which agrees with Ogunsanwo (2001) that application of briquetting technology of
 156 saw dust is promising solution to the problems of unutilized agricultural residues. The
 157 environment friendliness properties of briquettes also agrees with Yaman *et al.*, (2000) and
 158 Olorunnisola (2004) reported that greater heat intensity, cleanliness, convenience in use, and
 159 relatively smaller space requirement for storage are notable merits of briquettes. The use of
 160 briquettes from sawdust ubiquitous at sawmills in urban, towns, villages and other rural dwellers
 161 living close to them may reduce the energy, time and danger trekking to the forests to harvest
 162 fuel wood which a pragmatic paradigm shift to exploration of alternative source of energy. This
 163 agrees with Barrow *et al.*, (2007) who reported that restoration of woodland around the
 164 communities reduced the time taken to collect fuel wood by up to four hours and this has
 165 potential to free up time for women to engage in other productive activities that can improve
 166 gender empowerment, equity and sustainability of woodland. Applying this concept to
 167 availability of briquettes, the time would be less than four hours, the limitation of briquetting is
 168 the manual production method used.

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Comment [YML12]: What were the environmental parameters evaluated to discuss the issue in the results of the investigation

Comment [YML13]: Which physical properties were evaluated that were not declared in the methodology

Comment [YML14]: How eye irritation was evaluated that is not described in the methodology

Comment [YML15]: I think it would be more interesting to study the properties of briquettes as a source of energy for cooking food, and as a complement to evaluate the acceptance that it has for traders

Comment [YML16]:

Comment [YML17]:

Comment [YML18]: I consider it interesting to consult the most up-to-date bibliographic references on the subject, which can better guide to evaluate the properties of briquettes

171 **Table 2: Assessment of Environmental Friendliness and Physical Properties of Briquettes**

Physical Properties	Illaobuchi	Marine Base	Remarks
	Mean	Mean	
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

Comment [YML19]: Describe in the methodology how these physical properties were determined

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

173 **Assessment of Problems Associated with Briquettes Utilization**

174 The results of respondents users problems like darkening pots, burning with dark smoke and
 175 being affected by water had their cut off mark (M) ranged from 1.33 and 1.40 (rejected), 2.63
 176 and 2.50 (accepted) and 2.01 and 2.12 (rejected) from Illaobuchi and Marine Base respectively
 177 (Table 3). The briquettes were portable, cheap and useful had M= 2.45 and 3.00, 3.60 and 3.60
 178 and 3.40 and 3.09 from Illaobuchi and Marine Base sawmills respectively (Table 3). In terms of
 179 cost and ease of use, it agrees with Yaman *et al.*, (2000) and Olorunnisola (2004) reported that
 180 greater heat intensity, cleanliness, convenience in use, and relatively smaller space requirement
 181 for storage are notable merits of briquettes.

Comment [YML20]: I consider that the calorific value of the briquettes, the time it takes to burn, the amount of ashes should also be considered

182 **Table 3: Assessment of Problems Associated with Briquettes Utilization**

Problems	Illaobuchi	Marine Base	Remarks
	Mean	Mean	
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

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

184 **Conclusion**

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

Comment [YML21]: What were the environmental quality parameters evaluated to conclude with that statement?

Comment [YML22]: What were those properties ????

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