Bio-energy properties of *Anthocleista djalonensis* (A. Chev.) in Parts of Rivers State, Nigeria

***David-Sarogoro, N. and Emerhi, E.A.**
Department of Forestry and Environment
Rivers State University of Science and Technology, Nkpolu, Port Harcourt, Nigeria
***Corresponding author: david.nwiisuator@ust.edu.ng**

David-Sarogoro, N. and Emerhi, E.A. (2015. Bio-energy properties of *Anthocleista djalonensis* (A. Chev.) in Parts of Rivers State, Nigeria. *Nigerian Journal of Forestry* 45(1):34-39

Abstract
The bio-energy properties of *Anthocleista djalonensis* were examined in this study Samples of the species were collected from Tai, Eleme Local Government Areas and University of Science and Technology (UST), Port Harcourt in Obio-Akpor Local Government Area, Rivers State, Nigeria. Three standing trees of the species were randomly selected and each were cut at classes of 3-10cm, 11-15cm and 16-25cm measured with a diameter tape at strategic positions of 25%, 50%, and 75% of merchantable height. The heat value (energy content), percentage volatile matter (PVM), percentage ash content (PAC) and percentage fixed carbon (PFC) were assessed. The results showed that there was significant difference (P<0.05: *P-value*=1.79E-27) between the heat values of the woods of the species at the various locations. The mean heat values (MHV) of *Anthocleista djalonensis* was within 32028.41 to 33619.13kJ/kg; the highest HV of 35074.83kJ/kg was in Eleme from Diameter Class (DC) of 16-25cm followed by 11-15cm DC with 34430.06kJ/kg and 3-10cm DC. Similar trend was observed in Tai but in UST 16-25cm DC had the highest HV of 303000 (kJ/kg) followed by 3-10cm DC with 30,000 (kJ/kg) while the 11-15cm DC had the lowest HV of 20,500 (kJ/kg). The results of the heat values within the various diameter classes showed that the middle (DC of 11-15cm) of the logs had the highest mean HV of 34251.43± 925.73 followed by top (DC of 3-10cm)- 32668.55±839.57KJ/kg and the lowest HV of 28679.04±4325.009KJ/kg. Consequently, in Tai, 16-25cm DC had mean HV of 33619.13 (KJ/kg), 11-25cm DC-32358.10KJ/kg while the 3-10cm DC was 32028.41KJ/kg. Similar trend was observed in Eleme LGA with 16-25cm having35074.83KJ/kg, followed by 11-15cmclass with 34430.06KJ/kg and the lowest was at the top with33249.39KJ/kg. UST wood samples had the lowest HV amongst the DCs; unlike the above pattern, bottom, 16-25cm, had 32368.49KJ/kg followed by 3-10cm DC with29749.22KJ/kg while the lowest was at the middle with 23919.41KJ/kg. The PVM, PAC and PFC had means of 15.21±0.903%, 1.65±0.032% and 80.35±4.67% respectively and their coefficient of variability were 5.93%, 1.21% and 5.81%.It was observed that the higher the percentage fixed carbon and volatile matter, the higher the heat values. Tree species with good cooking and other heating activities may be may be as a result of their high combustible properties, particularly the percentage volatile matter and fixed carbon which correlated positively with its heat values. The species heating properties and also its regeneration methods should be studied.

Key Words*:* Heat values, diameter class, volatile matter, *Anthocleista djalonensis*

Introduction
Generally, energy from different sources is used by mankind to change and transform lives and more importantly natural source from lignin-cellulosed woody materials. Accordingly, NAS (1980) reported that not less than one and half billion people in developing countries derive at least 90% of energy requirements from wood and charcoal and another one billion people meet up at least 50% of their energy needs this way. About half of the timber cut is still serving its original role for mankind: as fuel for cooking and heating. The upsurge in human population has affected the availability of fuel wood which has led to fuel wood being poached from forest reserves. Scaffolding at building sites are stolen at nights and animal dung ends in the fireplace as fuel rather than being in the field or farm as manure (Etukudo, 2000).

Consequently, indications are that more and more people will still continue to use wood as fuel in preference to gas, electricity, coal solar energy and kerosene as these and their cooking appliances are costly and outside the economic reach of ordinary third world citizens, availability as some of these woody fuels are ubiquitous and readily harvestable more so are cheapest. Etukudo, (1994) reported that cultural habits of the people will make them to continue to prefer the use of fuel wood to other sources of energy even among the rich and enlightened. The situation as regards fuel wood scarcity in some parts of Nigeria is so acute that aging or semi-dried palm fronds of palm trees are forcibly and prematurely brought down with hooks. These are taken home; stacks and used as firewood when partially or fully dried. It appears that any plant material containing cellulose is used as fuel wood species. It has been reported that the following species have high calorific values (Kcal/kg); *Rhizophora spp* and *Avicennia spp* (4000-4300), *Tremasp* (4500) and *Acacia auriculiformis* (4800-4900) (Etukudo, 2000).

Anthocleista djalonensis A. Chev.in the family Loganiaceae, extends from Guinea to Nigeria and is found in secondary forest, in drier areas than *A. vogelii*. The mature tree height is about 6-12meters, much like *A. vogelii* in habitat. The bark is grey; the slash has cream colour with orange streaks, the granular and wood are soft and whitish. The species could be described as a marginally-used-species (MUS) because of its low level of utilization (David, 2013) particularly the heating properties. Therefore, the research considered the bio-energy properties of this species collected from three LGAs of Rivers State.

Materials and methods

Materials for study were collected from three locations-from Tai, ElemeLocal Government Areas and University of Science and Technology (UST), Port Harcourt in Obio-Akpor Local Government Area- Rivers State, Nigeria. Three standing trees of *A. djalonensis* were randomly selected from each LGA and each tree was cut into diameter classes (DC) of 3-10cm, 11-15cm and 16-25cm measured with a diameter tape at specific positions of 25%, 50%, and 75% of merchantable height according to Akachukwu, (1984), Mitchell and Danne (1997) and Akpofure, (1992). The heat value (energy content), percentage volatile matter (PVM), percentage ash content (PAC) and percentage fixed carbon (PFC) and heating value (HV) were assessed.

Percentage Volatile Matter

Two grammes of pulverized samples were put in a crucible and oven-dried to constant weight and placed in the furnace at temperature of 550^0C for 10 minutes.

%volatile = $\frac{B-C}{B} x100$ (Adegoke and Fuwape, 2008)

Where B = Weight of oven dried samples, C = Weight of sample after 10 minutes in the furnace at 550^0C.

Percentage Ash Content: 2g of oven dried samples were placed in the furnace at temperature of 550^0C for 4hrs and weighed after cooling.

% Ash = $\frac{D}{B} x100$ Where D= weight of Ash, B= weight of oven dried sample.

Percentage Fixed carbon was calculated by subtracting the sum of PVM and PAC from 100%:

% fixed carbon (PFC) = 100 – (% V+%A) (Adegoke and Fuwape, 2008).
Where: %V = Percentage Volatile Matter, %A = Percentage Ash content

Heating Value (HV)

HV = 2.326 (147.6C + 144V) KJ/kg (Adegoke and Fuwape, 2008)
Where HV = Heating value, C = Percentage Fixed Carbon, V =Percentage Volatile Matter

Experimental Design and Data Analysis

The experiment design used was completely randomized design (CRD) replicated thrice. Data collected were been subjected to descriptive statistics, Analysis of Variance (ANOVA) and significant means separated using standard deviation.

Results and Discussion

The results showed that there was significant difference (P<0.05: *P-value*=1.79E-27) (Table 1) between the heat values of woods of the species from the three locations. The mean heat values (HV) is 32028.41-33619.13kJ/kg, the HV was highest (35074.83kJ/kg) in Eleme samples in the 16-25cm diameter class, followed by 11-15cm class with 34430.06kJ/kg and 3-10cm class (Figure 1). Similar trend was observed in Tai (Figure 1) but in UST (Obio-Akpor LGA) 16-25cm diameter class had the and hardness (David, 2013).

highest HV of 303000 (kJ/kg) followed by 3-10cm with 30,000 (kJ/kg) while the 11-15cm had the lowest HV of 20,500 (kJ/kg) (Figure 1). The woods from this species are attractive and useful to the rural people because of its burning efficiency which agrees with Spanner, (2016) that wood becomes particularly attractive if it is not only used as a source for heat, but also power. The mature wood is useful in the construction of houses particularly the roof because of its durability.

Table 1: Summary of Test of Significance amongst Parameters

Parameters	*F Stat*	*P-value*	*F- Critical*	*Significance*
PAC	22611.97	1.23E-26	4.493998	*Reject Ho
PFC	2666.969	3.15E-19	4.493998	*Reject Ho
PVM	2552.403	4.47E-19	4.493998	*Reject Ho
Columns (Locations)	8425.1653	1.79E-27	3.554557	*Reject Ho

**** Significant at P<0.05: Ho=Null Hypothesis***

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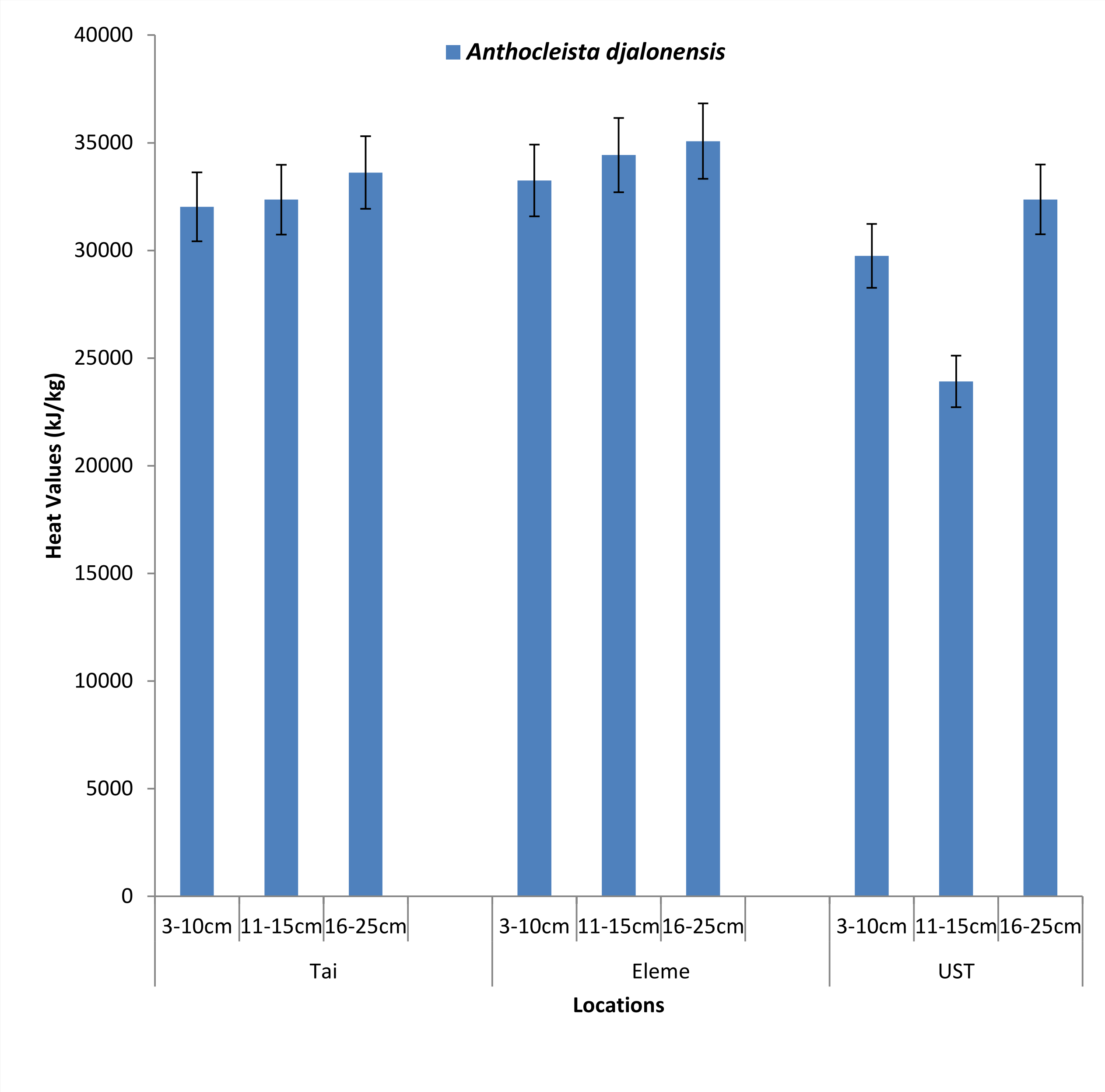

Figure 1: Heat values of *Anthocleista djalonensis* at various locations

Table 2 reveals that the middle (DC-11-15cm) of logs had the highest mean HV of 34251.43± 925.73kJ/kg, followed by top (DC-3-10cm)- 32668.55±839.57kJ/kg and the lowest HV of 28679.04± 4325.009kJ/kg. Consequently, in Tai, 16-25cm DC had a mean HV of 33619.13 kJ/kg and 35074.8. The 11-25cm DC had 32358.10 kJ/kg while the 3-10cm DC was 32028.41kJ/kg. Similar trend was observed in Eleme LGA with 16-25cm Dbh class having 35074.83kJ/kg, followed by 11-15 with 34430.06 kJ/kg and the lowest was at the top with33249.39 kJ/kg. UST (ObioAkpor LGA) had the lowest HV amongst the DCs. The bottom, 16-25cm had 32368.49 kJ/kg, followed by 3-10cm DC of 29749.22 kJ/kg while the lowest was at the middle with 23919.41KJ/kg (Table 2).

Table 2: Heat values of *Anthocleista djalonensis* according the Diameter classes (DC)

Diameter Class	Tai (KJ/kg)	Eleme (KJ/kg)	UST (ObioAkpor LGA) (KJ/kg)	Mean KJ/kg) ±	Std. Error
3-10cm	32028.4	33249.4	29749.2	32668.55±	484.72
11-15cm	32358.1	34430.1	23919.4	34251.43±	534.47
16-25cm	33619.1	35074.8	32368.5	28679.04±	2497.05

Table 3 indicates that derivable heat values from volatile matter and fixed carbon increased with heat values while the percentage ash content remained constant (CV=1.21%) within the diameter classes in each LGA. Percentage volatile matter and percentage fixed carbon which correlated positively with its heat values (r^2=0.9861).The high percentage volatile matter leading to high heating values is due to high natural extractives that are volatile and combustible (David, 2013). This implies that the bottom of the species provides more heat or burning ability than other parts of the species trees because of high concentration of burnable organic complex substances at bottom (Akpofure, 1992).

The heat values are energies derived from sources that unlock and liberate the excited and locked up latent energies in potential mass transcendental (David, 2013). The PVM, PAC and PFC had means of 15.21±0.903%, 1.65±0.032% and 80.35±4.67% respectively and their coefficient of variability were 5.93%, 1.21% and 5.81% (Table 3). This implies that PVM and PFC which are closely linked varied at almost the same rate with higher CV than PAC.

Table 3: Other combustion properties of Diameter classes (DC) of *Anthocleista djalonensis*

Locations	Diameter Class	% Volatile Matter	% Ash Content	% Fixed Carbon	Heat Value KJ/kg)
Tai	**3-10cm**	13.65	1.61	80.30	32028.41
	11-15cm	14.30	1.62	81.45	32358.10
	16-25cm	15.70	1.67	82.35	33619.13
Eleme	**3-10cm**	14.87	1.61	82.34	33249.39
	11-15cm	15.32	1.65	85.34	34430.06
	16-25cm	16.22	1.70	86.34	35074.83
UST (ObioAkpor)	**3-10cm**	14.67	1.62	72.34	29749.22
	11-15cm	15.76	1.65	74.34	23919.41
	16-25cm	16.34	1.68	78.34	32368.49
	Mean±St.Dev.	**15.21±0.903**	**1.65±0.032**	**).35±4.67**	**31866.34±3354.25**
	Coefficient Variability(%)	**5.93**	**1.21**	**5.81**	**10.52**

Conclusion and Recommendations

Anthocleista djalonensis wood has a high heat value particularly at the bottom of the species. The higher the percentage fixed carbon and volatile matter, the higher the heat values. The common use of this species for cooking and other heating activities may be attributed to its high combustible properties, particularly the high volatile matter and fixed carbon. Consequently, *A. djalonensis* is not one of the plantation species of Nigeria. It appears to be fast growing and results of this study confirm that it is a potential source of fuel wood. It is recommended therefore that the species' other heat properties, planting and regeneration methods need further studies.

References

Adegoke, I.A. and Fuwape, J.A. (2008). Combustion properties of briquettes as affected by production process in Proceeding of 2nd Biennial Nation Conference of the Forests and Forest Products Society in Akure. Ondo State, Federal University of Technology,.09th - 14th of November 2014 pp 47-58.

Akachukwu, A.E. (1984). The Effects of some internal and external factors on growth rate of *Lovoa trichiloides. Wood Anatomy. IOWA Bulletin*. 3 (5), 75-80.

Akpofure, E.A. (1992). *Variation in extractive and mineral contents and in wood density of some mangrove tree species in Nigeria*. (Unpublished doctoral dissertation).University of Ibadan, Oyo State. Pp 198

David, N. (2013). *Physico-chemical properties as indices to enhance utilization of two lesser-used-species in Rivers State, Nigeria* (Unpublished doctoral dissertation).Rivers Science University of Science & Technology, Port Harcourt, Rivers State. Pp 154.

Etukudo, 2000). Etukudo, I. (2000). *Forest our Divine Treasure*. Akwa Ibom: Omniscience Publisher.

Etukudo, I. (1994). *Elements of Forestry.* Akwa Ibom: Omniscience Publisher.

Mitchell, M. D. and Danne, M. P. (1997). Variation in density of *Picea sitchensis* in relation to within tree trends in tracheid diameter and wall thickness. *Forestry-Oxford*, 70(1), 84.

NAS (1980). Firewood Crops: Shrubs and Tree Species for Energy Production. NAS, Washington D.C., USA.

Spanner, R. (2016). Concept of energy material at www.holz-kraft.de *retrieved on 30th August, 2016.*