WOOD ENERGY PRODUCTION EFFICIENCY IN AKINYELE LOCAL GOVERNMENT AREA OF OYO STATE

*OMOLE A.O., ** ADETOGUN, A.C & *0.0. OKONKWO *
Department of Forest Resources Management, University Of Ibadan
***Department of Forestry & Wildlife, University of Agriculture, Abeokuta*

ABSTRACT

A study was carried out to determine the efficiency of wood energy production in Akinyele Local Government of Oyo State. Ten fuelwood and five charcoal wood species were selected as samples using availability as criterion. Energy parameters including moisture, ash and energy contents, and density of the samples were determined. The earth kiln system of charcoal production was used to determine the efficiency of the charcoal production method. Data analysis was carried out using a combination of t-tests and descriptive statistical methods. Results showed that the moisture contents ranged between 10.6 and 32.45% for the fuelwood species and 5.2 and 7.7% for charcoal. The ash contents ranged between 1.0 and 6.0% for fuelwood species and 1.0 and 5.0% for charcoal. Energy contents for fuel wood range between 15.79 and 28.58 MJ/kg and between 2.51 and 6.82 MJ/kg for charcoal respectively. Specific gravity for fuelwood species ranged between 0.53 for Markhamia and 0.89 for Funtumia and between 0.46 for Parkia and 0.63 for Butyreospermum for charcoals species. Outputs from the earth kiln method were found to be about 21.01% which implies that at least one kilogramme of charcoal is produced from five kilogramme of wood.

Key words: Fuelwood, Charcoal, Energy Parameters

INTRODUCTION

Reconciling heavy dependence on wood energy in the developing countries with forest production and conservation has been of interest to forest utilization specialists and other forest stakeholders in recent times. The annual growth rate of global wood fuel demand was estimated as 3-4% by Amous, in 2000. This growth rate resulted in increased pressures on existing forest resources and as a result led to serious deforestation in some places. (Girard, 2002).

Fuelwood and charcoal are the wood fuels that readily come to mind when wood energy is discussed in context of rural energy in Nigeria and other African countries. This is because they are the major sources of fuel for a whole lot of rural activities, such as cooking, tobacco curing, tea drying, brick and pot burning and bread baking. This trend s likely to persist for some time due to increasing scarcity and high cost of conventional fuel coupled increasing populating of the country (Fuwape and Onyekwelu 1995, Nautiyal, 1979). Consequently Nigeria has been classified as one of the countries with fuel wood shortage (Nest, 1991). Other problems associated with wood energy production in the country include migration of population, desert encroachment and ecological imbalance. (FAO 1990, 1993, Fuwape and Onyekwelu 1995, Oguntala, 1995).

Low combustion efficiency of firewood stoves is one of the factors responsible for the quick return to the forest for fuel-wood collection and consequently making wood-energy systems unsustainable (FAO 1985). Energy parameters and charcoal production methods are some of the factors that have been identified to affect WOOD energy production efficiency significantly. According to Akachukwu (1993, 2001) energy content or calorific value is an important energy parameter which determines the amount of energy derivable from burning a wood fuel. Moisture and ash contents have also been

observed to have inverse relationship with energy contents of wood fuels while density (specific gravity) has a direct relationship with it (FAO 2001, Fuwape 1985). Girard (2002) assessing charcoal making techniques reported that a well-managed traditional earth kiln can yield up to 25% output but with poorer techniques and ill-managed earth kiln yields often do not exceed 15-20%.

According to Trossero (2002) adequate understanding of wood energy systems in the rural areas is necessary for planning sustainable wood energy production. Unlike fossil fuel, the use of wood for energy has lesser ills, and that wood as a biological material is renewable and will continue to be a major source of energy as long as the production and use is sustainably and efficiently done. Therefore a critical assessment of the production techniques for fuel wood and charcoal in Nigerian rural areas is necessary. Estimation and evaluation of some combustion related variables that would help in drawing reasonable conclusions on the degree of efficiency of wood fuel production and demonstration of the earth kiln method of charcoal production in Akinyele Local Government area of Oyo State to assess the efficiency of the method constitute the objective of this study.

MATERIALS AND METHODS

The study area was Akinyele Local Government Area of Oyo State, South Western Nigeria. Fifteen wood energy species were selected using availability and population distribution as criteria. Out of the fifteen species sample, ten species were collected for firewood and five species for charcoal production. Laboratory experiments were conducted to determine the energy parameters of the selected species, moisture content, ash content, density/specific gravity and energy content. The moisture content of each sample was determined in line with the method proposed by Dinwodie 1981 using the formular:

$$MC = \frac{Wet\ \ weight - Dry\ \ weight}{Dryweight} \times 100\ \%$$

The ash content of the samples was determined in accordance with ASTMD 1102 – 84 (ASTM 1990).

The density was estimated using the ASTMD 2395-89 standard test method for measuring specific gravity of fuel wood (ASTM 1989). While the energy content was determined using the Galen kamp brand of ballistic bomb calorimeter in accordance with ASTM = 870-82 standard test methods for analysis of wood fuel (ASTM 1998) using the relationship.

The efficiency of the earth kiln, method was evaluated using the selected wood species. This experiment was replicated 3 times. Inputs were weighed and placed on the cleared surface but with dry litter under lay. Dry litter was used to cover the wood and subsequently with soil leaving openings for ignition. Inputs were set on fire through openings on the soil and constantly monitored. Carbonization or charcoal formation was achieved after 5, 7 and 6 days respectively for each replicate.

RESULTS AND DISCUSSIONS

Results of studies on the energy parameters of fuelwood and charcoal are presented in Tables 3 and 4 respectively. Results of charcoal production using the earth klin method is presented in Table 5 a statistical summary of fuelwood and charcoal parameter data are presented in Tables 3 and 4 respectively.

Table 1: Selected Wood Energy Species in the Study Area

S/N	Species	Family	Local Name
1	*Alchornea cordifolia*	Euphorboaceae	Ijan
2	*Markham/a africana*	Bignoniaceae	Akoko
3	*Funtumi'a africana*	Apocynaceae	Ire
4	*Albizia zygia*	Leguminaceae Mimosidae	Ayunre
5	*Bridelia micrantha*	Euphorboaceae	Asa
6	*Harungana madagascariensis*	Gutifereae	Amuje
7	*Cola millenii*	Sterculiaceae	Obi-edun
8	*Cynometra mannii*	Leguminacea cersalpinioideae	Aka
9	*Peltophorum pterocarpum*	Leguminaceae	Cassia
10	*Blighia sapida*	Sapindaceae	Isin
11	*Anogeissus leiocarpa*	Combretaceae	Ayin
12	*Terminafia avicennioides*	Combretaceae	Idi
13	*Butyrospermum paradoxum*	Sapotaceae	Emi
14	*Pankia bigiobosa*	Leguminaceae mimosoideae	Abala
15	*Termilia catapa*	Combretaceae	Almond

Table 2: Fuelwood energy parameters of the selected species

Species	M.C (%)	Specific Gravity	Ash Content	Energy Content MJ/kg
Alchornea larifora	18.5	0.59	2	16.54
Markhamia Africana	27.4	0.53	1	15.79
Funtumia Africana	15.8	0.89	2	25.57
Albizia zygia	13.6	0.58	6	15.04
Bridelia zygia	10.6	0.72	1	22.56
Harungana madagascariensis	16.7	0.73	2	18.05
Cola millenii	32.5	0.59	1	22.56
Cynometra mannii	14.8	0.61	1	28.58
Peltophorun pterocapum	12.0	0.76	1	24.07
Blighia sapida	16.4	0.88	3	17.71
**Anogelssus leiocarpa*	5.6	0.52	5	3.95
**Terminalia aricenniodes*	5.2	0.58	1	3.95
**Butyreospermum paradoxum*	6.6	0.63	3	2.51
**Parkia biglobossa*	7.7	0.46	3	4.67
**Terminalia superba*	7.7	0.54	2	6.82

* The five charcoal types and the values of their energy parameters.

Table 3: Summary of Fuelwood Energy Data

	Specific Gravity	Moisture content (%)	Ash content (%)	Energy content (MJ/kg)
n	10	10	10	10
Mean	0.86	17.81	2	20.65
Std. Deviation	5.46	6.88	1.56	6.95
Minimum	0.53	10.56	1.00	15.04
Maximum	0.89	32.45	6.00	28.58

Table 4: Summary of Charcoal Energy Data

	Moisture content (%)	Ash content (%)	Specific Gravity)	Energy content (MJ/kg)
N Valid	5	5	5	5
Mean	5.64	3.00	0.55	4.38
Std. Deviation	2.04	1.63	4.86	4.09
Minimum	3.00	1.00	0.46	2.51
Maximum	7.74	5.00	0.63	3.95

Table 5: Result of earth kiln charcoal production demonstration

Species	Average Input of wood	Average Output of Charcoal	Efficiency %
Anogefssus leiocarpa	17.92	3.84	21.42
Terminalia·aricenniodes	16.68	3.40	20.38
Butyreospermum paradoxum	17.01	3051	20.58
Parkia biglobora	18.86	4.10	21.73
Termilia superba	17.51	3.67	20.95
Mean	17.60	3.70	21.01

Table 1 shows that the preferred species fot wood energy in the study area are mostly savanna wood species. The type of savanna in the study is is tree savanna with high density of shrubs and dispersed trees. Majority of these selected species such as *Bridelia, Annogeissus, Parkia ,Alchomea Catapa Blighia* etc. have been reported to have very thick bark almost 15mm which are resistant to annual fire attack.

As shown in Table 3, the specific gravity of fuelwood range between 0.53 and 0.89. While the moisture contents ranged between 10.56 and 32.5%. The ash contents of the selected species range between 1 and 6% and Energy content between 15.04MJ/kg and 28.58Mj/kg. The specific gravity, moisture contents, ash content and calorific or energy values are important parameters that affect the degree of efficiency in wood energy production and use.

From Table 4 it can be observed that mean specific gravity of charcoal species ranged between 0.46 and 0.63 with a mean of 0.55 while the energy content ranged between 2.51 and 3.95MJ/kg with a mean of 4.38MJ/kg. The Mean moisture content was 5.64% while mean ash content was 3% and the range is between 1 and 5%.

As shown in Table 5, the efficiency of the earth kiln method of charcoal production was 21.01%, that is, the input - output ratio was about 5:1 which means 1kg of charcoal from 5kg of wood. The energy contents of the wood species were relatively high because the specific gravity values were relatively high. Positive correlation has been established between specific gravity and energy content of wood. This findings is in line with the report of FAO (2002), Fuwape (1985), Akachukwu (1993) and Stassen (2002).

At 17.8% and 5.6% mean moisture for the wood energy species, the level of efficiency is expected to be high because the values are relatively low. Although drying of wood and charcoal below these levels will lead to a greater efficiency, the traditional dependence on environmental factors such as temperature and humidity is a major limitation in the study area. The mean ash contents for fuelwood and charcoal were 2% and 3% respectively. The result showed that the wood energy species are generally low in ash content. At this ash content value, waste due to non combustible solid substances is minimal and this is an indication of high efficiency. The energy content was observed to increase with density (but not always as this may be attributed to variations in volatile matter composition of different wood species) as more energy is stored with increasing cellulosic materials. Fuelwood and charcoal species in this study were generally found to be relatively high in energy contents.

CONCLUSION

Fuelwood and charcoals Akinyele Local Government Area are relatively low in moisture and ash contents and high in density and energy contents. The study also show that fuelwood from the study area are low in moisture content and in fact satisfies conditions that are prerequisites to obtaining maximum calories from burning them. This shows that given good burning methods, the woodfuels would give good yields of energy. Nevertheless there is room for improvement so as to ensure maximum energy possible is obtained when they are burnt. This can be achieved through proper drying, preservation and storing of the wood for charcoal production. The efficiency of the method of charcoal production (earth kiln) in the study area is comparable with efficiency values in similar charcoal earth kiln systems.

REFERENCES

Akachukwu, A.E (1993) Calorific value of *Gmelina arborea* wood and its relationship with plantation age. Nigerian Journal of Forestry No. 23 Vol. ±. P47-49.

Akachukwu, A. E (2001) Wood as a source of energy for national development. Proceedings of the

27th annual conference of the Forestry association of Nigeria, held in Abuja, FCT, 17th-21st September, 2001, titled "Forestry and National Development".

Amous, S. (2000). Review of wood energy reports from Acp African Countries. EC - FAO partnership programme working document, Rome.

ASTM, (1989). ASTM D 2395-89 Standard Test Methods for Measuring Gravity of Wood. Annual Book of ASTM Standards Construction Wood No.04. American Society for Testing and Materials, Philadephia.

ASTM (1990). ASTM D 1102-84 (Re-approved 1990) Standard Test Methods for Ash in Wood. American Society for Testing and Materials, Philadephia.

ASTM (1998) ASTM E870-82 (1998) Standard Test Method for Analysis of Woodfuel, American Society for Testing and Materials, Philadephia

Dinwoodie, J.M. (1981). *Timber: Nature and Behaviour.* Van Nostrand Reinhold, Workingham. 190pp.

FAO. (1985). Industrial Charcoal Making. FAO Forestry paper No. 63 Rome.

FAO. (1990). A new approach to energy planning for sustainable rural development. FAO - Environment and energy paper. Forestry topics report No. 1, United Nations Development Programme, Economic and Social Commission for Asia and the pacific Food and Agricultural Organisations of the United Nations - Electronic Document.

FAO. (1993). A decade of wood energy activities within the Nairobi programme of action. FAO forestry paper No. 108 - Rome.

FAO. (1995). Forests, Fuel and the future - Wood energy for sustainable development. Forestry topics report No. 5 Electronic document.

FAO. (2001). Socio economic aspects of bio energy: a focus on employment, by E.M. Rome document, Rome.

FAO. (2002). Unified Wood Energy Terminology Working document, FOPW/01/05/. Rome. P.80.www.fao.org/forestry/FOP/FOPH/ENERGY /doc/UWET/eng/uwet-eOO.htm

Fuwape, J.A (1985). Heat of combustion of twenty savannah trees species. Proceedings of 1985 annual FAN conference, 25th - 29th, November, 1985. P 70-79.

Fuwape, J.A and Onyekwelu, J.C (1995). The Effect of Uncontrolled Fuelwood Collection on the Environment. Proceedings of the regional training workshop held at the Federal University of Technology, Akure, Nigeria on the 23rd - 26th July 1995 by UNESCO - Darkar / Map national committee - Nigeria, titled *"Impact of Human Activities on the West African Savannah.* P256-261.

Girard, P. (2002). Charcoal production and use in Africa what future? Unasylva vol. 53, No.211, 2002/04 P30-34

Naufiyal, J.C (1979). Aforestation programmes in arid zone of Nigeria. Field document No.2. NIR/75/053. FAO, Rome.

Nigerian Environmental Study/Action Group (NEST) (1991). Nigerian Threatened Environment. A Nigerian profile. 287pp.

Oguntala, A.B (1995). Effect of firewood collection and logging on environment. Proceedings of A the regional training workshop held at Federal University of Technology/ Akure, Nigeria, 23rd - 20th July 1995 by UNESCO - Darkar/Map national committee, Nigeria, title "*Impact of human activities on the African savannah*". P268-272.

Stassen, H.E (2002). Developments in charcoal production technology. Unasylva, vol.53. No. 211, 2002/04 P.34-40.

Trossero, M . (2002). Wood energy, the way ahead. Unasylva, vol.53/ No.211, 2002/04 P.3-11.