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Energy value and related properties of desert date (*Balanites aegyptiaca*) L. (Del)

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Abstract
A fresh wood sample of *Balanites aegyptiaca* L. (Del.) was taken from Buskuri open forest and tested for moisture content, calorific value, combustion rate and its coppicing ability. The study shows that the moisture content at the time of energy determination was found to be 3.81 percent and the calorific value of 16.49 Mj/Kg was recorded. The results also reveals that in eight minutes, the temperature of the wood sample reached 500^{o}C and temperature above 100^{o}C was retained for a period of 26minutes. The species was found to coppice at the rate of 100cm per annum. An urgent need to stop cutting *Balanites aegyptiaca* for fuel wood and the need for advance research on the wood properties of the same species for enhanced diversification of utilization were recommended.

Key words: Calorific value-Coppice-Combustion rate-Temperature-Moisture

Introduction
Forest provides the bulk of domestic energy for cooking and space heating among the rural communities in Nigeria (Akpan*et al*., 2005). This is due to its availability, accessibility, affordability and simplicity in utilization. Other forms of energy of fossil origin are beyond economic capability of the majority of people living in rural areas. In addition, the supply of such energy is limited and erratic.
Forest in the tropical developing nations are extensively used for grazing, fuel wood collection, cutting for medicinal purposes and other numerous subsistence needs by local people even inside protected areas that have been priotized for biodiversity conservation (Kothari *et al*., 1989). The heavy dependence on wood for fuel and timber products has contributed to the accelerated forest and woodland degradation. This is particularly serious where population is dense and with little or substitute of biofuel as a result of lean financial earnings.

Fuel wood is the dominant energy form throughout Africa and the rest of developing world (Hall, 1991; Pandey, 2002). The importance of fuel wood in economic development cannot be overemphasized. In Nigeria and in the rural areas in particular, it is the major energy source.

Fuel wood collection is a common and widely practiced economic activity of the rural dwellers and this was necessitated by the ever increasing demand for fuel wood as a formidable source of energy for household cooking, barbecuing, bakery and blacksmithing industries, fish smoking and oil palm production (Tella *et al*., 2005).

Presently due to increased loss of floral biodiversity, fuel wood collection is indiscriminate as a result; species of low energy value but of higher pharmaceutical, constructive and conservative values and numerous socio-economic importances are being carelessly removed. This leads to the loss of species of high quality timber and pharmaceutical potentials, and its attendant deforestation that leads to severe environmental degradation. To stop this ecologically ill practice, it is of paramount importance to investigate the energy related attributes of commonly used woody species in order to show case same to the teeming fuel wood users, government and non-governmental organizations within developing nations, so that a choice can be made in terms of utilization and woodlot establishment and management (Wakili *et al*., 2009).

Energy sources need to be managed for enhanced sustained yield that will guarantee benefits for present and future generation. This is because fuels of fossil origin are depletable in nature and indiscriminate cutting of natural vegetation tends to destroy the quality and quantity of biodiversity and its attendant environmental backwardness. These conditions either in solitary or in association, threatens the survival of mankind. It is of paramount importance therefore to know the right species to cut for a particular usage so that the delicate balance between the ecosystems and its components are maintained.

The objectives of this study were to determine a) Energy value (Calorific value), b) Combustion rate and c) Coppicing Ability of *Balanites aegyptiaca* (L.) Del. With a view to either encourage its cooption in to woodlot plantation schemes in the tropics or discourage its utility for energy generation because of poor energy related attributes.

Materials and Methods

The species 'Desert Date' (*Balanites aegyptiaca)* (L.) Del.

It is a xeric plant of variable shrub or small to medium size tree with a thick fissures bark belonging to Balanitaceae family. It grows to the height of 13m when fully mature, but in most cases the height ranges from 8-10m. It is semi-ever green and spiny with branches which spread irregularly or pendulous forming round foliage. The trees bear heavy yields- as many as 10000 fruits annually on a mature tree in good condition. Each fruit, weighing 5-8g, consist of an epicarp (5-9%), a mesocarp or pulp (28-33%), an endocarp (49-54%), and a kernel (8-12%) (Chapagain, 2006). *B. aegyptiaca* (L.) Del. has wide ecological amplitude within African continent and one of the oldest plant upon which mankind depends for valuable resources. It is slow growing, drought resistant and stress tolerant multi-purpose tree species (Usama, 2007).

Collection of Wood sample

A fresh wood sample of desert date was obtained from Buskuri open forest in Bauchi State, Nigeria (90301 and 120 301 north of the equator and longitude 80501 and 110 east of the greenwich meridian). This forest is denuded woodland as a result of excessive cutting for fuel wood. The collection was made in the dry season. The collected sample was tested for moisture, calorific value, combustion rate and its regeneration effort measured.

Determination of Moisture Content

The apparatus used for this test were an electric oven (DHD 1901), digital weighing balance, wet and dry bulb thermometers. The wood sample was introduced in to an oven maintained at 105OC for one to four hours until uniform weight was attained (ASTM-D143-82). The moisture was determined using an equation, thus,

$$MC = \frac{A-B}{B} * 100$$

Where MC = Moisture content

A = Original mass of sample

B = Oven dry mass of sample

Determination of Calorific Value

To determine the energy value of the wood sample, a bomb calorimeter (LECO-AC-350) and an electric balance were used in accordance with ASTM-D143-82. The analysis was conducted at National Metallurgical Centre Jos, Plateau State- Nigeria.

Determination of Combustion Rate

The apparatus used were Pyrometer, Thermocouple and Crucible. The test was conducted in a form of open fire under indoor condition. After ignition, the wood sample was allowed to flame until completely burnt in to ash. 30g of the wood sample was put in to crucible. The sample was ignited using matches and a little kerosene. The temperature of the burning sample was taken at an interval of two minutes until it completely get burnt. This test was conducted at the thermodynamics laboratory, Abubakar Tafawa Balewa University, Bauchi- Nigeria.

Determination of Regeneration Ability of the Species

The natural regeneration ability of the species was measured by observing its stump that gives out coppice shoot under natural condition. An annual average height and number of successful coppice shoot were measured. An average height of the species were obtained by summing of all year old re-growth of five stools of the species and divided by number of the species (stools). The number of the coppice shoot that graduated in to tree size were considered as successful coppice shoot.

Results and Discussion

Moisture Content

The moisture content of *Balanites aegyptiaca* at the point of energy determination (3.81%) was found to be below equilibrium moisture content of 15% (Zobel and Van Bejutenem, 1989). This is because when the fresh sample of the wood was collected, it was splitted there by exposing much of the wood surface to the drying wind and sun. Wood begins to dry out as soon as it is cut and progress through several stages. In the first stage of drying, free water is lost until fibre saturation point is reached. Drying beyond this point to equilibrium moisture content takes progressively longer, since it involves the removal of bound water. The moisture content at this levels and the rate of drying vary depending on humidity and temperature (Wakili*et al*., 2012). Since even at 25% moisture content, 80% of the content energy will be available for utility (Reyes *et al*., 1992), drying wood sample to as low as 3.81% will necessitate the release of all the quantum of energy of the wood sample.

Calorific Value

The results of calorific value determination indicates that *Balanites aegyptiaca* wood sample contains 16.4 Mj/Kg at the time bomb calorimetric analysis as a result of low moisture the sample was having at the time of the analysis. Moisture content of wood is one of the major determinants of wood's energy for utilization. This is because the higher the moisture content of wood, the lesser the utility energy and the lesser the moisture content of wood the higher the available usable energy.

The energy value obtained is higher than that of *Anogeissus leiocarpus* (23.945Kj/Kg) and *Prosopis africana* (20.925Kj/Kg) at 10.75% and 9.82% respectfully as reported by Onuarah (1999). The variation may be as a result of differences in moisture content because moisture affects the production of usable energy when wood is burnt (Zobel and Van Bejutenen, 1989).

However, the energy value obtained in this study is lower than the energy value of some fuel wood tree species reported by Wakili *et al*. (2009) and Wakili and Abdullahi (2010). The former reported the energy value of 16.554Mj/Kg for *A. leiocarpus* and the later reported energy value of 17.934 Mj/Kg for *P. africana.* The energy value obtained from this study will not provide the needed energy for small and medium enterprises, and homes which are dependent on wood as a source of energy. The energy value of *B. aegyptiaca* (16.49Mj/Kg) indicates that much quantity is needed to carry out a heating or cooking exercise and by extension; many trees of the same species must be cut in order to have the required quantum of energy. This will increase the rate of deforestation and its attendant environmental degradation. The valuable money and time needed to address other important issues at the family and community levels are being wasted in acquiring less energy value wood.

Combustion Rate Test

The combustion rate test of *Balanites aegyptiaca* indicated that in eight minutes the highest temperature of 500^{o}C was reached and which in just two minutes dropped to 425^{o}C and progresses to 100^{o}C in sixteen minutes there after (Table 1). Temperature above boiling point was maintained for a period of 26 minutes and there after the heat drastically dropped. The combustion rate test of *Acacia hebecladoeids* shows that in ten minutes, a peak temperature of 335^{o}C was obtained in 26minutes and dropped to 110^{o}C in 28 minutes, and maintained temperature above 100^{o}C for 25minutes (Wakili *et al*., 2012). Comparatively also, Wakili *et al*. (2009) reported that *Anogeissus leiocarpus* attained a temperature of 320^{o}C in ten minutes and immediately starts *to* drop. Desert date attains the highest temperature (500^{o}C) among these tree species but this temperature drops immediately indicating that it will not be suitable for heating operations requiring a sustained heat for longer period of time.

Since many contributors (Chapagain, 2006;Usama, 2007; Abdullahi *et al*.,2010)have reported areas where Desert date play an important role in solving a variety of socio-economic problems; suitability of its wood for agricultural hand tools handle, forage tree, fruits used for votive offerings, medicinal attributes, construction and conservative values among others, the attention be therefore tailored towards provision of these vital goods and services rather than cutting this species for fuel wood.

Coppicing Ability of *Balanites aegyptiaca* L. (Del.)

The coppicing ability of *Balanites aegyptiaca* L. (Del.) was observed in Buskuri open forest by noticing the presence and measuring the height of coppice regrowth from the stool of the same species. It was observed that the stool profusely coppice and the coppice shoot can grow at the rate of more than 100cm per annum. This clearly indicates that this species can be used in the establishment of other forms of plantations rather than woodlot. Even though the species is slow growing towards maturity, if a project is meant to produce small sizable wood, this species can be a good candidate because its double root system can adequately support its coppice shoot. *Acacia hebecladoeids* was reported to coppice at the rate of 135cm per annum, *Combretum molle* 131cm, *C.glutinosum* 132cm, *Pterocarpus erinaceus* 175cm, *Khaya senegalensis* 156cm and *Nauclear latifolia*180cm (Wakili *et al.*,2012).

Table 1: Combustion rate test of *Balanites aegyptiaca* L. (Del.)

Time (Mins)	Temperature (^{o}C)
0	30
2	98
4	210
6	410
8	500
10	425
12	360
14	310
16	290
18	270
20	240
22	200
24	170
26	130
28	100

Conclusion

Balanites aegyptiaca have little energy value compared to many fuel wood tree species even though the temperature of the available calories can be maintained for a considerable period of time. This indicated that this species is not suitable for fuel wood but since it was reported that the species plays a vital role in the provision of wood for tool handles, construction, and pharmaceuticals, the species can be managed for these reasons rather than fuel wood.

Recommendations

1. That there is an urgent need to stop cutting *Balanites aegyptiaca* for fuel wood because of its low energy content.
2. That the species (*Balanites aegyptiaca*) will be good for timber plantation because of its strong and durable wood.
3. That as an incentive, plantation inputs be made available to all intending plantation developers free of charge by both government and non-governmental organizations.
4. That there is the need for advance research on wood properties of *Balanites aegyptiaca* for enhanced diversification of utility.

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