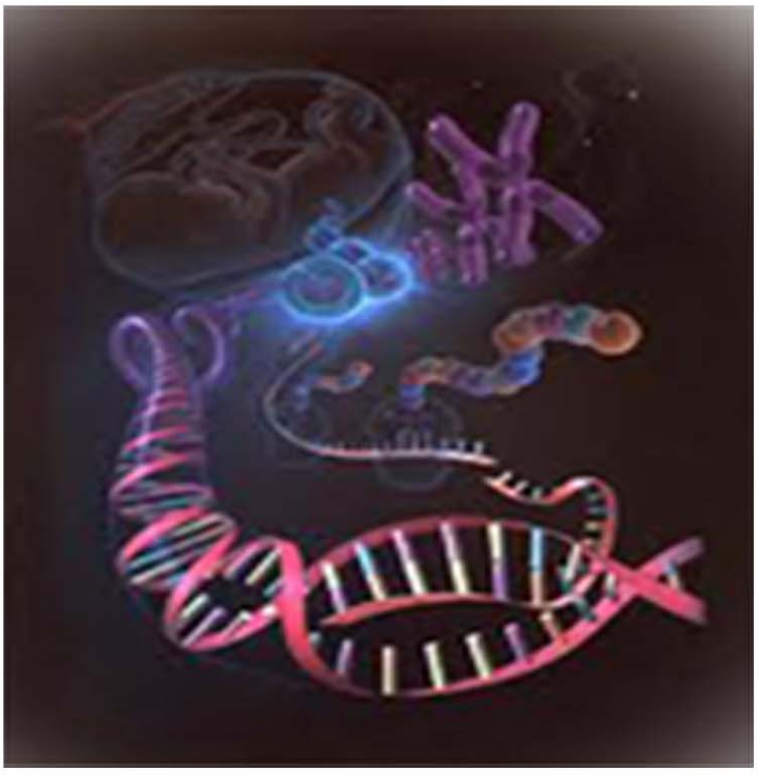
IJLBPR

ISSN 2250 - 3137
Vo1. 2, No. 3, July 2013

International Journal of

Life Sciences Biotechnology and Pharma Research



International Journal of Life Sciences Biotechnology and Pharma Research
Hyderabad, INDIA

www.ijlbpr.com

Email : editorijlbpr@gmail.com or editor@ijlbpr.com

International Journal of Life Sciences Biotechnology and Pharma Research

ISSN 2250-3137 www.ijlbpr.com
Vol. 2, No. 3, July 2013

Research Paper

FIRE CHARACTERISTICS OF THIRTEEN NIGERIAN TIMBERS AT OGBOOSISI BRIDGEHEAD ONITSHA NORTH LGA OF ANAMBRA STATE, NIGERIA

Udeozo I P[1]*, Opara N V[1], Okoye N H[2] and Umedum N L[2]

Corresponding Author: **Udeozo I P, ✉ okechukwup.cugwu@gmail.com*

Timber has become so important to human throughout history. It is a combustible material. The fire characteristics of West African timbers are not known unlike that of developed countries. An attempt is thus made to address this problem by investigating the fire characteristics of 13 Nigerian timbers. The characteristics were Ignition Time (IT), Flame Propagation Rate (FPR), Flame Duration (FD), After Glow Time (AGT), Oven Dry Density (ODD), Moisture Content (MC) , water imbibitions (porosity index) and Ash Content (AC). The highest and least of these fire characteristics among the 13 timbers were noted. Oven dry density which is an important factor in determination of the fire characteristics of timbers should not be exceptionally used without considering the cellular structure, molecular composition, orientation of fiber and timber extractives. In the absence of structural differences in the anatomy of timbers, this study has provided some of the fire characteristics of the selected Nigeria timbers.

Keywords: Timbers, Ignition time, Flame propagation density, Moisture content, After glow time and Ash content

INTRODUCTION

Wood is a hard, fibrous tissue found in many trees. It has been used for hundreds of thousands of years for many purposes. It has an organic material, a natural composite of cellulose fibers (which are strong in tension) embedded in matrix of lignin which resists compression (Young, 1989). Wood is produced as secondary xylem in the stem of trees. In a living tree it performs a support function, enabling woody plants to grow large or to stand up for them.

Wood is a natural product and when used responsibly is a sustainable means of energy which will not result in any damage of the environment. All woods are composed of cellulose, lignin, hemicelluloses and minor amounts (5% to 10%) of extraneous materials contained in a cellular structure (Kubler, 1990).

[1] Department of Industrial Chemistry, College of Natural and Applied Sciences, Tansian University Umunya (Oba Campus), Anambra State, Nigeria.

[2] Department of Pure and Industrial Chemistry, Nnamdi Azikiwe University Awka, Anambra State, Nigeria.

Woods are effectively water carrying tubes. These fibers are laid in the direction of the tree trunk or branch from which the wood is removed. The strength of wood is highly dependent on the loading direction. Wood is the strongest in tension among the fibers and the weakest in the radial and tangential direction (Rowell, 1984). Wood, in the strict sense is yielded by trees, which increases in diameter by the formation between the existing wood and the inner back of new woody layers which envelop the entire stem, living branches and roots. This process is known as secondary growth. This occurs as the result of cell division in the vascular cambium and subsequent expansion of the new cells where there are clear seasons. Growth can occur in a discrete annual or seasonal pattern, leading to growth rings; these can usually be most clearly seen on the log, but are also visible on other surfaces. If these seasons are annual, these growth rings are annual rings. Where there is no seasonal difference, growth rings are likely to be indistinct or absent (Brush, 1980).

If there are differences with a growth ring, then part of the growth ring nearest to the center of the tree and formed early in the growing season when growth is rapid, is usually composed of wider elements, it's usually lighter in color than that of the near outer portion of the ring, and is known as early wood or springwood. The outer portion formed later in the season is then known as the late wood or summerwood (Brush, 1980).

With the increasing population and high industrial activities, the use of wood as fuel and other industrial purposes have also increased and this necessitated the research on the various types of wood such as *Chlorophera excelsa*, *Mansonia nymphaeifolia*, *Mitragyna ciliate, Alstonia boonei*, *Gmelina arborea, Lovoa trichilioides, Entandro phragma, Nauclea diderrichii, Bombax* sp.*, Khaya* sp.*, Tripochiton scleroxylon, Brachystegia* sp. *and Mansonia attissima* in order to note there various fire characteristics.

The purpose of this study was to determine the fire characteristics of 13 Nigerian timbers and to find out which of the timbers that are fire resistant and those that are not.

MATERIALS AND METHODS

Sample Collection and Preparation

The 13 timber sample were collected from Ogbo-Osisi Bridge Head Onitsha, the timber dealers were able to give the local (common) names of the timbers while the botanical names were obtained with the aid of Director of Forestry at Department of Forestry, Ministry of Agriculture, Enugu State. The samples were taken to the saw mill at Onitsha timber Shade where each timber was cut into two different shape and sizes.

Also dust from each timber was collected. The timbers were cut into splints of dimensions 25.0 cm by length and 1.5 cm by width and cubes of dimension 2.0 cm x 2.0 cm x 2.0 cm. The cubes were dried in an oven at 105 degree for 24 h before the experiments

Materials

Weighing balance, Sensitive balance, Wood samples (both cube and splint) from Ogbo-Osisi at Onitsha, Lighter, Stop watch, Tap water, Heat testing furnace (Budpest KGYV) main voltage = 3x380 V, Temperature = 950 °C, work no = 10427, Type = kco 80750 – 120), Clamp, Saw dust from each species of wood, Clay pot, Ruler, Bucket .

METHODOLOGY

Three samples each from 13 wood species

Table 1: Botanical Names, Common Names and Wood Types of the Thirteen Nigerian Selected Timbers

Botanical Names	Common Names	Types of Wood
Chlorophera excelsa	Oji, Iroko	Hardwood
Mansonia nymphaeifolia	Epe-mansona, noce monsonia	Hardwood
Mitragyna ciliate	Owen, uwen, nahia	Hardwood
Alstonia boonei	Egbu, Austriatian blackwood, Tasmanian blackwood	Hardwood
Gmelina arborea	Melina, Kashour tree, Beechwood	Hardwood
Lovoa trichilioides	Walnut, African walnut, Tiger wood, Conge wood	Hardwood
Entandro phragma	Omor, Umu, Muyovu, Mukusu	Hardwood
Nauclea diderrichii	Opepe, African peach	Hardwood
Bombax sp.	Akpu, Condrotti, Kondroti	Hardwood
Khaya sp.	Mahogany, Mkangazi, Nyasaland mohagany	Hardwood
Tripochiton scleroxylon	Obeche, Ayous, wawa, African maple, African whitewood	Hardwood
Brachystegia sp.	Achi, Okwen, Ogunri, Ach.	Hardwood
Mansonia attissima	Mansonia, bête	Hardwood

(splint) were set in a clamp and ignite with a lighter the average ignition time was taken and recorded. That is, time from flame touching the splint until ignition occurred.

The time interval from the ignition to the time the flame went off or splint burnt completely was recorded as flame duration. Flame duration is recorded in seconds from the average of the three splints readings for each timber samples.

During the after glow time experiment, two stop watches were use to determine the time interval between flame extinction and last visually perceptible glow of the three (3) splint samples of each 13 wood species, and the time in seconds between flame extinction and the last visually perceptible glow was taken. That is after glow time = last visually perceptible glow – flame extinction.

Oven dry density experiment was carried out with three cubes of each samples; the original weight of the wood was determined by weighting the cubes. The furnace was heated at 105ºC and weighed until a constant weight was attained by each sample. The average weight of the dried samples were taken and recorded. Sample was determined by dividing the average dried weight by the average volume, i.e.

$$\text{Oven dry density} = \frac{\textit{average dried weight of the asample}}{\textit{average volume}}$$

FPR was done using splint of the timbers in accordance with ASTME 84 (ASTM, 1998). The splint was allowed to burn for some time till the flame went off or was blown off.

The distance traveled at a stipulated time interval by the char front was measured. The

distance traveled was obtained by subtracting the remaining length of the splint from the original length. The average distance traveled by the char front and average time interval in the three splint of each timber were calculated and used to determine the flame propagation rate or flame velocity.

FPR =

$$\frac{Distance\ \ travelled\ \ by\ \ the\ \ char\ \ front\ \ (cm)}{Time\ \ (sec)}$$

The water imbibitions experiment was carried out using three cubes of each species. Their average dry weight was taken. The cube samples were soaked in a bucket of water, for a period of 5 h, 24 h and 48 h respectively. The average weight of the saturated sample was taken. Water imbibitions after three respective times were calculated thus:

$$\text{Water imbibitions} = \frac{W_2 - W_1}{W_1} \times \frac{100}{1}$$

where, W_1 = average dry weight of the samples

W_2 = average weight of the saturated sample

The ash content was determined using dust from each timber species. The dust was weighed before it was taken to the furnace. The ash content was obtained using the ASTM E 119 (ASTM, 1998b). The ash is placed in a clay pot and put into the furnace at a temperature of about 300ºC for an hour, after the furnace attained 300ºC in an hour, it maintained a constant temperature for a period of 145 min so that every ash particles inside the clay pot will homogenized. The ash was allowed to cool and weighed, and the weight of the char was recorded.

Ash content =

$$\frac{weight\ \ of\ \ ash}{Dry\ \ weight\ \ of\ \ the\ \ sample} \times \frac{100}{1}$$

The amount of moisture present in wood varies appreciably in different circumstance, but the dry weight of wood substance in a given sample is constant. Hence, its usual to express the variable-moisture content as a percentage of the constant dry weight of the sample (Desch *et al.,* 1981) the ratio is

$$\frac{Weight\ \ (or\ \ volume)\ \ of\ \ water\ \ present}{Dry\ \ weight\ \ of\ \ sample} \times \frac{100}{1}$$

The most satisfactory method for determining the moisture content of timber sample is the oven-dry method ASTM D54442. (Method A) where it is obtained as follows:

$$\text{Moisture content \%} = \frac{W_1 - W_2}{W_1} \times \frac{100}{1}$$

where, W_1 = initial weight of each sample

W_2 = oven dry weight of each sample

RESULTS

Results from Table 2 below show that timber such as *Brachystegia sp.* had the highest ignition time, *Nauchea diderrichii* recorded the highest flame duration, *Bombax spp.* had the highest after glow time, *Lovoa trichiliodes* had the highest flame propagation, and a null hypothesis that timbers such as *Bombax sp.* had the least ignition time and *Mansonia altissima* recorded the least flame duration, *Entandro phragma* recorded the least after glow time and *Triplochiton sceleroxylon* had the least flame propagation.

Table 2: Results of the Characteristics of 13 Nigerian Timbers

Botanical Names	Ignition Time (s)	Flame Duration (s)	After Glow Time (s)	Flame Propa-gation	Water Inbibition (%)			Oven Dried Density (G/cm)	Ash Content (5)
					5 h	24 h	48 h		
Chlorophera excelsa	16.00	38.00	114.33	0.047	5.10	50.15	200.30	6.05	200.00
Mansonia nymphaeifolia	11.00	44.30	84.67	0.043	53.85	157.33	375,30	6.37	200.69
Mitragyna ciliate	14.00	48.30	118.00	0.044	62.60	442.27	921.15	2.62	209.63
Alstonia boonei	10.80	56.67	162.34	0.041	73.61	261.27	760.50	3.89	201.57
Gmelina arborea	12.30	52.00	171.33	0.038	38.87	130.27	323.05	7.82	200.00
Lovoa trichilioides	12.30	48.67	36.35	0.033	36.61	218.03	583.06	3.15	200.57
Entandro phragma	11.00	28.67	58.00	0.072	37.03	242.38	416.04	6.39	176.95
Nauclea diderrichii	15.00	65.67	82.70	0.036	34.52	74.43	236.32	7.43	191.97
Bombax sp.	7.80	31.67	178.33	0.041	75.64	134.19	408.51	9.28	198.76
Khaya sp.	20.30	32.67	11.66	0.041	97.38	175.19	356.91	7.81	200.56
Tripochiton scleroxylon	16.43	30.00	101.60	0.022	112.55	313.76	563.58	7.71	199.37
Brachystegia sp.	41.67	39.30	195.67	0.028	193.49	391.12	301.70	3.25	198.18
Mansonia attissima	11.30	29.30	73.00	0.045	49.10	223.35	570.65	2.87	200.00

DISCUSSION

The experiment shows that *Nauclea diderrichii* had the highest flame duration of 65.67 s and *Lovoa trichillodes* recorded the least flame duration with 28.67 s.

The experiment shows that *lovoa trichllodes* recorded the highest flame propagation of 0.072 cm/s and *Triplochition scleroxylon* had the least flame propagation of 0.022 cm/s while *khaya sp., Bombax sp*., and *Alstonia boonel* recorded the same flame propagation rate of 0.041 cm/s.

The experiments also showed that *Gmelina arborea* had the highest ignition time of 41.57 s and *Nauclea diderrichii* recorded the least ignition time of 7.8 s while *mansonia altissima, mitragyna ciliate* had the same ignition time of 11.00 s and *Alstonia boonei*, *chlorophora excelsahas* also the same ignition time 12.30 s.

The experiment shows that *Bombax sp*. had the highest after glow time of 198.33 s and *khaya sp.* recorded the least after glow time of 11.66 s.

The experiment shows that *Bombax sp*. recorded the highest oven dry density of 9.28 g/cm^3 and *Mansonia nymphaeaifolia* had the least oven dry density of 2.62 g/cm^3

There was a rapid decrease in the weight of all samples during the ash content experiment and a spontaneous increase in the weight of all samples during the water imbibitions experiment. The weight of all samples increased simultaneously against the time duration of 5 h, 24 h and 48 h.

CONCLUSION

The sample species used during this experiment are all hardwood as shown in Table 1, there depicts a direct relationship between ignition time and oven dry density. All the timbers are hardwood and has their after glow time less than 5 min (<5 min). Therefore, they are fire resistant timbers, and less hazardous timber and will be good for various purposes.

RECOMMENDATION

This work has provided the fire characteristics of 13 different timber species. It is recommended that the major constituents of timber and their orientation should be determined as they may help to explain the observations made. Also, afforestation and use of the thirteen timbers and other timbers with low after glow time should be encouraged. This will help in controlling of the disastrous effect of fire outbreak.

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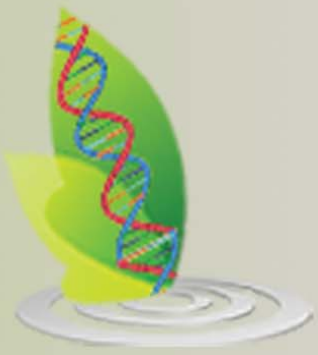

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ISSN 2250-3137