ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

The Effect of Flame Propagation Rate on Fifty-Two Selected Nigerian Timbers Nigerian Timbers.

Udeozo Ifeoma P[1,2]*, Eboatu AN[2], Kelle IH[3], Umedum NL[2] and Okoye NH[2]

[1]Department Of Chemical Sciences, 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.
[3]National Open University, Nigeria.

ABSTRACT

Effects of flame propagation rate and oven dry density on flame propagation rate of fifty two selected Nigeria timbers were analyzed. The results showed that timbers with least and highest flame propagation rates (FPR) were *Erythrophleum ivorense* (0.008cmS^{-1}) and *Protea elliottii* (0.29cmS^{-1}) respectively. Some timbers had equal flame propagation rates. These include; *Berlinia gradiflora* and *Anogeissus leiocarpus* (0.021cmS^{-1}); *Macaranga hurifolia*, *Glyphaea brevis* and *Sterculia oblonga* (0.038cmS^{-1}); *Oncoba spinosa* and *Cassipourea barteri* (0.042cmS-^{1}); *Hildegaridia barteri* and *Hymenocardia acida* (0.044cmS^{-1}); *Afzelia bipindensis* and *Afrormosia laxiflora* (0.046cmS^{-1}). The timber *Protea elliottii* with the least oven dry density (19.9 x 10^{-2} g.cm^{-3}) had the highest flame propagation rate of (0.29cmS^{-1}) while the timber, *Erythrophleum ivorense* with the highest oven dry density (108.7 x10^{-2}g. cm^{-3}) had the least flame propagation rate (0.008cmS^{-1}). There depicts an inverse relationship between flame propagation rate of the timbers and their oven dry densities.

Keywords: Flame propagation rate, Oven dry density, Nigerian timbers and Softwoods.

***Corresponding author**

INTRODUCTION

Flame Propagation/Spread Rate is the sliding movement of the flaming ignition point over the surface of a solid combustible. Once wood (any material) is ignited, one factor that affects the hazard is how fast the flames will spread from the point of origin. Various tests have been used to measure surface flammability [1]. Test results for flame spread are very dependent on the test procedures. The orientation of the materials, the direction of flame travel, the intensity of the external heat source, airflow and the material itself affects the result. In this work, the test method used for flame spread rate is ASTME84 (ASTM 1998) [2]. Rate of flame spread is inversely related to the density, moisture content, surface emissivity, surface temperature at ignition and thermal conductivity of wood [3], [4] and [5]. The correlation between flame propagation rate and density is only true for hardwood species. There is likely no such single parameter correlation for the softwood species. Douglas-Fir and Southern pine, the two dominant softwood species in North America, have similar densities but their flame propagation rate's are dramatically different. Chemical composition, both lignin content and extractives are likely important factors in the FPR of softwood species. Higher lignin contents of softwoods likely reduce the FPR (higher residual char layer) but any presence of flammable extractives likely results in high FPR's [4] and [5].

MATERIAL AND METHODS

Sample Collection and Preparation

The Fifty- two (52) timber samples were collected from fourteen States in Nigeria. The States are Anambra, Enugu, Ebonyi, Imo, Delta, Edo, Cross River, Akwa Ibom, Abia, Oyo, Lagos, Kano, Sokoto and Rivers State. The timber samples were obtained from the timber sheds at Nnewi, Awka, Enugu, Abakaliki and Benin. The States from where these timbers were collected were ascertained from timber dealers and confirmed by literature [6], [7]. The timber dealers were able to give the Local or common names of the timbers while the botanic names were obtained with the aid of forest officers and the literature [6], [7].

The samples were taken to the saw mill at Nnewi Timber Shed where each timber was cut into two different shapes and sizes. Also dust from each timber was realized. The timbers were cut into splints of dimensions 30x 1.5 x 0.5cm and cubes of dimensions 2.5cm x2.5cmx 2.5cm i.e. 15.625 cubic centimeters. The splints were dried in an oven at 105^0C for 24 h before the experiments.

ISSN: 0975-8585

Table.1 Names of the Selected Fifty-Two (52) Timbers Used For This Research

S.No	Botanical Names	Igbo Names	Yoruba Names	Hausa Names	Areas of Location in Nigeria
1.	Monodora tenuifolia	ehuru ofia	lakesin	gujiyadanmiya	Port Harcourt
2.	Pycnanthus angolensis	Akwa-mili	akomu	akujaadi	Calabar, Awka
3.	Moringa oleifera	okwe oyibo	ewe igbale	zogallagandi	Lagos, Ibadan
4.	Protea elliottii	okwo	dehinbolorun	halshena	Nsukka
5.	Caloncoba glauca	udalla-enwe	kakandika	alibida	Onitsha
6.	Barteria nigritiana	ukwoifia	oko	idonzakara	Nsukka, Enugu
7.	Bacteria fistulosa	oje	oko	kadanya	Awka
8.	Anogeissus leiocarpus	atara	ayin	marike	Onitsha, Awka
9.	Rhizophora racemosa	ngala	egba	loko	Calabar
10.	Allanblackia floribunda	egba	eku,eso roro	guthiferae eku	Calabar, Ikom
11.	Garcinia kola	adi	orogbo	namijin-goro	Onitsha, Nnewi
12.	Glyphae brevis	anyasu alo	atori	bolukonu kanana	Calabar
13.	Hildegaridia barteri	ufuku	eso, shishi	kariya	Okigwe
14.	Sterculia oblonga	ebenebe	oroforofo	kukuki	Ibadan
15.	Cola laurifolia	ufa	aworiwo	karanga	Onitsha, Calabar
16.	Bombax brevicuspe	akpudele	awori	kurya	Ikom
17.	Bridelia micrantha	ogaofia	ida odan	kirni	Calabar, Ikom
18.	Bridelia ferruginea	ola	ira odan	kirni and kizini	Onitsha, Awka
19.	Uapaca guineensis	Obia	abo-emido	wawan kurmi	Onitsha
20.	Antidesma venosum	okoloto	aroro	kirni	Onitsha, Udi
21.	Parinari robusta	ohaba-uji	idofun	kasha-kaaji	Onitsha
22.	Cynometra vogelii	ubeze	anumutaba	alibida	Onitsha, Abakali
23.	Amphimas pterocarpoids	awo	ogiya	waawan kurmii	Umuahia, Iko
24.	Lovoa trichiliodes	sida	akoko igbo	epo-ipa	Calabar
25.	Berlinia grandiflora	ububa	apodo	dokar rafi	Enugu
26.	Albizia adianthifolia	avu	anyimebona	gamba	Enugu, Nsukka
27.	Oncoba spinosa	akpoko	kakandika	kokochiko	Onitsha
28.	Dichapetalum barteri	ngbu ewu	ira	kirni	Onitsha, Agulu
29.	Afzelia bipindensis	aja	olutoko	rogon daji	Benin
30.	Afzelia bella	uzoaka	peanut	epa	Owerri, Orlu
31.	Erythropleum ivorense	inyi	erun	idon zakara	Ogoja, Ijebu
32.	Dichrostacys cinerea	amiogwu	kara	dundu	Onitsha
33.	Pentaclethra macrophylla	ugba	apara	kiriya	Onitsha
34.	Tetrapleura tetraptera	oshosho	aridan	dawo	Onitsha
35.	Stemonnocoleus micranthus	nre		waawan kurmi	Ukpor, Awka
36.	Piliostigma thonningii	okpoatu	abafe	kalgo	Kano,Oyo
37.	Hymenocardia acida	ikalaga	orupa	jan yaro	Awka, Enugu
38.	Afrormosia laxiflora	abua ocha	shedun	don zakara	Sokoto
39.	Phyllanthus discoideus	isinkpi	ashasha	baushe	Enugu, Ikom
40.	Gardenia imperialis	uli	oroto	karandafi	Jos
41.	Macaranga hurifolia	awarowa	ohaha		Awka
42.	Sacoglottis gabonensis	nche	atala	chediya	Rivers
43.	Cassipourea barteri	itobo	odu	daniya	Eket
44.	Combretodendron macrocarpum	anwushi	akasun		Udi, Owerri
45.	Lophira lanceolata	okopia	iponhon	namijin kadai	Udi
46.	Homalinum letestui	akpuruukwu	out,obo-ako		Ikom
47.	Cordial millenii	okwe	omo	waawan kurmii	Owerri
48.	Gmelina arborea	gmelina	igi Melina	kalankuwa	Ibadan
49.	Drypetes aframensis		tafia		Ibadan
50.	Khaya ivorensis	ono	oganwo	madachi	Calabaar
51.	Spathodea campanulata	imiewu	Oruru	delinya	Onitsha
52.			Shanty		

Determination of Flame Propagation Rate (FPR) of the timbers:

This was done using splint of timbers dried in an oven for 24h at 105°C. Three splints were selected from each of the timber samples. Each splint was clamped vertically and ignited at the base with a cigarette lighter in a draught-free room. The cigarette lighter was withdrawn, once the splint was ignited. The splint was allowed to burn for sometime till the flame went off or was blown off. The distance travelled at a stipulated time interval by the char front was measured. The distance travelled was obtained by subtracting the remaining length of the splint from the original length. Also the time interval from ignition time to when the flame went off was recorded in seconds, using a stop watch. The average distance travelled by the char front and average time interval in the three splints of each timber sample were calculated and used to determine the flame propagation rate or flame velocity. The results obtained are shown in Figures 1A and 1B.

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

RESULTS

Fig. 1A: The Flame Propagation Rate of Nigerian Timbers.

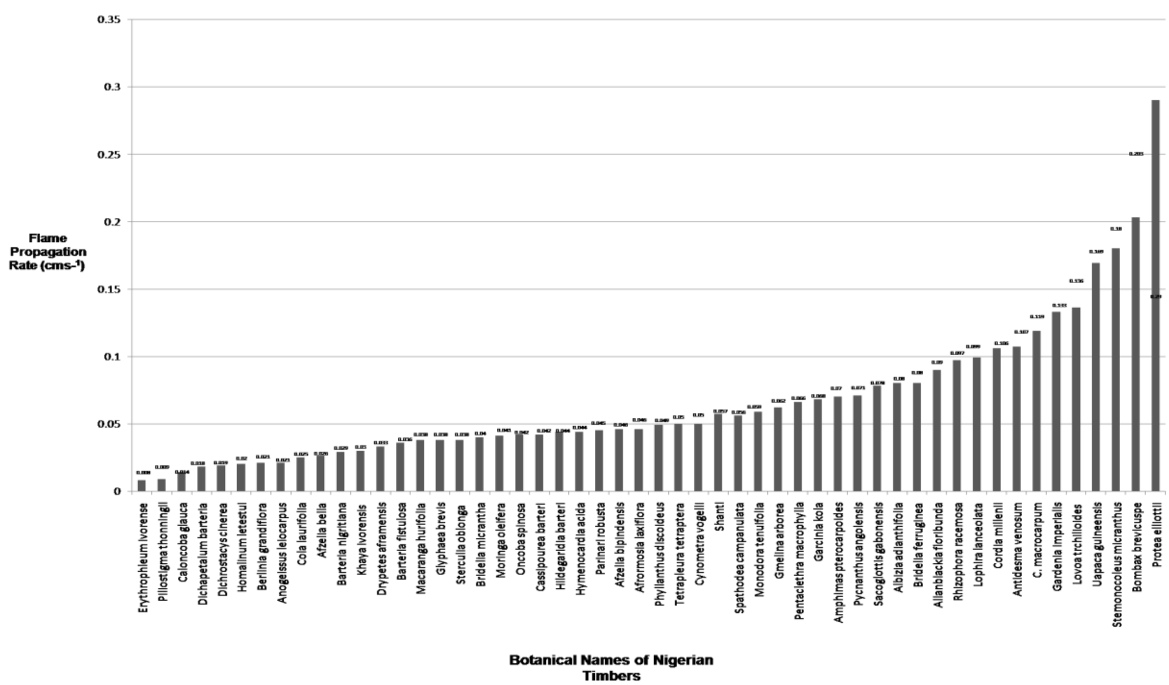
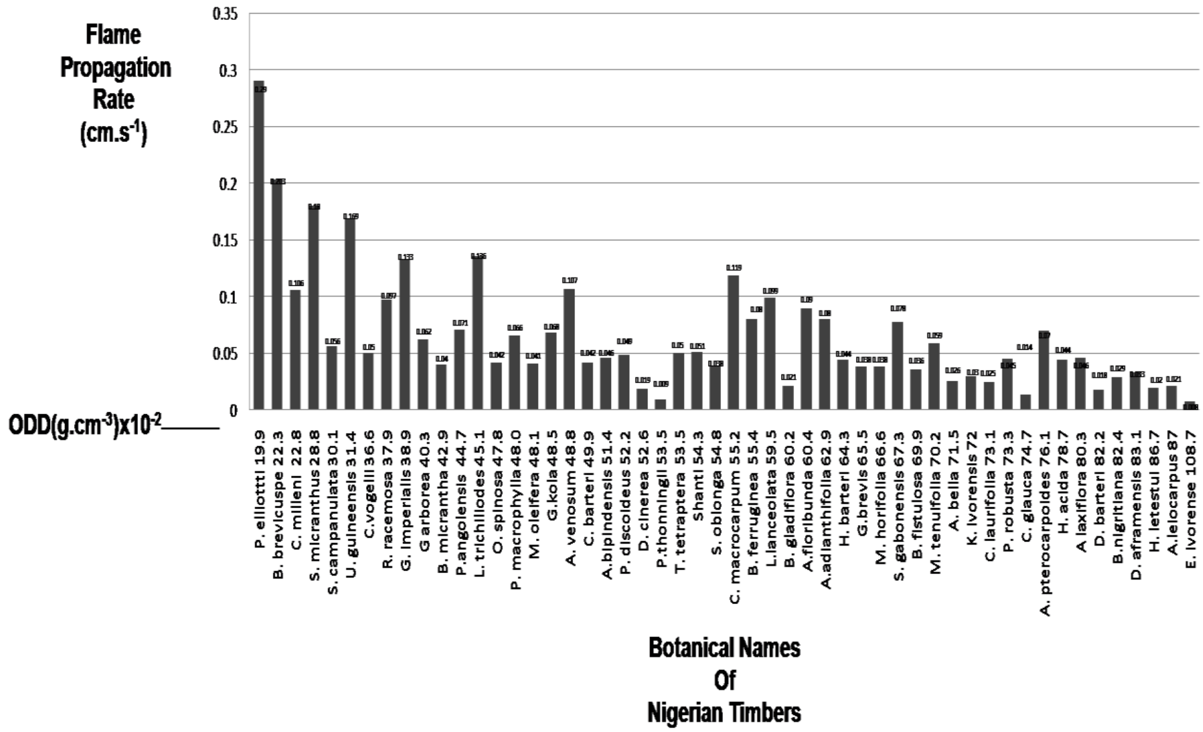


Fig. 1B Effect of ODD on FPR of the Timbers



DISCUSSION

Figure 1A portrays the effect of flame propagation rate of fifty-two timbers. The flame propagation rate of these timbers is represented in their increasing order of magnitude. The Figure shows that the timbers with least and highest flame propagation rates (FPR) were *Erythrophleum ivorense* (0.008cmS^{-1}) and *Protea elliottii* (0.29cmS^{-1}) respectively. It is also observed that, some of these timbers had equal flame propagation rates. These include; *Berlinia gradiflora* and *Anogeissus leiocarpus* (0.021cmS^{-1}); *Macaranga hurifolia*, *Glyphaea brevis* and *Sterculia oblonga* (0.038cmS^{-1}); *Oncoba spinosa* and *Cassipourea barteri* (0.042cmS^{-1}); *Hildegaridia barteri* and *Hymenocardia acida* (0.044cmS^{-1}); *Afzelia bipindensis* and *Afrormosia laxiflora* (0.046cmS^{-1}).

In Figure 1B, the effect of ODD on FPR. The timber *Protea elliottii* with the least oven dry density (19.9 x 10^{-2} g.cm^{-3}) recorded the highest flame propagation rate of (0.29cmS^{-1}). The timber, *Erythrophleum ivorense* with the highest oven dry density (108.7 x10^{-2}g. cm^{-3}) had the least flame propagation rate (0.008cmS^{-1}). The timbers, *Glyphaea brevis, Sterculia oblonga* and *Macaranga hurifolia* with equal flame propagation rates (0.038 cmS^{-1}) had oven dry densities of 65.5 x 10^{-2} g.cm^{-3}, 54.8 x10^{-2}g.cm^{-3} and 66.6 x10^{-2}g.cm^{-3} respectively. It was thus evident in Figure 1B that generally there was an inverse relationship between flame propagation rate and oven dry density of these timbers. As pointed out earlier, the work of Panshin and co-workers held the view that there is an inverse relationship between these two characteristics [4], [5] and [8]. In other words, heavy hardwoods take more time to ignite than resinous softwoods. Considering the nature of arrangement of grains and the porosity nature of the heavy hardwoods and light softwoods, one can see really that inverse relationship is also bound to exist between flame propagation rate and oven dry density. This means that in the absence of any other variables, the higher the ODD, the lower the flame propagation rate. The more porous a material (wood) is, the greater the ease with which the material propagates flame. The thermal conductivity of the material also increases in that order. Hence increases in ODD should reduce flame.

CONCLUSION

From the results of this analysis, one can conclude that there is an inverse relationship between flame propagation rate of the timbers and their corresponding oven dry densities.

REFERENCES

[1] Eicker, H.W. (1977): Surface flammability measurements for building materials and related products, In: Treatise on analytical chemistry, part 3, Vol. 4. New York: John Wiley & Sons.

[2] Justin B. S., Raymond O.R., Christopher J.S., Amie D.S. and David W.T. (2010): Compositional Analysis of Lignocellulosic Feedstocks., Journal of Agricultural and Food Chemistry. Vol. 58, 9043-9053.

[3] Bryden K.M. (1998): Computational modeling of wood combustion. Ph.D. Thesis, University of Wisconsin-Madison, WI.

[4] Browne F.L. (1958): "Theories of the combustion of wood and its control" USDA FPL Rep, p.2138.

[5] http://www.terramai.com/userfiles/file/technical/usi/Fire-performance-of-hardwoodspecies.pdf.

[6] Esau K. (2007): Plant Anatomy, John Wiley and Sons Inc, New York, p. 393.

[7] Akindele S.O. and LeMay V.M., (2006): Development of tree volume equations for common timber species in the tropical rain forest area of Nigeria. *Journal of Forest Ecology and Management.* 226: 41-48.

[8] PanshinA.J. and Carl De Zeeri Vi (1980); Introduction to Textbook of wood Technology, McGraw-Hill, 4th Edition, Series in Forest Resources, pp 72-105.