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Original Research Article

The effect of flame duration on fifty-two selected Nigerian timbers

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Keywords

Flame duration; Combustible material; Nigerian timbers and Exothermicity.

A B S T R A C T

Flame duration is the time of self-sustained combustion of materials. For a flame to exist there must be heat and fuel (combustible material). Since combustion entails self-sustained exothermicity, its life time (or flame duration) must depend on fuel source, quantity and availability. Effects of flame duration and oven dry density on flame duration of fifty two selected Nigeria timbers were analyzed. The results showed that the timber *Proteo elliottii* with the highest flame propagation rate recorded the least flame duration (14.67sec). It can also be seen that *Erythrohleum ivorense* with the least flame propagation rate had the highest flame duration (441.33sec). There were some timbers with equal flame duration. There are; *Bombax brevicuspe* and *Gmelina arborea (113.33sec); Afzeli bipindensis* and *Cola laurifolia* (181.33sec); *Rhizophora racemosa* and *Macaranga hurifolia* (260.00sec). In the absence of varied chemical composition of these timbers, direct relationship exist between the flame duration and oven dry density.

Introduction

Wood is the hard, fibrous substance found beneath bark in the stems and branches of trees and shrubs. Practically all commercial wood comes from trees. It is plentiful and replaceable. Since a new tree can be grown where one has been cut, wood has been called the world's only renewable natural resource (Wood Encyclopaedia Britanica on line 2011 Science and Technology). It is also an organic material, a natural composite of cellulose fibres (which are strong in tension) embedded in a matrix of lignin which resists compression. In the strict sense, wood is produced as secondary xylem in the stems of trees (and other woody plants). In a living tree it transfers water and nutrients to the leaves and other growing tissues, and has a support function, enabling woody plants to reach large sizes or to stand up for themselves (Larson, 1994). Wood (secondary xylem) is manufactured by a succession of five major steps, including cell division, cell expansion (elongation and radial enlargement), cell wall thickening

(involving cellulose, hemicellulose, cell wall proteins, and lignin biosynthesis and deposition), programmed cell death and heartwood formation (Larson, 1994) and (Higuchi , 1997).

Materials 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 (Esau, 2007; Akindele and LeMay, 2006). 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 (Esau, 2007; Akindele and LeMay, 2006).

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.

Determination of the Flame Duration (FD) of the timbers

Three splints of each timber sample was vertically clamped, cigarette lighter with steady flame was also used to ignite the splints. The time interval from the ignition to the time the flame went off or the 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 sample.

Determination of Oven Dry Density ODD

Three 2.5cm cubes of each timber sample were randomly selected. Each was weighed with top loading balance, Make: Mettler Toledo, Model: PL 203. After recording the initial weight, the sample was transferred into the drying oven at the temperature of 105^oC. The sample was left in the oven for three hours. After the heating, the oven was switched off, and the sample left overnight to cool. The sample was re-weighed after twelve hours. Care was taken to ensure that sample did not absorb moisture before and during weighing. After recording the second weight for the respective samples, they were taken back into the oven for another three hours at the same temperature. This was repeated until any two subsequent weights were equal i.e. constant weight attained. The weight of a cube was obtained by calculating the average of the three samples of each timber. The volume of each timber sample was calculated by taken the dimensions of the three 2.5cm cubes of each timber sample. The average volume of the three samples was recorded as the volume of each sample of the timbers. The oven dry density of each timber sample was determined by dividing the average oven dry weight of the three samples by the average volume of three samples.

$$\textbf{ODD} = \frac{\textbf{Average dry weight of samples}}{\textbf{Average volume of samples}}$$

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
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
16.	Bombax brevicuspe	akpudele	awori	kurya	Ikom
17.	Bridelia micrantha	ogaofia	ida odan	kirni	Calabar
18.	Bridelia ferruginea	ola	ira odan	kirni and kizini	Onitsha
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
23.	Amphimas pterocarpoids	awo	ogiya	waawan kurmii	Umuahia
24.	Lovoa trichiliodes	sida	akoko igbo	epo-ipa	Calabar
25.	Berlinia grandiflora	ububa	apodo	dokar rafi	Enugu
26.	Albizia adianthifolia	avu	anyimebona	gamba	Enugu
27.	Oncoba spinosa	akpoko	kakandika	kokochiko	Onitsha
28.	Dichapetalum barteri	ngbu ewu	ira	kirni	Onitsha
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
36.	Piliostigma thonningii	okpoatu	abafe	kalgo	Kano,Oyo
37.	Hymenocardia acida	ikalaga	orupa	jan yaro	Awka
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
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		
50.	Khaya ivorensis	ono	oganwo	madachi	Calabaar
51.	Spathodea campanulata	imiewu	oruru	delinya	Onitsha
			Shanty		

Fig. 1A: **Flame Duration of Nigerian Timbers.**

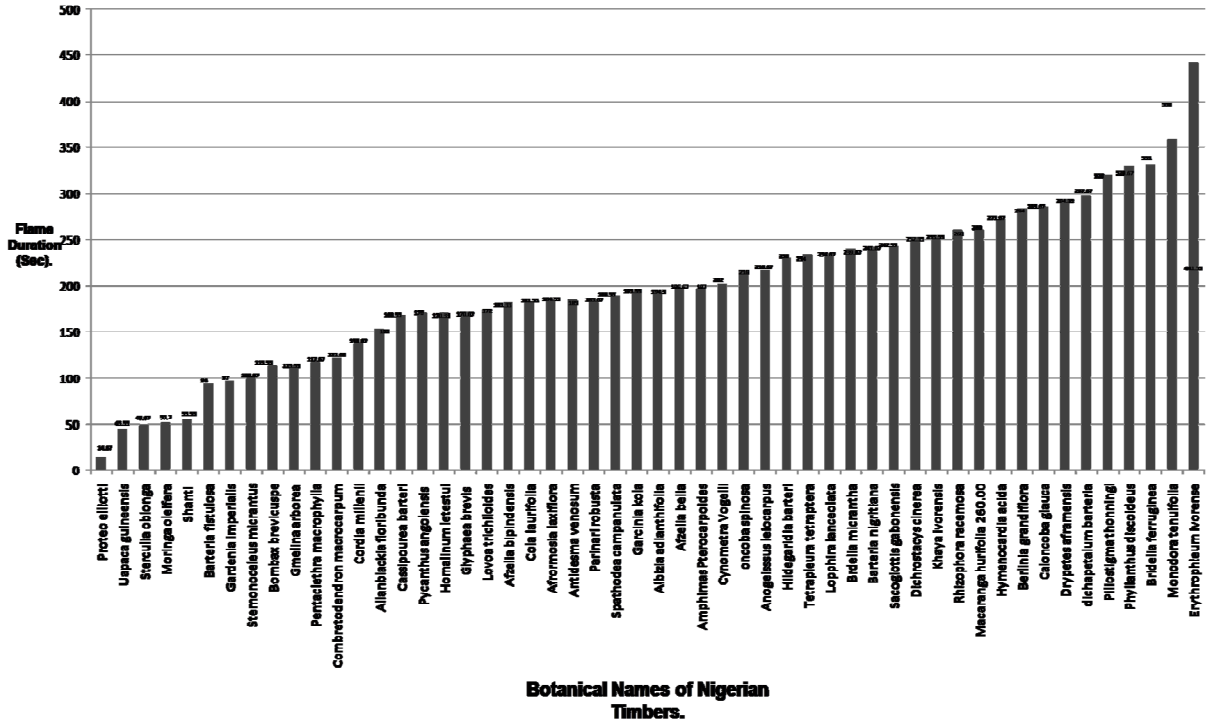
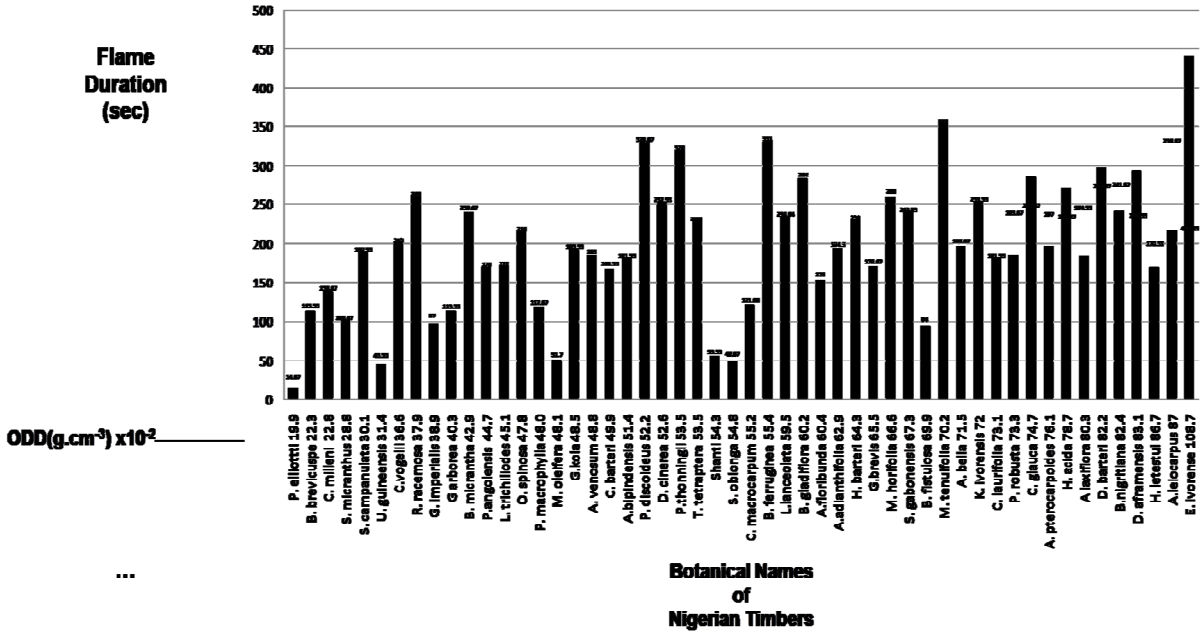


Fig. 1B **Effect of ODD on Flame Duration of the Timbers**



Results and Discussion

The figure 1A above shows that timber *Proteo elliottii* with the highest flame propagation rate recorded the least flame duration (14.67sec) while *Erythrohleum ivorense* with the least flame propagation rate had the highest flame duration (441.33sec). Figure 1B above shows that *Protea elliottii* with the least flame duration (14.67sec) recorded the least ODD while *Erythrophleum ivorense* with the highest flame duration (441.33sec) had the highest ODD.

Figure 1A represents the bar graph of flame duration of Fifty-two timbers. The flame duration of these timbers is represented in their ascending order of magnitude. The Figure indicates that the timber *Proteo elliottii* with the highest flame propagation rate recorded the least flame duration (14.67sec). It can also be seen that *Erythrohleum ivorense* with the least flame propagation rate had the highest flame duration (441.33sec). There were some timbers with equal flame duration. There are; *Bombax brevicuspe* and *Gmelina arborea* (113.33sec); *Afzeli bipindensis* and *Cola laurifolia (181.33sec); rhizophora racemosa* and *Macaranga hurifolia* (260.00sec). The rates of flame propagation of these timbers (with equal flame duration) differ but in terms of combustion, they can self-sustain themselves till the whole length of wood is burnt. Flame duration is the time of self-sustained combustion of materials. For a flame to exist there must be heat and fuel (combustible material). Since combustion entails self-sustained exothermicity, its life time (or flame duration) must depend on fuel source, quantity and availability. Figure 1B depicts the graph of flame duration against oven dry density. It was observed that *Protea elliottii* with the least flame duration (14.67sec) possess the least ODD. *Erythrophleum ivorense* with the highest flame duration (441.33sec) had the highest ODD. Also majority of the timbers with higher ODD values recorded higher flame duration while lesser number of the timbers with low ODD had lower flame duration. From this graph, one can assert that in absence of varied chemical composition of these timbers, those with higher ODDs possess higher flame duration and those with lower ODDs had lower flame duration. From the results, there was a direct relationship between the flame duration and oven dry density of the fifty-two Nigeria timbers. In conclusion, *Proteo elliottii* with the highest flame propagation rate recorded the least flame duration (14.67sec) while *Erythrohleum ivorense* with the least flame propagation rate had the highest flame duration (441.33sec). Also, *Protea elliottii* with the least flame duration (14.67sec) recorded the least ODD while *Erythrophleum ivorense* with the highest flame duration (441.33sec) had the highest ODD.

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