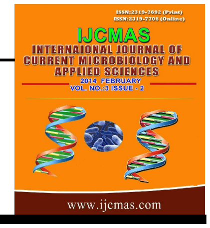

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Original Research Article

The effect of moisture contents on fifty-two selected Nigerian timbers

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Moisture contents; wood; ODD; timbers and chemical composition.

A B S T R A C T

In wood, moisture can be absorbed in the cell wall, protoplasm and cell cavities. The presence of moisture has a profound influence on the properties of wood. There is an increase in the strength and density of wood with reduction in moisture content. This is because of the shortening and consequent strengthening of the hydrogen bond linking the microfibrils together. *Erythropleum ivorense* had the least moisture content of 9.27% while *Spathodea campanulata* recorded the highest moisture content of 87.60%. It was observed from the graph in Figure 1A that, there was no two timbers with equal moisture contents, though, majority of the timbers had close moisture content values. The timber *Protea elliottii* with the least ODD (19.9 x10^{-2} g.cm^{-3}) had moisture content of 16.21% while *Erythrophleum Ivorense* with the highest ODD (108.7 x10^{-2} g.cm^{-3}) recorded the least moisture content of 9.27%. It was also observed that all the timbers with high ODD values had low moisture content values. Few high moisture content valued timbers were identified among the low ODD valued timbers. Though, few timbers with low moisture content values had low ODD values too. This may be due to their chemical compositions.

Introduction

The size of a tree also varies with the climate, the depth and type of soil in which it grow (Wood Encyclopaedia Britanica, 2011). Timbers are known as trees grown to be used in building or for making other things. It can be referred to as wood prepared for use in building or for making other things. Wood is the most important natural and endlessly renewable source of energy which has a major future role as an environmentally cost-effective alternative to burning fossils fuel (Larson, 1994). The major role of wood is not only the provision of energy but also the provision of energy-sufficient material for our buildings and many other products. In addition, developing wood cells represent one of the most important sinks for excess atmospheric CO_2, thereby reducing one of the major contributors to global warming Higuchi, 1997)

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). 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 Moisture content.

The amount of moisture present in wood varies appreciably in different circumstances, but the dry weight of wood substance in a given sample is constant. Hence, it is usual to express the variable-moisture content as a percentage of the constant dry weight of the sample (Feirer John 2000). The ratio is:

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

The most satisfactory method for determining the moisture content of timber samples is the oven-dry method ASTM D4442 (method A) (American Society for Testing and Materials 1999a), the moisture content of the sample is obtained as follows:

$$\text{Moisture content (\%)} = \frac{W_I - W_O \times 100}{W_O}$$

Where W_1 =Initial weight of each sample
Wo = Oven Dry weight of each sample

The initial weight of a sample is the actual weight at the time of test, and the dry weight is the weight of the sample after the moisture has been expelled [8]. In this work, three 2.5cm cubes of each timber sample, top loading balance, Make: Mettler Toledo, Model: PL 203 and drying oven that can be maintained at a constant temperature (105^{o}C) were used to determine the moisture content of wood (timber) sample. The samples initial weight (W_1) was first recorded before transferring them into the oven at the temperature of 105^{o}C. The samples were left in the oven overnight. After the heating, the samples were re-weighed (W_O) first thing on the following morning, and again some hours later, Rapidity of weighing is of importance when the samples are oven dry, as in this state, they will absorb moisture in very short space of time (Joao et al., 2009). Drying in an oven does not expel all the moisture, but the small discrepancy the last one percent or so is not of practical importance (Desch and Dinwoodie 1981).

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^{o}C. 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.

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

Results and Discussion

Figure 1A depicts the graph of moisture content of fifty-two timbers. Where the timber; *Erythropleum ivorense* had the least moisture content of 9.27% while *Spathodea campanulata* recorded the highest moisture content of 87.60%.

Figure 1B depicts the graph of moisture content against ODD. The timber *Protea elliottii* with the least ODD (19.9 $x10^{-2}$ $g.cm^{-3}$) had moisture content of 16.21% while *Erythrophleum Ivorense* with the highest ODD (108.7 $x10^{-2}$ $g.cm^{-3}$) recorded the least moisture content of 9.27%.

The timber; *Erythropleum ivorense* had the least moisture content of 9.27% while *Spathodea campanulata* recorded the highest moisture content of 87.60%. It was observed from the graph in Figure 1A that,

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
52.	Shanty				

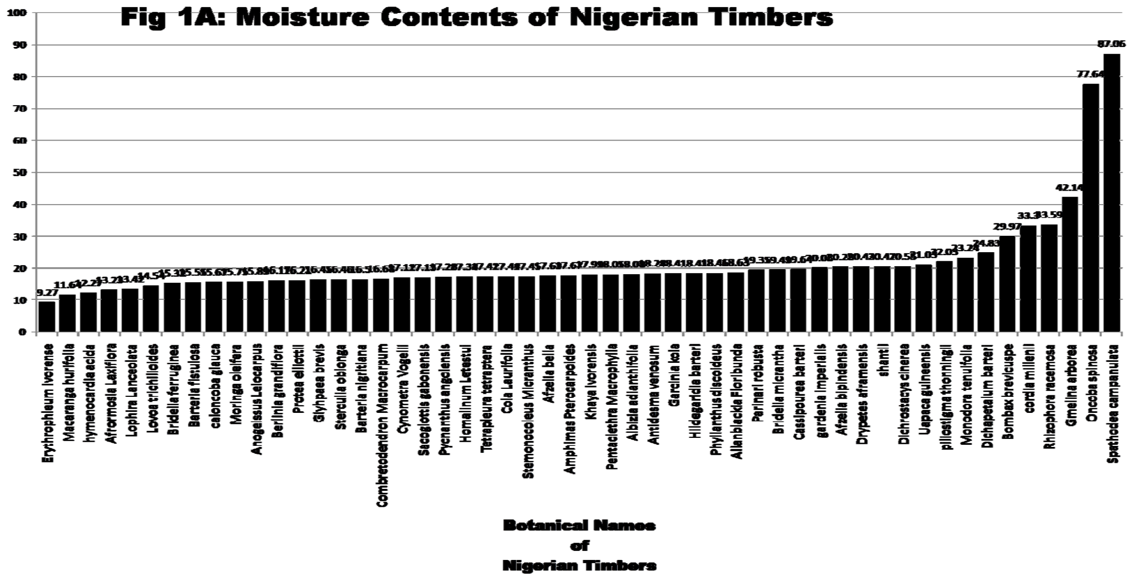
Fig 1A: Moisture Contents of Nigerian Timbers
Botanical Names
of
Nigerian Timbers

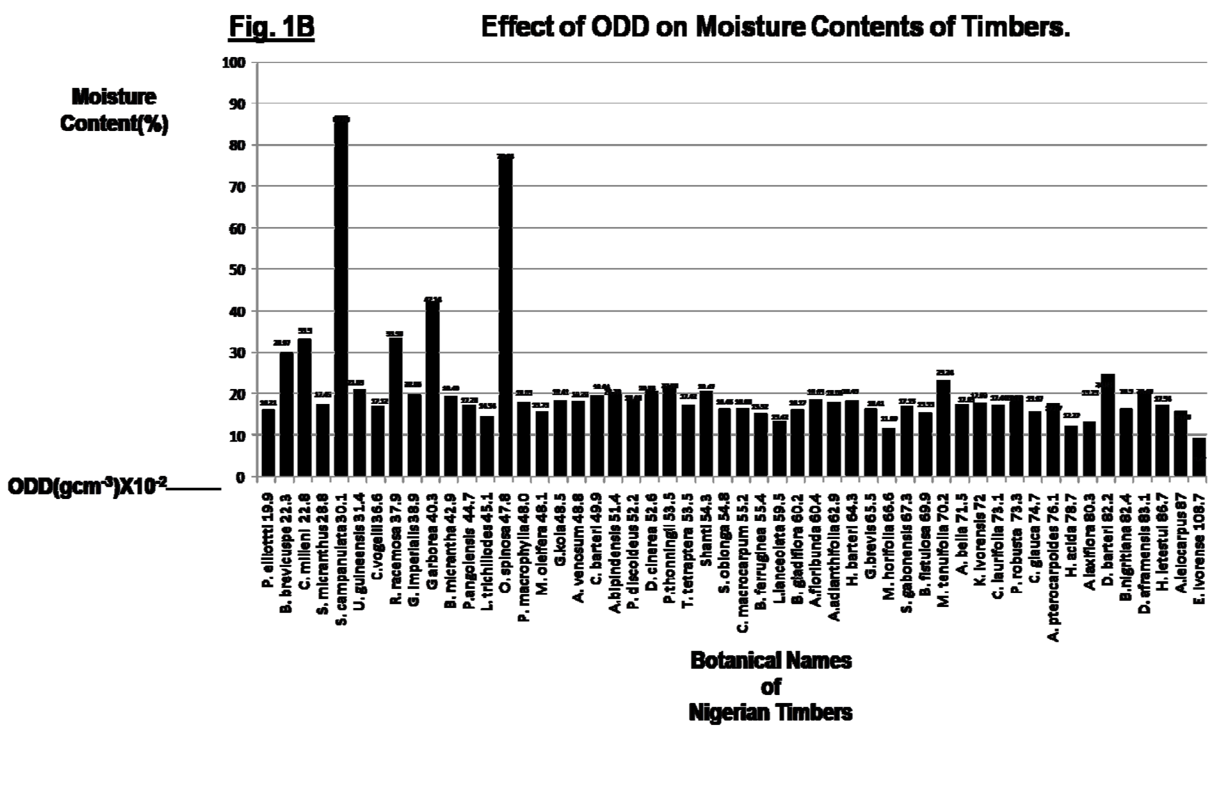
Fig. 1B
Effect of ODD on Moisture Contents of Timbers.
Moisture
Content(%)
ODD(gcm-3)X10-2
Botanical Names
of
Nigerian Timbers

there was no two timbers with equal moisture contents, though, majority of the timbers had close moisture content values. The timber *Protea elliottii* with the least ODD (19.9 $x10^{-2}$ $g.cm^{-3}$) had moisture content of 16.21% while *Erythrophleum Ivorense* with the highest ODD (108.7 $x10^{-2}$ $g.cm^{-3}$) recorded the least moisture content of 9.27%. From this work, two timbers with very high moisture content values when compared to others *Spathodea campanulata* (87.06%) and *Oncoba spinosa* (77.64%) had low ODD values of $30.1x10^{-2}g.cm^{-3}$ and $47.8g.cm^{-3}$ respectively. It was also observed that all the timbers with high ODD values had low moisture content values. Few high moisture content valued timbers were identified among the low ODD valued timbers. Though, few timbers with low moisture content values had low ODD values too. This may be due to their chemical compositions. From these results, one can state that in the absence of varied chemical composition of these timbers, those timbers with high ODDs would normally record low moisture content and those with low ODDs could also have high moisture contents. Therefore, there was an inverse relationship between moisture content and oven dry density of the fifty-two timbers analyzed. This is not surprising as timbers with high ODD are less porous than those with less ODD. Moisture or any liquid inclusions are accommodated in the pores and there exist a direct relationship between pores and moisture contents.

From the results in fig.1A and fig. 1B one can conclude that there was an inverse relationship between moisture content and oven dry density of the fifty-two timbers analyzed. This is not surprising as timbers with high ODD are less porous than those with less ODD. Moisture or any liquid inclusions are accommodated in the pores and there exist a direct relationship between pores and moisture contents.

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