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# Water Imbibition Assay of Fifty-Two Selected Nigerian Timbers

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**Abstract:** The effect of water imbibition (porosity index) on fifty-two selected Nigerian timbers was analyzed. The timber; *Erthrophleum ivorense* had the least water imbibition capacity of 7.2%, 10.0% and 15.4% at the stipulated times (0.5h, 5h & 24h) respectively. *Spathodea campanulata* with respective water imbibition capacity of 104.8%, 185.7% and 280.0% had the highest porosity index. From the results, *Protea elliottii*, after 0.5h and 5h water imbibitions had the highest porosity index of 136.6% and 198.4% respectively while *Spathodea companulata's* porosity index at the same time were 104.8% and 185.7% respectively. The porosity index of *Spathodea campanulata* increased to 280.0% after 24h water imbibition while that of *Protea elliotttii* increased to 253.3% after 24h. This showed that *Spathodea campunlata* has the capacity of absorbing water over a period of time more than other timbers. The results also revealed an inverse relationship between water imbibition (porosity index) and ODD of fifty-two selected Nigerian timbers.

**Key words:** Water imbibitions · Oven dry density · Nigerian timbers and Moisture contents

## INTRODUCTION

In woods, water constitutes a greater proportion by weight than the solid material itself. The water has a profound influence on the properties of wood, affecting its weight, strength, shrinkage and liability to attack by some insects and by fungi that cause stain or even decay [1].Water occurs in living wood in three conditions, namely:

- In the cell walls
- In the Protoplasmic content of the cells and
- As free water in the cell cavities and spaces.

In heartwood it occurs only in the first and last forms. Wood that is thoroughly air-dried retains from 8-16% of water in the cell walls and none, or practically none in the other forms. Even oven-dried wood retains a small percentage of moisture but for all except chemical purposes, may be considered absolutely dry [2]. The general effect of the water content upon the wood substance is to render it softer and pliable. A similar effect of common observation is in the softening action of water on paper or cloth. Within certain limits, the greater the water content, the greater it's softening effect. Drying produces a decided increase in the strength of wood, particularly in small specimens. An extreme example is the case of a completely dry space block 5cm in section, which will sustain a permanent load four times as great as that which a green (undried) block of the same size will support [3].

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 [4].

$$\text{The ratio is simply: } = \frac{\text{Weight (or Volume) of water present}}{\text{Dry weight of wood substance}} \times \frac{100}{1}$$

There are several ways of determining the moisture content of wood. The oven-dry method ASTM D4442 (method A) [5], the most satisfactory method for most purposes was used in this work.

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There is an increase in strength of wood with reduction in moisture content. This is because of the shortening and consequent strengthening of the hydrogen bond linking together the microfibrils [1 ] and [5].

## MATERIAL AND METHODS

**Sample Collection and Preparation:** The Fifty- two (52) timber samples were collected from Anambra, Enugu, Ebonyi, Imo, Delta, Edo, Cross River, Akwa Ibom, Abia, Oyo, Lagos, Kano, Sokoto and Rivers State, Nigeria. 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 botanical 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$^0$C for 24 h before the experiments.

**Determination of Water Imbibition:** Three cubic samples of each timber were used. They were numbered e.g. for sample 1 (1a, 1b, 1c), sample 2 (2a, 2b, 2c) etc. The numbered samples were put in a deep plastic bucket containing some water after taking their dry weight. A bowl containing a heavy load was placed on top of the samples to ensure that the dried cubic samples would not float and that they were properly covered by water. The samples were left in the bucket of water for 30 minutes, surface water dabbed out, after which they were re-weighed. The whole samples were again transferred into a fresh water and left for another 5h, after which they were re-weighed. The samples were finally transferred into a fresh water for 24h, thereafter they were re-weighed. Some of the sample did not show appreciable change in their weight after 5h immersion. Thus water imbibition of each timber sample at different times was determined. The average dry weight of the sample ($W_1$) and the average weight of a saturated cubic sample ($W_2$) were determined. Then the percentage of water imbibed by timber samples at different times was calculated, thus:

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

- $W_1$ – average dry weight of the samples
- $W_2$ – average weight of saturated sample

$$\text{For 30 minutes water imbibitions (\%)} = \frac{W_2 - W_1}{W_1} \times \frac{100}{1}$$

- $W_1$ – average dry weight of the sample
- $W_2$ – average weight of the sample after 30 minutes of being immersed in water.

The same was calculated for 5h and 24h respectively.

## RESULTS

| S.No | Botanical Names | Igbo Names | Yoruba Names | Hausa Names | Areas of Location in Nigeria |
|---|---|---|---|---|---|
| 1. | Monodora tenuifolia | eburu 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 | kimi | Calabar, Ikom |
| 18. | Bridelia ferruginea | ola | ira odan | kimi and kizini | Onitsha, Awka |
| 19. | Uapaca guineensis | Obia | abo-emido | wawan kurmi | Onitsha |
| 20. | Antidesma venosum | okoloto | aroro | kimi | Onitsha, Udi |
| 21. | Parinari robusta | ohaha-uji | idofun | kasha-kaaji | Onitsha |
| 22. | Cynometra vogelii | ubeze | arumutaba | 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 | kimi | 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. | Phyllanthas discoideus | isinkpi | ashasha | baushe | Enugu, Ikom |
| 40. | Gardenia imperialis | uli | oroto | karandafi | Jos |
| 41. | Macaranga harifolia | awarowa | ohaha | | Awka |
| 42. | Sacoglottis gabonensis | nche | atala | chediya | Rivers |
| 43. | Cassipourea barteri | itobo | odu | daniya | Eket |
| 44. | Combretodendron macrocarpam | anwushi | akasun | | Udi, Owerri |
| 45. | Lophira lanceolata | okopia | ipeshon | namijin kadai | Udi |
| 46. | Homalinum letestui | akpurukwu | 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 | | |

## DISCUSSION

Figure 1, represent the graph of water imbibition of fifty-two Nigerian timbers at different times; 0.5hours, 5hours and 24hours. The porosity indices of these timbers were represented in their increasing order of magnitude. The timber; *Erthrophleum ivorense* had the least water imbibition capacity of 7.2%, 10.0% and 15.4% at the

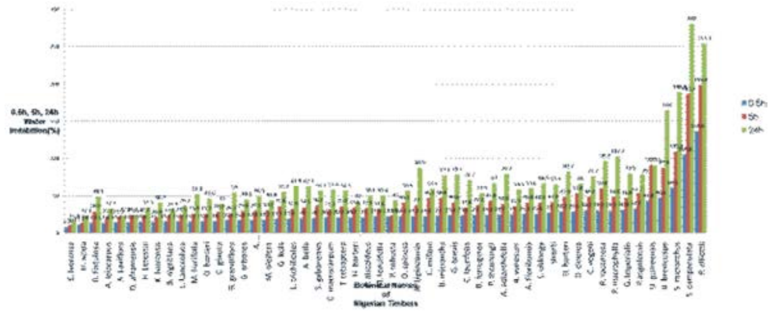


Fig 1: Effect of Soaking Time on Water Imbibition by the Timbers

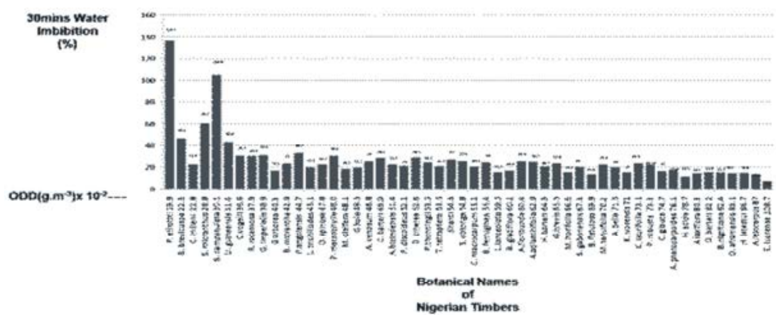


Fig 2: 30 Mins Water Imbibitions Against ODD

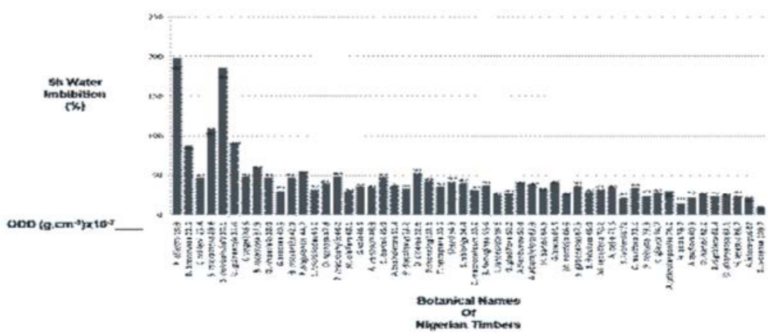


Fig 3: 5hrs Water Imbibitions Against ODD

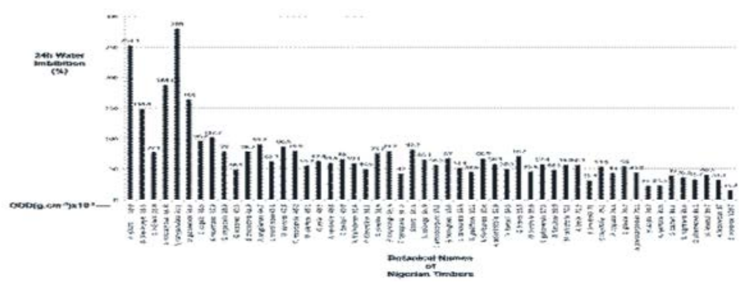

Fig 4: 24h Water Imbibition Against ODD

stipulated times (0.5h, 5h & 24h) respectively. *Spathodea campanulata* with respective water imbibition capacity of 104.8%, 185.7% and 280.0% had the highest porosity index. From the graph, *Protea elliottii*, after 0.5h and 5h water imbibitions had the highest porosity index of 136.6% and 198.4% respectively while *Spathodea companulata's* porosity index at the same time were 104.8% and 185.7% respectively. The porosity index of *Spathodea campanulata* increased to 280.0% after 24h water imbibition while that of *Protea elliotttii* increased to 253.3% after 24h. This shows that *Spathodea campunlata* has the capacity of absorbing water over a period of time more than other timbers. Therefore, it has the highest porosity index. There are some other timbers represented in the graph with similar capacity when compared with those around them.

Figures 2, 3 and 4 showed the graph of 0.5h, 5h and 24h on water imbibitions against oven dry densities respectively. Figure 2 revealed that *P. elliottii* with the least ODD (19.9 $\times10^{-2}$g.cm$^{-3}$) recorded the highest porosity index (132.6%) while *E. ivorense* with the highest ODD (108.7 $\times10^{-2}$g.cm$^{-3}$) had the least porosity index (7.2%). From the graph, few timbers with high porosity index had low ODD. Also, there was reduction in the porosity index as the ODD increases. Figure 3 also reveals that *P. elliottii* with the highest porosity index of 198.4% after 5h imbibitions while *E. ivorense* with the highest ODD still exhibit the least porosity index of 10%. This depicts an inverse relationship between Porosity index and ODD. Figure 4 also reveals that *E. ivorense* with the highest ODD (108.7 $\times10^{-2}$ g.cm$^{-3}$) still possesses the least porosity index of 15.4% after 24h water imbibition. The timber; *S. campanulata* with ODD of 30.1 $\times10^{-2}$ g.cm$^{-3}$ had the highest porosity index (280.0%) while *P. elliottii* with the least ODD (19.9 $\times10^{-2}$ g.cm$^{3}$) had second to the highest porosity index (253.3%). It also shows that, all the timbers with low ODD exhibited high porosity index while those with high ODD exhibited low porosity index. Therefore, the graph of 24h water imbibition or porosity index against ODD of fifty-two Nigerian timbers confirmed the inverse relationship between the porosity index and ODD of the timbers.

## CONCLUSION

In conclusion, an inverse relationship exists between water imbibition (porosity index) and ODD of fifty-two selected Nigerian timbers as shown in figures 1, 2, 3 and 4.

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