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Assessment of the Differences in Drying Rates of Open Air and Shed Methods using Three Selected Nigerian Wood Species

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ABSTRACT

Differences in drying rates of open air and shed methods using three selected Nigerian wood species was examined. The samples of the three wood species (Brachystegia eurycoma, Trichilia emetica and Cordia millenii) were collected from freshly sawn logs from a sawmill in Akure' Nigeria for evaluation. They were processed into 300 mm (length) × 100 mm (breadth) × 100 mm (thickness) blocks, weighed and stocked in each of the drying medium for rate of drying assessment. The results of the study indicated that Brachystegia eurycoma, dried from 41% and 40.5% to 24.2% and 20.8%, Trichilia emetica dried from 38.5% and 36.5% to 19.1 % and 18.3% while Cordia milenii dried from 38.1% and 37.9% to 17% and 16.1%, respectively for open air and shed methods after 21 days of drying. The density of the wood species as obtained from literature influenced the drying rate. There was significant difference (p<0.05) between open air and shed methods in the drying of the three wood species. For the reason of wood protection and rapid drying, the shed method will be preferred for wood drying.

Keywords: Drying, Moisture Content, Density, Temperature, Wood Species

INTRODUCTION

Drying if undertaken promptly after wood conversion protects timber against decay, fungal infestation and insect attack. Wood destroying agents which cause decay and stain etc. generally cannot thrive in timber with moisture content below 20% (Amouzgar, 2010). Moisture content below 20% is generally acceptable for durable wood under different climatic regions. Some insect pests can thrive only in green timber. Dried wood is less susceptible to decay than green wood which is above 20 % moisture (Deacon, 2005). Air drying is the method of reducing the moisture of timber by exposing it to the ambient weather conditions. This technique consists mainly of making a stack of sawn timber with the layers of boards separated by stickers placed on raised foundations, in a clean and dry place. Rate of drying largely depends on climatic conditions and the air movement. For successful air drying, a uniform and continuous flow of air throughout the pile of the timber is necessary (Desch and Dinwoodie, 1996).

The rate of loss of moisture can be controlled by coating the planks with any substance that is relatively impermeable to moisture; such as mineral oil (Oduor, 2011). Coating the ends of logs with oil or thick paint also improves wood quality after drying. Wrapping planks or logs in materials which will allow some movement of moisture is effective in wood drying provided the wood is first treated against fungal infection by coating in petrol/gasoline or mineral oil. Mineral oil (a byproduct of petroleum) will generally not get wood soaked by water in more than 1–2 mm below the surface and is easily removed by planning when the timber is suitably dry (Rizvi et al., 2000). It can be less expensive to use natural drying method (there are still costs associated with storing the wood and with the slower process of getting the wood to market). The drying rate of wood differs due to the amount of moisture content present in each wood cell. Hardwood is said to be more complex than softwood species, due to the presence of vessel in the hardwood cell wall which is absent in softwood species and is discovered to require more drying period (Desch and Dinwoodie, 1996). The structural composition of wood and variation in the physical properties of different wood species are the reason for different seasoning period. All wood species has different tendency to dry when exposed to a particular drying phenomenon (Hoadley, 2000).

It is important to dry wood before subjecting it to any use in order to limit dimensional changes to drying process only (Pang, 2007). There are various drying procedures which have been practiced over the years and the drying rate of these techniques differs from one another. Some have been discovered to be faster than the others during the process of subjecting the wood to drying. The cost of installation of the equipment for the artificial drying techniques are very expensive e.g. Kiln dryer (Keey et al., 2000). Kiln drying is a more reliable means of drying techniques but when considering the cost required for installation of the equipment, it is highly expensive and may not be affordable in local community. Upgrading the effectiveness of air drying (natural drying) is a cost saving approach compare to kiln drying.

MATERIALS AND METHODS

The study area

Wood samples for this study were sourced from a sawmill along Orita-Obele juncture in Akure, Ondo State, Nigeria. Samples were collected from freshly sawn logs of *Brachystegia eurycoma, Trichilia emetica and Cordia millenii* for evaluation. The wood samples were exposed to the drying media at Department of

Forestry and Wood Technology, Wood Workshop, Federal University of Technology, Akure, Nigeria. The workshop is located on Longitude 005.14889°N and Latitude 07.29264°E. The site area allows for free flow of air because of the need for air circulation to facilitate the drying of the wood samples. The soil of the area was well drained and the vegetation of the area was cleared to prevent hindrances. This experiment was carried out between period of April and May, 2011. The density ranges of the three wood species were obtained from previous research by Owoyemi et al., (2013).

Sample collection and preparation

Samples were sawn to 300 mm (length) × 100 mm (breadth) × 100 mm (thickness). The initial moisture content was determined by drying 20 mm x20 mm x 60 mm samples in an oven for 24 hours at 105°C until the weight became constant. The remaining fresh samples were taken to the media for drying over a period of 21 days. The samples were removed after 21 days of drying and another 30 mm was cut from each samples and weighed to get the final weight at oven dried state. Cemented floor was used as a platform for stack in the open air method while the drying shed method was covered with black polythene sheet due to its ability to attract heat and a wooden platform was used for the stack. Densities of the three wood species were obtained from literature. The moisture content was calculated using the initial weight and the final weight. The moisture content of the three wood species at open air and shed methods was compared, to know the effect of temperature, density and differences in the rate of drying of the media on the wood samples. Temperature readings were taken three times a day throughout the drying period to determine the average daily temperature for both media. The moisture content of the wood was calculated according to Siau, (1984):

$$MC = \frac{Mg \quad Mod}{Mod} \times 100\%$$

Where: MC = percentage of moisture content; Mg = Green mass of the wood; Mod = Oven dry mass of the wood

The experimental design was a 2 × 3 factorial experiment arranged in randomized complete block design. Data collected was initially processed using Microsoft Excel. Descriptive statistics and Analysis of variance (ANOVA) was undertaken using SPSS (Statistical package for social science) to test for significant difference between the treatment combinations.

Results

The open air method of drying showed a decrease in percentage moisture content (MC) for *Brachystegia eurycoma* from 41.0 to 16.2%, *Trichilia emetica* 38.5 to 17.1% and *Cordia milenii* 38.1 to 17.1% for initial and final MC respectively for 21 days period while the shed method showed a decrease from 40.5 to 17.8% for *Brachystegia eurycoma,* 36.5 to 17.0% for *Trichilia emetica* and 37.9 to 17.1% for *Cordia milenii* for initial and final MC respectively revealing the suitability of the two media for wood drying (Table 1). The analysis of variance and descriptive statistic showed that there was a significance difference between the open air and shed methods of drying (Table 2). The results of mean separation showed that attainable MC was significantly different between *Brachystegia eurycoma, Trichilia emetica and Cordia milenii.*

Table 1: Mean values for initial and final moisture content of the wood species.

Source of variation		*Brachystegia eurycoma*	*Trichilia emetica*	*Cordia millenii*
Open air (M.C %)	Initial mean	41.0	38.5	38.1
	Final mean	16.2	17.1	17.0
Shed method (M.C %)	Initial mean	40.5	36.5	37.9
	Final mean	17.8	17.0	17.1

Table 2: Mean values showing differences between drying methods and wood species

Source of Variation		Moisture Content (Mean + Std.)
Drying Method	Open Air	20.10 ± 3.63ᵃ
	Shed Method	18.40 ± 2.28ᵇ
Wood Species	*Brachystegia eurycoma*	22.5 ± 2.10ᵃ
	Trichilia emetic	18.70 ± 1.16ᵇ
	Cordia milenii	16.55 ± 2.21ᶜ

Mean with different letters are significantly different ($P < 0.05$)

The mean temperature reading for open air and shed methods shown in Figure 1 revealed that temperature readings were higher for the shed method than for the open air method.

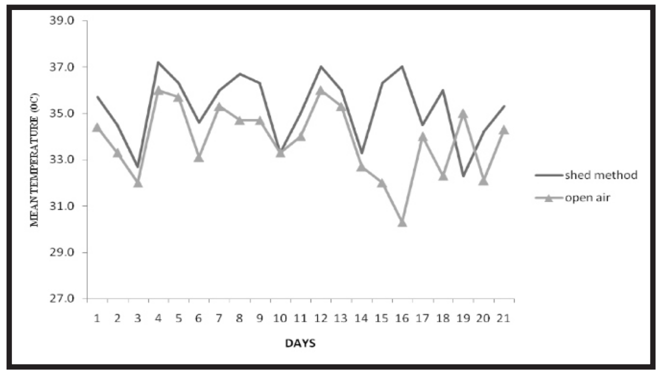

Figure 1: Mean temperatures of the shed and open air method during the drying periods

The effect of density on the drying pattern of the three wood species (Figures 2 and 3) showed a strong correlation between density and attainable MC meaning higher density wood dried faster than low density wood.. Linear regression equation showed relationship between the three wood species densities and the rate of drying for open air and shed method (Figures 2 and 3). Lower density wood dry faster while high density wood dry slower.

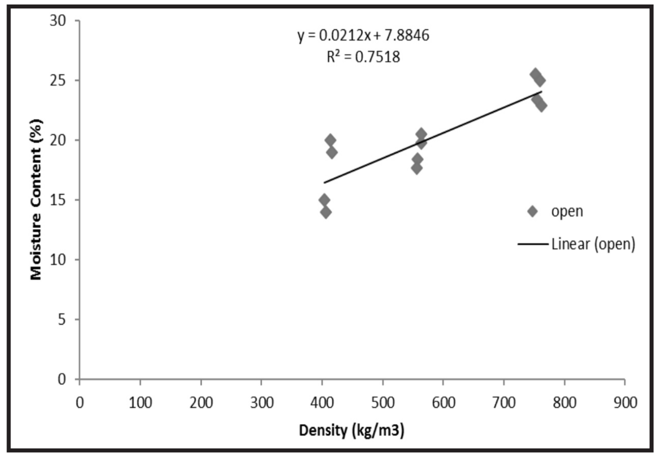

Figure 2: Effect of wood density on final moisture content in open air method

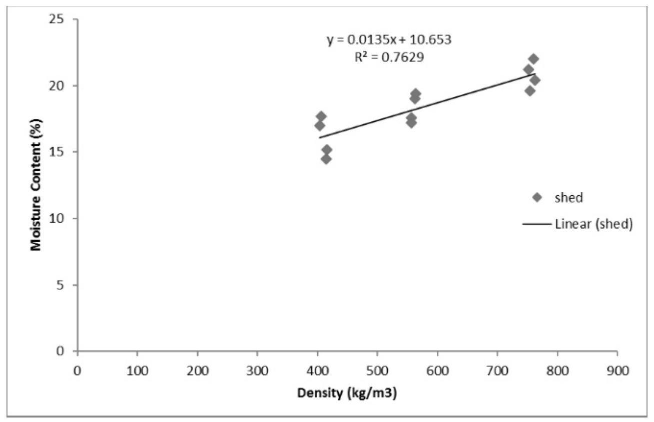

Figure 3: Effect of wood density on final moisture content in shed method

Discussion

Wood is a hygroscopic material which absorbs and desorbs moisture until it attains equilibrium moisture content with the environment. Open air and shed methods of drying rely on the prevalent weather conditioning during drying. The lowest initial moisture content recorded was 36.5% for *Trichilia emetica* while the highest initial MC% recorded was 41% for *Brachystegia eurycoma.* The lowest final moisture content recorded was 16.1% for *Cordia millenii* while the highest final M.C% recorded was 24.2% for Brachystegia eurycoma. *Brachystegia eurycoma* have the lowest drying rate in both drying media as the final moisture content was higher than *Cordia millenii* and *Trichilia emetica.* There was significant difference in the moisture content attained by wood samples in the open air and shed methods with 20.10% and 18.40%, respectively at 95% probability level. The faster drying rate observed in the drying shed covered with black polythene sheet could be attributed to the higher temperature attained by the shed throughout the drying period. This was pointed out by Desch and Dinwoodie (1996) that temperature is a factor of importance to drying rate of wood species.

The result of mean daily temperature for open air and shed methods during the period of the study (April/May) presented in figure 1 showed mean daily temperature was higher in the drying shed compared to the open air. The differences in the daily mean temperature of each medium affected the drying rate of the samples because the black polythene sheet covering absorbed heat from the sun which raised the temperature under the shed. The temperature recorded under the shed method was higher than the temperature recorded in open air medium. Early work done by Hills, (1984) found out that low temperature affect the drying rate as it was found under the open air method.

Variation in density of the wood species was observed to affect the drying rates and the final moisture content attained. The wood species could be classified into three major density classes using the density values of the species to high, medium or low density as reported by Owoyemi et al, (2013). *Brachystegia eurycoma* falls within the higher density range with a mean density of 757 kg/m3, *Trichilia emetica* in the medium density of 560 kg/m3 and *Cordia milenii* in the low density of 410 kg/m3, Owoyemi et al., (2013). As shown in Figures 2 and 3 for the final moisture content for both open air and shed methods with a very strong R^2 values of 0.75 and 0.76 for open air and shed methods. Wood density was found to influence the final moisture content attained. The strong R^2 value shows that 75% of the total variance in equation Y is explained by the linear regression model for open air while 76% of the total variance in equation Y is explained in linear regression model for shed method. The strong value of R^2 i.e. value closer to 1.0 which is a help of perfect prediction of Y, which means that the regression equation is valid for open air and shed method and a prove that there is a relationship between wood density and drying rate. *Brachystegia eurycoma,* a high density wood had slower drying rate resulting to a final moisture content of 24.2% and 20.8% compared to those in medium and lower density range. This agrees with the study conducted by Kiona et al, (2013) asserting that drying rate is faster in low density species. Therefore, the higher the density, the slower the drying rate i.e. density is attributed to drying rate (Desch and Dinwoodie, 1996). Drying rate was observed to be faster with *Cordia millenii* and significantly different from B*rachystegia eurycoma and Trichilia emetica* because the wood was in low density group.

CONCLUSION

A comparison of open air and shed method showed that the shed method could be used where there are no facilities of wood drying as it produced an improved result. The open air method exposes the stack to rain, dew and sun which is a major disadvantage. Therefore, shed method is preferable in the drying of sawn timbers. It can also serve as a pre-drying method to condition the wood stack prior to loading into the kiln. This will reduce energy consumption and drying time in the artificial system of drying by reducing the schedule period. Cordia millenii was observed to dry faster than other species as a result of low density. This showed that wood density should also be taken into consideration as a determinant of performance during drying process.

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