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Effect of Age on the Natural Resistance of *Gmelina arborea* (Roxb) Wood to Subterranean Termites' Attack.

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Abstract

This study examined the natural resistance of *Gmelina arborea* wood to termites' attack. Untreated *Gmelina* wood of ages 10, 15, 20 and 25 years respectively were exposed to termites at the timber graveyard. Visual examination according to American Society for Testing Materials was carried out for a period of 18months. The result showed that *Gmelina arborea* wood attained a visual rating of 3.5 and 2.8 for ages 25 and 20years in the 18th month, 15-year old wood attained a visual rating of 0 at the 18th month while the 10-year old wood attained a rating of 0 at the 12th month. This result showed that the visual rating for the ages examined were tending towards zero or completely failed before the 18th month. The result indicated that *Gmelina arborea* wood is not naturally resistant to termites. However, the study revealed the effect of age (maturity) on the ability of the wood to withstand attack. It is therefore necessary that *Gmelina arborea* wood be treated with preservative irrespective of the age at which it is procured to extend its service life beyond the level of its natural durability.

Keywords: *Gmelina arborea*, age, termites, durability, natural resistance.

Introduction

Wood as a material of biological origin goes through bio-chemical transformation as a growing tree from sapwood to heartwood leading to stiffening of the wood structure and inclusion of chemical compounds called extractives which impregnate cell walls leaking the wood nature and increases its to decay and insects. According to Jim and Ruth (1998), the presence of extractives in wood increases its natural resistance and that domestic woods are classified as highly durable, moderately durable and slightly durable or non-durable. Many types of wood have their own natural defence deference's against insects and other pest species. This is especially true in tropical environments because there is no frost to keep pest population down (Beal *et al*, 1974). Rachael *et al*, (2006) asserted that one goal of wood preservation industry should be to exploit the natural defence mechanisms of durable wood species.

Gmelina arborea belongs to the family Verbanaceae and was introduced to Nigeria from Burma, India. The first plantation of the species was established in Enugu in 1921 to provide pit props for coal scams. The potentials of *Gmelina arborea* wood for pulp and paper production led to increase in plantation establishment in the South-western Nigeria. It was established to serve as raw material for pulp and paper production between the ages of 7 – 8years. Today, the objectives of those early *Gmelina* plantations have drastically changed on realization that the species can grow to big exploitable timber size of 24.3m high and 1.52m in girth at breast height (FPRR, 1965). Previous studies by Ifebueme et al, (1990) have shown that *Gmelina* wood is straw yellow to creamy white. The sapwood appears slight grayish than the heartwood. Thus, there is only a slight difference between the sapwood and the heartwood. The wood is of medium density averaging about 474kg/m^3. The texture is fine to medium with mostly straight grain. The suitability of *Gmelina* wood for furniture and other forms of constructions has been reported in a previous study by Fuwape and Owoyemi, (1998).

Insects constitute tremendous hazards to forest trees and wood in service. Onyekwelu (2001) reported that insects are the most widespread among the agents of destruction that had been reported to destroy *Gmelina arborea* plantations in some parts of the world. From the standpoint of structural design, termite is of serious concern when compared to other wood destroying insects like powder-post beetles and carpenter ants (Walters 1981). Termite has become very prominent and of great economic importance among other wood destroying agents as a result of its destructive nature. The scourge of termite infestation of wood is most popular in the tropics. Chemical preservatives have been used to combat the increasing damage caused by termites. In recent times their use has been discouraged as a result of the effect they have on the environment in general. There is need to use wood that are naturally resistant to termites to make them last longer in service.

The term 'natural durability' refers to the degree of resistance of wood to bio-deteriorating agents. The natural durability of wood can only be appreciated through adequate knowledge of physiological processes of tree growth. As trees get older and larger, the storage cells in the centre at the bottom begin to die resulting to a gradual transformation of the sapwood region to heartwood. Trees with more toxic natural chemicals deposited during the transformation have very durable heartwood that is highly resistant while some may be moderately resistant and others have no resistance to insect attack. The degree of natural resistance of some age series of *Gmelina arborea* wood to subterranean termites was examined in this study.

Materials and Methods:

Materials for this study were freshly sawn *Gmelina arborea* wood obtained from Ondo State Afforestation Project, Lisagbede. *Gmelina arborea* wood of ages 10, 15, 20 and 25years respectively were randomly selected. Each of the sample plots were located 20m from the boundary to avoid edge effect. One tree was felled in each of the plots according to their ages and billets of 1200mm in length were cut close to the base of the sampled trees. Ten stakes of 35 × 35 × 450mm were cut from each billet and dried in the oven to constant moisture content at 100^{o}C for 24 hrs. The dried samples were conditioned at room temperature for 24 hrs before the field exposure test.

Field Test:

The field exposure test was carried out at the timber graveyard site at the Federal university of Technology Akure, Nigeria (Lat 7^{o}17'N, Long 5^{o}10'E) in the tropical forest zone. Mean annual temperature; 20^{o}C, elevation; 350 m, relative humidity; 85 – 100% during raining season and 60% during harmattan period. The wooden stakes grouped according to age classes were pegged 225 mm below the ground level for termite attack evaluation. The soil of the study area is classified as ferruginous tropical soil (Alfisol) on crystalline rock of basement complex. The soil belongs to the Egbeda series; (Smyth and Montgomery, (1962). Visual estimation of the stakes were done monthly and rated as specified in ASTM D 3345 – 74 standards below:

10 = Sound, surface nibbles permitted.
9 = Light attack
7 = Moderate attack penetration
4 = Heavy attack, 30 – 40% of the wood cross-section eaten up by termites
0 = Failures, over 50% of the wood cross-section eaten up by termites

The field test was terminated after 18 months when a total failure was noticed. The mean visual rating was taken and the data subjected to analysis of variance (RCBD). Mean differences was done with Duncan Multiple Range Test where significant difference existed.

Results and Discussion:

The natural resistance test of *Gmelina arborea* wood to termites' attack showed that the 25 years old wood samples recorded the highest mean visual rating of 7.92, 20 years old recorded 6.80, 15 years old had 5.08, while the 10 years old samples had 3.12 for the 18 months period of exposure at the timber grave yard (Table 1). The trend of this result revealed the influence of age (maturity) of *Gmelina arborea* wood on its natural resistance to termites attack. There is a significant difference ($p<0.05$) in the mean visual rating across the age series of *Gmelina arborea* wood. The experiment was terminated at the 18th month as all the samples had their visual rating tending toward 0. There also existed a significant difference in the visual

rating of the wood sample at every interval of 3 months. Since the highest visual rating of the samples lies between 9.88 and 6.83, it shows that the natural resistance of *Gmelina* wood to termites could only last between 3-9 months.

The age series of *Gmelina arborea* wood that falls within this range is between 20-25years (Figure 1.) Result in Table 2 shows the mean exposure period of *Gmelina* wood. This result revealed that at 3 months, *Gmelina* wood were sound with little or no surface nibbles on the samples. At 6 months termites' attack on the wood samples were gradually approaching 8 on ASTM scale signifying a moderate attack, penetration and degradation of the wood samples.

At the ninth month, *Gmelina* wood samples had recorded mean rating of 6.83 moving from moderate attack to heavy attack with between 30 and 40% of the wood cross – section eaten up by termites proving that its natural resistance could not go beyond 6 months of exposure.

From these results it could be inferred that *Gmelina arborea* wood is not naturally resistant to the attack of subterranean termites. As trees grow older, it is expected that the extractives content increase. Wood extractives contain both the organic and inorganic components. Miller (1999) and Rowell *et al.* (2005) stated that the organic components of extractive influence some wood properties such as color, odor, taste, decay resistance, density, hygroscopicity, and flammability.

The effect of the extractives on natural resistance wood could be noticed in the age series of *Gmelina arborea* wood, although they were not significantly different. On the average, the wood could be completely attacked by termites within 12 months. This indicates that *Gmelina arborea* wood did not contain a toxic extractive strong enough to resist termite attack for a relatively long period of time. Thus, it could be classified as perishable (Wilkinson 1979) - wood species with expected service life between 0-5 years. Although there is a significant difference in the visual rating especially with 25-year old wood, its expected service life is very minimal. To extend its expected service life beyond this level, a preservative treatment becomes necessary. *Gmelina arborea* wood should be allowed to reach the minimum age of 25 years before harvesting for timber to ensure that matured wood is used for construction and to ensure a minimum level of natural resistance.

Conclusion

The prevalence of termites' attack in the tropical rainforest zone has made it of utmost importance to examine the natural resistance of wood species and the need for preservative treatment to extend their service life. This study has shown that age is an important factor in natural durability. As trees grow older, they tend to produce chemical extractives which could provide a natural resistance against termite attack. Furthermore, this study has shown that the natural extractives in the age series of *Gmelina arborea* wood do not provide a sufficient protection against termite attack. One the average, *Gmelina* wood could only last between 3 – 6 months in service. There is the need therefore to use chemical preservatives or that the wood is modified to improve its resistance to termite attack to for its safe use and longer service life.

Table 1: Mean ASTM Rating of the age series off Gmelina arborea wood to subterranean termites

Age series of *Gmelina* wood	**Mean ASTM Visual Ratings**
25years	7.92 ± 0.26^{a}
20years	6.80 ± 0.28^{ab}
15years	5.08 ± 0.33^{c}
10years	3.12 ± 0.33^{cd}

*Means with the same alphabets are not significantly different (p>0.05)

Table 2: Mean ASTM values of the period of exposure of *Gmelina arborea* wood to subterranean termites.

Period of Exposure to Termites	Mean ASTM Visual Ratings
3months	9.88 ± 0.09^{a}
6months	8.40 ± 0.33^{ab}
9months	6.83 ± 0.41^{bc}
12months	4.60 ± 0.47^{cd}
15months	3.10 ± 0.44^{de}
18months	1.58 ± 0.34^{e}

*Means with the same alphabets are not significantly different (p>0.05)

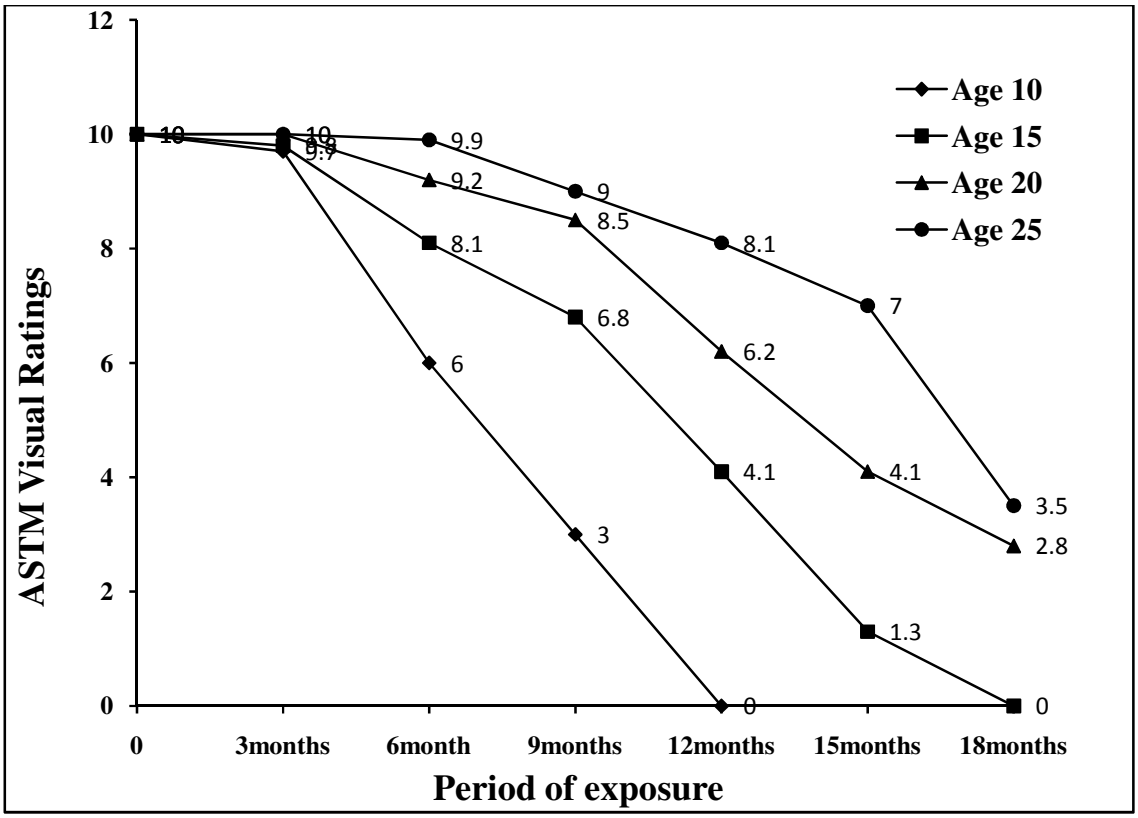

Figure 1: ASTM visual ratings of Age series of *Gmelina arborea* wood to subterranean termites

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