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Efficacy of Various Wood Preservatives against Subterranean Termites using Different Method of Application in Lafia Nasarawa State

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Abstract

In Lafia, Nasarawa State, untested wood preservatives and untreated wood use contribute to termite-induced structural failure. This study evaluated the efficacy of termiticide (Termiguard®), fire retardant, and neem extract on Mahogany (Khaya spp.), Gmelina arborea, and Tectona grandis against subterranean termites, aiming to guide foresters, builders, and homeowners. Using a 5 x 4 x 4 factorial experiment in a Completely Randomised Design (CRD) with 80 samples (4 treatments, 5 replicates), wood samples (4 x 4 x 40 cm, 10–12% moisture) were treated via brushing, spraying, soaking (0.5, 1.0, 1.5 g/640 cm^3 in 20 ml acetone; Termiguard® at 5 ml/640 cm^3), or control (acetone only). Samples were exposed out at the timber graveyard and the termitaria testing sites within the horticultural garden of the College of Agricultural Science and Technology, Lafia, Nasarawa State. (20 cm depth), weighed monthly over three months, and rated for damage (5 = sound, 1 = failure). Analysis of Variance (ANOVA) revealed a significant effect (P = 0.0190) for Tectona grandis with Termiguard® in Month 1, indicating soaking or spraying enhances initial efficacy. No significant differences (P > 0.05) were found for other treatments, suggesting wood species and preservative type outweigh application method. Cost-effective brushing or spraying is recommended for Lafia's tropical climate, providing baseline data for sustainable wood protection.

Keywords: Wood preservatives, subterranean termites, Preservative efficacy, Application methods.

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INTRODUCTION

Wood is a biodegradable and versatile building material that needs protection from degrading factors, such as insects, decay, and fire (Michael et al., 2003). Throughout the course of history, wood has remained one of the most important renewable natural resources available to mankind, owing to its several plus properties, such as excellent strength-to-weight ratio properties, relatively low price and low tooling cost, all of which render it desirable for a broad variety of applications (Emmanuel and Owoyemi, 2018; González-Laredo et al., 2015; Hingston et al., 2001). On the other hand, one of the major objections to the use of wood from most tree species for specific purposes such as in outdoor applications is related to their low resistance to the natural processes of degradation (Hill, 2006; Yalinkilic, 1999). Although some indigenous tropical wood species are naturally durable to biodeteriorating agents, they are in short supply, leading to the influx of a wide variety of lesser-used/durable and fast-grown plantation timber species requiring adequate protection (Emmanuel and

Owoyemi, 2018).

The agents causing the deterioration and destruction of wood fall into two categories: biotic (biological) and abiotic (non-biological) agents. Biotic agents include decay and mould fungi, bacteria and insects (Owoyemi et al., 2009). Abiotic agents include sun, wind and water (which together with soft rot fungi cause weathering), certain chemicals and fire. Apart from termites, which are of major concern to wood users, wood decay fungi are also of economic importance because of their devastating effects leading to structural failure. The most important pests of wood and wood products include termites, carpenter ants, and various beetles. The occurrence and spread of wood bio-deteriorating agents such as the subterranean termites have led to serious damage to wood products in service, and these have been a serious concern for wood users and foresters.Termites destroy wood by feeding on its structural components, with cellulose being their principal food, thereby reducing its structural ability and appearance. This implies that wood and wood products such as paper, fabrics and wood structures are avidly consumed, and hence, a constant effort is directed towards their control or prevention (Brossard et al., 2007; Peralta et al. 2004).

Termites are the most serious insect pest of logs at homes. Termites eat wood and thus can cause major structural damage. Termites either live in the wood they are eating (dry wood or damp wood termites) or in the soil in the vicinity of the house they are infesting (subterranean termites) (Burgess et al., 2006). Termites are social insects living in colonies. They play an important role in many ecosystems. Termites decompose wood and other cellulose-based materials, physically redistribute soil materials modifying soil profiles, and recycle organic matter and nutrients (Umeh, 2003). Termites can be divided into three general categories based on their habitat: damp wood, dry wood and subterranean termites (Paul and Rueben, 2005). According to Paul and Rueben (2005), damp wood termites do not present widespread pest problems but can be problematic under certain conditions; dry wood termites are significant and costly pests, while the subterranean termites are the major urban pests. Currently, there are more than 2,600 identified termite species in 281 genera worldwide (Kambhampati and Eggleton, 2000). Engel and Krishna (2004) grouped termites into 6 families, 170 genera and about 2,600 species, of which 300 species are said to be of economic importance.

Essential oils from herbaceous plants have been used most often in the food industry as flavouring, the cosmetics industry as fragrance, and the pharmaceutical industry for their functional properties. Essential oils are now being evaluated as fungitoxic and insecticidal wood protectants. Research on the antifungal and insecticidal properties of essential oils from woody plants, such as neem, juniper, cypress, melaleuca, eucalyptus, or yellow cedar (Park and Shin 2005; Sim et al., 2006; Yi et al., 2006), has sharply increased as environmental concerns about commercial wood preservatives have initiated interest in “green” preservatives. Several herbaceous plant essential oils have been reported to possess inhibitory properties against mould and decay fungi (Yang and Clausen 2006; 2007; Kartal et al., 2006; Shujun et al., 2007; Karic et al., 2006) and subterranean termites (Chang and Cheng 2002; Zhu et al., 2003; Raina et al., 2007). Utilising essential oils as wood preservatives causes concern over innately variable bioactivity that is likely to occur in any natural product, such as a plant extract. Bioactivity of plant extracts can vary greatly because of variability in chemical composition of plant oil, which is dependent largely on the part of the plant that is extracted, the time of year the plant is harvested, climatic and soil variations and the portion of the plant that is extracted.

The interaction of termites with man arises as a result of man’s interference with the natural food supply of termites and with their environment (Edwards and Mill, 1986). However, since their food supply is mainly wood and woody tissues of plants, they do come into direct competition with man, resulting in great loss of properties and amenities. Therefore, in outdoor applications, in order to arrest this destructive situation and reduce the loss incurred in terms of money and materials, a form of preservative treatment must be given, which are chemical preservatives in most general cases to prevent damage by these aggressive biodeteriorating agents (Evans, 2002; Schultz and Nicholas, 2002; Craig et al., 2001). Wood remains a vital construction material in developing countries due to its availability and affordability. However, its durability is significantly threatened by subterranean termites, which cause considerable economic losses. In Nigeria, especially in Lafia, Nasarawa State, termite infestation is a persistent problem in rural and urban structures. The application of chemical and natural preservatives is a common practice to enhance wood resistance against termites. While synthetic preservatives such as Fire Retardant (Zero Flame) and Solignum (termiticide) have proven effective, natural alternatives like neem extract offer environmentally safer solutions. Moreover, the method of application, whether brushing, soaking, or spraying, can influence the depth and uniformity of preservative penetration. This study aims to assess the comparative efficacy of three preservatives using different application methods against subterranean termites under local conditions in Lafia.

MATERIALS AND METHODS

The project research location

The research experiments were carried out at the timber graveyard and the termitaria testing sites within the horticultural garden of the College of Agricultural Science and Technology, Lafia, Nasarawa State. Nasarawa State falls within the Southern Guinea Savanna Zone of Central Nigeria. Lafia lies between latitude 7° N and longitude 7° E. It has a climate typical of the Tropical Zone because of its location and has a temperature ranging from 20°C in October to 36°C in March, while rainfall varies from 13.73 cm in some places to 14.00 cm in others (NIMET 2008). And sandy-loam soil conditions are favourable to subterranean termite activity.

Research Methodology

The study was laid out in a 5 x 4 x 4 factorial experiment in a Completely Randomised Design (CRD) with a total of 4 treatment combinations replicated 5 times, making a population of 80 test samples to facilitate the interpretation of the main treatment effects. This was adopted in order to facilitate the interpretation of the main and interacting effects that could evolve (Akindele, 2004; Adesoye, 2004). Data was collected on preservative absorption of the three (3) wood species. It was obtained through the initial weight and the final weight of samples after 30 minutes of surface brushing, spraying and soaking before and after the application of chemicals on the wood sample, and their chemical retention level was determined. The test wood samples were buried in the timber graveyard and the termitaria testing sites and weighed at 1-month intervals up to 3 months. Visual assessment of wood samples in the sites was done at the end of months of exposure to termite attack and biodegradation attack in the testing sites; samples were rated as follows:5 – sound (sample without biodegradation attack), 4 – slight (sample with little attack), 3 – moderate (sample with moderate attack), 2 – severe (sample attacked but not as bad), 1 – failure (sample attacked badly by termite).

Treatment of Serving Wood Samples with neem extract and Termiguard®

The servicing wood samples were purchased at UAC Road Timber Shed Market in Lafia, Nasarawa State. A total of 80 test samples with a dimension of 4x4x40 cm were made from Gmelina arborea, Tectona grandis, and Mahogany (Khaya spp.). Each serving wood sample was weighed, using a laboratory digital weighing balance before and after oven drying to determine the percentage moisture loss using the standard method. The wood samples were seasoned to an almost uniform moisture content of about 10 - 12% in the laboratory in order to ascertain their level of chemical absorption in accordance with Egbewole et al. (2011) and Ajayi et al. (2017). Fire Retardant (Zero Flame), Solignum (Termiticide), and Neem extract, used as wood preservatives, were each applied at the rate of 0.5, 1.0, and 1.5 g/640 cm³ of servicing wood samples. The plant oil (Neem extract used) was carried in 20 ml of analytical-grade acetone in order to have an even spread over the servicing wood samples and applied with the aid of a 2.5 cm fine bristle paint brush. Application was by surface brushing, spraying and the soaking method of application. Control samples for each oil treatment sample and treated check (Termiguard®) were set along with the treatment oil samples but treated with 20 ml analytical grade acetone alone. The standard control was also set along by applying the Termiguard® at the recommended rate of 5 ml/640 cm³ on the wood sample. Each treatment was replicated 5 times.

Exposure of Treated Servicing Wood Samples to Subterranean Termites

The 80 pieces of test servicing wood (Gmelina) are Gmelina arborea, Tectona grandis and Mahogany (Khaya spp.). Samples were divided into two halves (40 pieces each). Each half was exposed to the forestry timber graveyard located at a timber graveyard located within the horticultural garden of the College of Agricultural Science and Technology, Lafia, Nasarawa State. And the other half planted on some identified termitaria located on the college land. The wood samples were exposed to subterranean termites at the graveyard by planting the treated wood samples at the depth of 20 cm below the earth's surface with the remaining 20 cm exposed above the earth's surface at the spacing of 1 x 0.5 m. On the other hand, treated wood samples exposed to subterranean termites on 15 termitaria were planted round identified termitaria at a spacing of 40 x 40 cm and at a depth of 20 cm.

RESULTS AND DISCUSSION

The present investigation assessed the efficacy of three wood preservatives—Neem Extract, Fire Retardant (Zero Flame), and Solignum (a commercial termiticide)—applied through brushing, spraying, and soaking on Tectona grandis (Teak), Khaya spp. (Mahogany), and Gmelina arborea (Gmelina). The resistance of treated specimens against subterranean termites was evaluated over a three-month period using Analysis of Variance (ANOVA).

For Tectona grandis, neem extract treatments yielded no significant differences across application methods at any observation point (P = 0.7119 kg, 0.8436 kg, 0.3646 kg), suggesting uniform performance irrespective of method. Fire retardant exhibited a similar pattern (P = 0.8664 kg, 0.6823 kg, 0.2934 kg). In contrast, Solignum produced a significant difference in Month 1 (P = 0.0190) but not thereafter (P = 0.1838 kg, 0.1874 kg). This indicates a transient effect of the application method, likely attributable to differences in preservative absorption or surface adherence, with soaking and spraying outperforming brushing in the short term. These findings corroborate Oyekanmi et al. (2018), who reported that soaking enhances preservative penetration, particularly during initial exposure.

For Khaya spp. (mahogany), no treatment displayed significant variation across application methods. P-values for Neem Extract were 0.1268 kg, 0.0833 kg, and 0.3979 kg; for Fire Retardant, 0.5339 kg, 0.5867 kg, and 0.3095 kg; and for Solignum, 0.5887 kg, 0.7861 kg, and 0.6038 kg. Although the Month 2 Neem Extract value (P = 0.0833) approached significance, it did not meet the threshold. The uniform response may reflect the inherent density and low porosity of mahogany, which minimises variability in preservative uptake. These results are consistent with Abolarin et al. (2017), who emphasised the limited absorptive variability of hardwood species such as Khaya.

For Gmelina arborea, all treatment–method combinations produced non-significant ANOVA outcomes. Neem extract values were 0.3629 kg, 0.6699 kg, and 0.6196 kg; fire retardant 0.3400 kg, 0.9515 kg, and 0.6713 kg; and Solignum 0.5904 kg, 0.0948 kg, and 0.4775 kg. Although the Month 2 Solignum value (P = 0.0948) approached the 0.05 threshold, it did not attain significance. These findings suggest uniform preservative performance and indicate that Gmelina is broadly receptive to treatment. Similar outcomes were reported by Awoyemi and Agbeja (2015), who observed consistent preservative responses in Gmelina arborea regardless of application method.

The results underscore the role of wood anatomy in influencing preservative efficacy. Teak displayed a short-term sensitivity to application method under Solignum treatment, mahogany demonstrated resistance properties that minimised methodological variation, and gmelina exhibited general receptivity across treatments. The outcomes reinforce species-specific treatment dynamics and confirm earlier observations in the literature regarding preservative penetration and wood durability.

DISCUSSION

The Analysis of Variance (ANOVA) conducted on the efficacy of three preservatives—Neem Extract, Fire Retardant (Zero Flame), and Solignum—applied by brushing, spraying, and soaking across Tectona grandis (Teak), Khaya spp. (Mahogany), and Gmelina arborea (Gmelina) revealed limited methodological effects. Only one statistically significant result was recorded: Tectona grandis treated with Solignum in the first month (P = 0.0190). This suggests that soaking or spraying may offer initial performance advantages, though such effects diminished over time. For all other treatment–wood combinations, the application method did not significantly alter efficacy (P > 0.05) across the three-month period. The grouping of results, confirmed through superscript similarities (a, b, c), further substantiated the lack of statistical divergence. These outcomes imply that wood type and preservative formulation may exert greater influence on termite resistance than application technique. In field conditions where practicality and cost-efficiency are paramount, simpler methods, such as brushing or spraying, may therefore be preferred.

Tectona grandis treated with neem extract and fire retardant showed similar results across all observation periods (P > 0.05), confirming that the application method did not influence efficacy. In contrast, Solignum-treated specimens showed significant variation in Month 1, but not thereafter. This transient methodological effect aligns with the findings of Olajide et al. (2016), who demonstrated that soaking and spraying facilitated greater short-term penetration of preservatives in open-grained species such as teak, with soaking in particular yielding higher early-stage retention and decay resistance. Similarly, Aina and Fuwape (2018) emphasised that Solignum, as a synthetic preservative, displays greater variability in its early effectiveness due to its enhanced penetration capacity compared to traditional plant- or oil-based treatments.

For Khaya spp. (Mahogany), all preservatives exhibited P-values above 0.05 across the three months, with Neem Extract in Month 2 producing the closest value to significance (P = 0.0833). The absence of significant differences corroborates earlier work by Ibrahim and Lawal (2015), who attributed mahogany’s low preservative responsiveness to its dense and oily structure, which impedes penetration regardless of application method. Eromosele et al. (2017) similarly reported that even potent preservatives showed negligible method-dependent differences in hardwoods such as mahogany, due to their intrinsic durability and low permeability. These findings suggest that the preservative efficacy in mahogany is more strongly governed by wood anatomy than by application technique.

For Gmelina arborea, results also indicated no significant methodological variation across treatments (P > 0.05). Although Solignum in Month 2 approached significance (P = 0.0948), it did not surpass the 0.05 threshold. Ajayi and Ogunleye (2014) observed that the moderately porous structure of Gmelina enables relatively uniform absorption across application methods, particularly in freshly cut wood, with brushing and spraying remaining effective if treatments are reapplied periodically. Ogunwusi and Onwualu (2016) further reported that short-duration soaking (less than 24 hours) failed to provide meaningful advantages in retention or protection compared to brushing or spraying. Thus, Gmelina appears to respond evenly to preservative applications, regardless of method.

Collectively, the results underscore that the wood species itself exerts a stronger influence on preservative performance than the method of application. Only Tectona grandis treated with Solignum demonstrated a short-term methodological effect, while mahogany and gmelina exhibited negligible variability across treatments. These outcomes echo the conclusions of Arowosoge and Ogunwusi (2015), who argued that application technique exerts minimal influence unless preservative exposure times are extended or formulations are specifically modified for deeper penetration.

From a practical standpoint, the absence of widespread methodological differences suggests that cost-effective and time-efficient approaches such as brushing or spraying are sufficient when employing conventional preservatives like neem extract or fire retardant. However, for species such as Tectona grandis, which display early responsiveness to preservative penetration, soaking may provide enhanced short-term protection when paired with industrial formulations such as Solignum.

CONCLUSION AND RECOMMENDATIONS

This supports industry best practices, where soaking is generally reserved for high-value or long-term structural applications, while brushing and spraying are preferred for routine maintenance or temporary treatments. The results of this study show that while method of application may influence short-term efficacy, especially in some wood preservative combinations like Solignum (termiticide) on Tectona grandis, there is no consistent, statistically significant advantage of one method over another in the majority of cases. This aligns with several previous studies across Nigeria and West Africa and reinforces the importance of wood type and preservative selection over application technique in many preservation contexts. There is, however, the need for further subject this report to more future study.

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