

EVALUATION OF SELECTED PLANT OIL EXTRACTS AS PRESERVATIVE TREATMENT ON WOOD SPECIES AGAINST TERMITES INFESTATION

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ABSTRACT

*This study was carried out to examine the effectiveness of agricultural based oil extracts from *Elaeisis guineensis*, *Vitellaria paradoxa* and *Azadirachta indica* as preservative material against termite attack. Four wood species were used for this study they are; *Terminalia superba*, *Triploxyton sclereloxylon*, *Gmelina arborea*, and *Cynometra mannii*. Before exposing the treated wood samples to both laboratory and field test, they were oven dried for 24 hours at 105°C, cold soaked for 24 hours and conditioned for 72 hours. The results indicate that absorption of plant oil extracts varied across the different wood species. The value of percentage weight loss for Shea butter oil, *T. superba* was significantly higher ($p \geq 0.05$) and significantly lowers for *T. sclereloxylon* ($p \leq 0.05$). Neem oil treatment, *T. superba*, *G. arborea* and *C. mannii* were not significantly different while for *T. sclereloxylon*, the value was significantly different ($p \geq 0.05$). Palm kernel oil treatment was found to be not significantly different ($p \leq 0.05$) for *T. superba*, *G. arborea* and *T. sclereloxylon* while *C. mannii* was found to be significantly higher ($p \geq 0.05$). The results of this study demonstrate that the use of agricultural based oil extracts such as Neem oil, Shea Butter oil and Palm kernel oil can be effective in preserving wood and protecting it from termite degradation.*

Keywords: Agricultural based preservatives; Termites; absorption and weight loss

INTRODUCTION

Wood has been one of the most significant renewable natural resources available to mankind throughout history (Adeduntan 2015). It is a naturally occurring, cellular, renewable material with great strength to weight ratios, a fair price, and the capacity to ensure its sustainability through tree replanting. In the stems of trees and other woody plants, wood is a porous and fibrous structural substance (Pramreiter, 2020). It is an organic material made of cellulose fibers that can withstand compression and are naturally embedded in a matrix of lignin (Hickey 2001). Due to the high cellulose content of different wood species, there are many species of termites that consume it and have specialized mid guts that break down the fiber (Freyman *et al.* 2008). Termites are detritivores consuming dead plant at any level of decomposition, they obtain nutrient by decomposing plant and animal part as well as faeces (Wetzel 2001), and they play a vital role in ecosystem by recycling waste material such as dead wood, faeces and plants. Several hundred species are economically significant as pest that can cause serious damage to building, crops or forest plantations (Mitchell 2002). The most familiar damage done by termite is to the wooden fabric of buildings and furniture this is done by creating a tunnel underground and entering the buildings from the foundations or any wooden part in contact with the ground, to obtain the wood for their food they make extensive tunnels through the structures weakening them and eventually causing their collapse. Wood preservation increases the durability and resistance from being destroyed by insects or fungus. Preservatives are applied on the basis of how and where the products will be used, the expected conditions of exposure to wood- destroying agents, and the cost per year of service life (Kingsland 2011) enumerated the qualities of a good wood preservative to be: poisonous to the destructive agents but harmless to its operators, easy to handle and apply to wood, odorless, cheap and easily obtainable, chemically stable for a long period, leach and evaporation proof. The forest has been heavily exploited in order to meet the population's growing demand for wood, but it will be difficult to treat every piece of wood used to make materials for termite infestation. As a result, it will be necessary to stop damage from occurring to wood-made furniture, structures, or forest plantations. In order to increase the endurance of wood in use and to protect it from agents that cause wood to deteriorate, preservation is also necessary (Adeduntan 2015). By guaranteeing that wood used for construction and other wood-related purposes can be sturdy and endure long enough, this also contributes to easing the burden on the forest. Therefore, it is essential to understand which wood species will be less likely to be harmed by termites after being treated with specific seed oil extracts, and further education about the advantages of alternative preservatives that are affordable, environmentally friendly, and readily available to users is also necessary (Adeduntan 2015).

OBJECTIVE

The study was carried out to evaluate some selected seed oil extracts of *Elaeisis guineensis*, *Vitellaria paradoxa* and *Azadirachta indica* as preservatives treatments on *Gmelina arborea*, *Terminalia superba*, *Triplochiton scleroxylon* and *Cynometra mannii* against termite infestation.

METHOD

The study site used for this research was located at the Federal University of Technology Akure (FUTA), Akure South Local Government Area with longitude 5.09°E and latitude 7.18°N and elevation of 359m above sea level with 1,524mm rainfall per annum. The climate is tropical with two distinct seasons; the raining season (March- November) with the heaviest rains occurring between March and July (Average rainfall 400mm) and the dry season (December – February) with an average rainfall of 25mm. However, slight variation occurs from year to year.

Wood species obtained from the timber market and was processed at the Forestry and Wood Technology Departmental Wood Workshop into sizes of 20mm by 20mm by 60mm (breadth by width by length) using the circular sawing machine, the wood species surface and edges was smoothened using planing machine. The wood species were replicated in three (s) and labeled accordingly. The labeled wood samples were taken to the Forestry and Wood Technology wet Laboratory at Obakekere, at the laboratory the samples were dried in the oven for 24 hours at a temperature of 105°C. The wood samples after drying were weighed using weighing balance and labelled T1. The samples were then cold soaked in seed oil extracts for 24hours (1day), after 24 hours, the samples were removed and allowed to drain then weighed and labelled T2. The samples were then conditioned on a wired mesh for 72 hours (3days), after conditioning for 3days the samples were weighed and labelled T3. The grave yard to be used for this study was cleaned and cleared manually from any form of plants growth; the wood samples were taken to the graveyard and were laid on the ground for 12 weeks. After 12 weeks the samples were collected and measured as T4. A close examination of the extent of termite damage, weight loss of wood in percentage, the visual observation of the wood species was taken and absorption of the plant extracts were measured.

The wood samples of *Gmelina arborea*, *Terminalia superba*, *Triplochiton scleroxylon* and *Cynometra mannii* used in this study were obtained from the timber market located in Akure metropolis while the seed oil extracts of *Elaeisis guineensis*, *Vitellaria paradoxa* and *Azadirachta indica* were obtained from the city of Ibadan in Oyo State and Kaduna State.

The extent of termite infestation and evaluation of wood samples are based on the standard American Society of Testing materials (ASTM) 3345-17 (2017). Visual ratings were calculated as follows:

10= Sound surface nibbles permitted,

9= Light attack,

7= Moderate attack penetration,

4 = Heavy Attack, 40% of the wood cross section eaten up by the termites,

0 = Failure, over 50% of the wood cross section eaten up by the termites.

In the determination of the absorption of the preservatives by the wood samples, the formula below was used:

$$\text{Absorption\%} = \frac{100 (T_2 - T_1)}{T_1}$$

Where T2 represents treated wood weight;

T1 represents Oven dried wood weight (initial weight).

Weight loss due to the termite attack was calculated as;

$$\text{Weight loss in \%} = \frac{100 (T_3 - T_4)}{T_3}$$

Where T3= Conditioned weight after treatment with preservatives;

T4= Weight of conditioned wood

The experimental design to be used is Randomized Complete Block Design (RCBD), in which 3 different seed oil extracts and 4 different wood species were used in the experiment. The data was analyzed using SPSS (Statistical Package for Social Sciences) and Microsoft Excel.

$$Y_{ijk} = \mu + B_i + T_j + \epsilon_{ijk}$$

Y_{ijk} = Individual Observation;

μ = General Mean;

B_i = Effect of Block (wood species);

T_j = Effects of Treatment (Seed oil extracts);

ϵ_{ijk} = Experimental error

RESULTS AND DISCUSSIONS

The result on table 1 shows the percentage of absorption of plant extracts as applied to various wood species, (*Ceiba pentandra*, *Triploxyton sclereloxylon*, *Gmelina arborea*, and *Cynometra mannii*) with treated with Shea butter, Neem oil, and Palm kernel oil extracts. The result shows that *Ceiba pentandra* wood species had the absorption percentages of 9.08±4.41% for Palm kernel, 6.39±0.82% for Neem oil and 5.96±1.56% for Shea butter. But the results in the experiment shows that *Triploxyton sclereloxylon* had the absorption percentages of 20.94±5.75% for Shea butter, 21.60±11.06% for Neem oil, and 20.52±7.65% for Palm kernel respectively. In *Gmelina arborea*, the absorption percentages were 13.45±9.25% for Palm kernel, 11.07±3.51% for Shea butter and 8.68±2.60% for Neem oil. In *Cynometra*

mannii, absorption percentages were 11.46±1.81% for Shea butter, 9.62±1.40% for Palm kernel and 9.15±2.23% for Neem oil.

The Follow up test revealed that for Shea butter, the value of percentage absorption for all the wood species are not significantly difference ($p \leq 0.05$). Neem oil treatment for *Ceiba pentandra*, *Gmelina arborea* and *Cynometra mannii* were not significantly different while for *Triploxyton sclereloxylon*, the value was significantly different ($p \geq 0.05$). Palm kernel oil treatment was found to be not significantly different ($p \leq 0.05$) for *Ceiba pentandra*, *Gmelina arborea* and *Cynometra mannii* while *Triploxyton sclereloxylon* was found to be significantly higher ($p \geq 0.05$).

Table 3 shows that the percentage of absorption of plant oil extracts used for wood treatment against termite attack is significantly different ($p \geq 0.05$) between wood species, with *Triplochiton scleroxylon* absorbing more oil than *Termilania superba*. There is no significant difference in the percentage of absorption of plant oil extracts oil between the treatment groups.

Table 1

The mean value of absorption in percentage (%) by wood species

Wood species	<i>Terminalia superba</i>	<i>Triploxyton sclereloxylon</i>	<i>Gmelina arborea</i>	<i>Cynometra mannii</i>
Shea butter oil	26.95±2.97 ^a	44.59±1.92 ^a	16.20±0.80 ^a	42.01±7.40 ^a
Neem oil	24.25±3.81 ^{ab}	55.44±3.96 ^b	13.12±2.47 ^{ab}	36.912±11.51 ^{ab}
Palm kernel oil	24.86±3.63 ^{ab}	45.21±2.55 ^a	13.71±2.02 ^{ab}	40.70±18.23 ^{ab}

Mean values with the same superscript in a row are not significantly different at ($p \leq 0.05$). Each value is a mean of three replicate ±SD.

The results of this study in table 2 shows the percentage of weight loss of plant extracts (Shea butter, Neem oil, and Palm kernel) on four different wood species i.e (*Terminalia superba*, *Triploxyton sclereloxylon*, *Gmelina Arborea*, and *Cynometra mannii*). The result was presented as mean values with standard deviations in parentheses. The results indicate that the weight loss of plant extracts varied across the different wood species. Among the four species, *Triploxyton sclereloxylon* showed the highest percentage weight loss of Shea butter oil ($20.94 \pm 5.75\%$), while *Gmelina Arborea* had the lowest ($11.07 \pm 3.51\%$). Similarly, for Neem oil, *Triploxyton sclereloxylon* had the highest percentage weight loss ($21.60 \pm 11.06\%$), while *Gmelina arborea* had the lowest $8.68 \pm 2.60\%$. The result of Palm kernel treated wood shows that, *Terminalia superba* had the highest percentage weight loss of ($9.08 \pm 4.41\%$), followed by *Triploxyton sclereloxylon* ($20.52 \pm 7.65\%$). *Gmelina arborea* and *Cynometra mannii* had similar percentage weight loss of Palm kernel treated wood at $13.45 \pm 9.25\%$ and $9.62 \pm 1.40\%$ respectively.

The Follow up test revealed that for Shea butter oil, the value of percentage weight loss for *Terminalia superba* is significantly higher ($p \geq 0.05$) and significantly lower for *Triploxyton sclereloxylon* ($p \leq 0.05$) while there is no significant difference for both *Gmelina arborea* and *Cynometra mannii* wood species. Neem oil treatment for *Terminalia superba*, *Gmelina arborea* and *Cynometra mannii* were not significantly different while for *Triploxyton sclereloxylon*, the value was significantly different ($p \geq 0.05$). Palm kernel oil treatment was found to be not significantly different ($p \leq 0.05$) for *Terminalia superba*, *Gmelina arborea* and *Triploxyton sclereloxylon* while *Cynometra mannii* was found to be significantly higher ($p \geq 0.05$).

Table 3 shows that there is no significant difference ($p \leq 0.05$) in the percentage of weight loss of oil used for wood treatment against termite attack between wood species, treatment groups, or the interaction between wood species and treatment groups.

Table 2

The result of the percentage of weight loss by treated wood species

Wood Species	<i>Terminalia superba</i>	<i>Triploxyton sclereloxylon</i>	<i>Gmelina arborea</i>	<i>Cynometra mannii</i>
Shea butter oil	5.96±1.56 ^a	20.94±5.75 ^b	11.07±3.51 ^{ab}	11.46±1.81 ^{ab}
Neem oil	6.39±0.82 ^a	21.60±11.06 ^b	8.68±2.60 ^a	9.15±2.23 ^a
Palm kernel oil	9.08±4.41 ^b	20.52±7.65 ^b	13.45±9.25 ^b	9.62±1.40 ^a
Control	100.00±00.00 ^c	100.00±00.00 ^c	100.00±00.00 ^c	100.00±00.00 ^c

Mean values with the same superscript in a row are not significantly different at ($p \leq 0.05$). Each value is a mean of three replicate $\pm$ SD.

Table 3

The Analysis of variance for percentage absorption and weight loss by wood species

Absorption					
Source	Sum of Squares	Df	Mean Square	F	Sig.
Wood Species	8247.493	3	2749.164	55.649	0.00*
Treatment	18.477	2	9.239	0.187	0.83ns
Wood Species*Treatment	372.002	6	62	1.255	0.30ns
Error	1778.473	36	49.402		
Corrected Total	10416.446	47			
Weight Loss					
Source	Sum of Squares	Df	Mean Square	F	Sig.
Wood Species	1309.61	3	436.537	2.351	0.09ns
Treatment	23.64	2	11.82	0.064	0.94ns
Wood Species*Treatment	59.177	6	9.863	0.053	0.99ns
Error	6683.175	36	185.644		
Corrected Total	8075.601	47			

The table 4 shows the visual rating of four wood species (*Terminalia superba*, *Triploxyton sclereloxylon*, *Gmelina Arborea*, and *Cynometra mannii*) treated with oil extracts (Neem Oil, Palm kernel Oil, and Shea Butter oil) and a control over a period of 12 weeks. The visual ratings were assessed according to ASTM standard. The results indicate that all wood species treated with the oil extracts showed less degradation compared to the control that was not treated with the oil extracts.

Table 4

Showing the results of the visual rating conducted on the exposed wood samples

Oil	Wood Species	2 weeks	4 weeks	6 weeks	8 weeks	10 weeks	12 weeks
Extracts							
Neem Oil	<i>T. superba</i>	10	9	7	7	4	4
	<i>T.scleroxylon</i>	10	9	7	7	4	4
	<i>C.mannii</i>	10	9	9	7	7	4
	<i>G.arborea</i>	10	10	9	9	7	7
Palm kernel Oil	<i>T. superba</i>	10	9	7	7	7	4
	<i>T.scleroxylon</i>	10	9	7	4	4	4
	<i>C.mannii</i>	10	10	7	7	7	4
	<i>G.arborea</i>	10	9	9	7	7	7
Shea Butter oil	<i>T. superba</i>	10	9	7	7	4	4
	<i>T.scleroxylon</i>	10	9	7	7	7	4
	<i>C.mannii</i>	10	10	7	7	7	4
	<i>G.arborea</i>	10	10	9	9	7	7
Control	<i>T. superba</i>	10	7	4	0	0	0
	<i>T.scleroxylon</i>	10	7	4	0	0	0
	<i>C.mannii</i>	10	9	7	7	4	0
	<i>G.arborea</i>	10	9	7	7	4	0

This study investigated the mean absorption of three different plant extracts, Shea butter, Neem oil, and Palm kernel oil, on four different wood species commonly found in Nigeria, namely *Terminalia superba*, *Triploxyton sclereloxylon*, *Gmelina arborea*, and *Cynometra mannii*. Among the four species, *Triploxyton sclereloxylon* showed the highest absorption rate of Shea butter (44.59 ± 1.92 %), followed by *Cynometra mannii* (42.01 ± 7.40 %). *Terminalia superba* and *Gmelina arborea* had the lowest absorption rates of Shea butter at 26.95 ± 2.97 % and 16.20 ± 0.80 %, respectively. For Neem oil, *Triploxyton sclereloxylon* had the highest absorption rate (55.44 ± 3.96 %), followed by *Cynometra mannii* (36.91 ± 11.51 %). The absorption rates for *Terminalia superba* and *Gmelina arborea* had the lowest absorption rates of Shea butter at 24.25 ± 3.81 % and 13.12 ± 2.47 %, respectively. For Palm kernel oil, *Triploxyton sclereloxylon* showed the highest absorption rate (45.21 ± 2.55 %), followed by *Cynometra mannii* (40.70 ± 18.23 %). *Terminalia superba* and *Gmelina arborea* had the lowest absorption rates at 24.86 ± 3.63 % and 13.71 ± 2.02 %, respectively. The results indicated that the absorption rates varied across the different wood species, with *Triploxyton sclereloxylon* showing the highest absorption rates for both Shea butter and Neem oil and Palm kernel oil extract which corroborates with previous findings of Adebawo (2019) who discovered that *T. sclereloxylon* absorbs more oil at higher concentration level. The result also revealed that the wood samples were easily impregnated without difficulty with plant based oil extracts due to low viscosity of the diluents which consequently lowered the viscosity of the extracts which also agreed with the work of Adetogun (2011). This study also revealed that *G. arborea* had a relatively low absorption rate when subjected to the plant oil extracts which is consistent with the findings of Adeduntan (2015) who discovered that the absorption rate of ranged between 9.06% to 28.44% when treated with selected plant based extracts and also with the findings of Owoyemi (2010) who stated that the dry heartwood of *G. arborea* is resistant to the penetration by both water borne and oil preservative solution even when treated with vacuum pressure and hot treatments methods. The Deposition of extraneous materials in the wood cell walls and in the lumens during the biochemical transformation of the sapwood into heartwood, encrustation of the pit membrane surface as well as the in-growth of obstructing tyloses into the vessels are majorly responsible for the impermeability of *G. arborea* heartwood.

This results also show that different wood species have varying absorption rates of plant extracts and the result of this study is consistent and agreed with previous research by Adeduntan (2015) who found that the absorption of wood preservatives differed among different wood species, with some species showing higher retention levels than others. This claim is also supported by (Ekhuemelo *et al.* 2020; Funke *et al.* 2015) who discovered that the percentage of absorption of solvents differs among wood species and that the rate of solvent absorption in wood is dependent on concentration of the solution used. According to Faruwa *et al.* (2015), they stated that the difference in absorption could be as a result of extractives deposited in the wood samples.

The results of the study showing the percentage of weight loss indicate that Shea butter, Neem oil, and Palm kernel extracts caused significant weight loss in all wood species studied compared to the control. The percentage weight loss observed in Palm kernel oil extract ranged from $9.08 \pm 4.41\%$ for *Terminalia superba* to $20.52 \pm 7.65\%$ for *Triploxyton sclereloxylon*. This finding is in agreement with previous studies that have reported the efficacy of Palm kernel oil extract in wood preservation (Olaniyi 2023) who conducted a research on the use of Palm kernel oil, Neem oil and *Jatropha* oil. However, the results also revealed that Neem oil extracts was more effective in reducing termiticidal attack compared to Palm kernel oil extract which is also consistent with the finding of Olaniyi (2023) who discovered during their study that palm kernel oil extract protective strength compared to Neem oil reduced significantly on exposure to termite attack. Other studies support the efficacy of Neem oil extract in the protection of wood against termite infestation (Sotande *et al.* 2011; Okweche *et al.* 2021). The high content of fatty acids in Palm kernel oil extract has been reported to contribute to its antimicrobial properties, which may explain its effectiveness in wood preservation (Ajiboye *et al.* 2019). On the other hand, the weight loss percentages varied among the different wood species and plant extracts. For instance, *Triploxyton sclereloxylon* showed similar weight loss percentages for all three plant extracts. *G.arborea* showed a relative low percentage weight loss across the three plant oil extracts which is consistent with the findings of Adeduntan (2015) which revealed that the rate of attack of termite on *G.arborea* was the least among of the wood samples treated with the selected plant extracts.

Furthermore, the differences in weight loss percentages among the different wood species and plant extracts were statistically significant. This finding underscores the need to tailor wood preservation treatments to the specific wood species in question. Previous studies have also reported the importance of considering the wood species in wood preservation treatment (Ogbogu 1996). The results showed that all three plant extracts caused weight loss in the wood species studied. In overall, the results of our study suggest that Shea butter, Neem oil, and Palm kernel oil extracts can be effective at preserving wood, but the effectiveness may vary depending on the wood species and the specific plant extract used.

The findings from the table 3 showing visual rating after 12 weeks of exposure of the treated wood species at the termite graveyard suggests that treating wood with Neem Oil and Shea butter oil can help preserve the wood and protect it from termite degradation. However, the anti-termite effect of the oil extracts reduced with time during its exposure on the field test leading to the progressive weight loss in the treated wood samples, this is consistent with the findings of Olaniyi (2023) who discovered that the strength of Palm kernel oil, Neem oil and *Jatropha* seed oil reduced faster than Solignum with increase in the period of exposure to termite attack. This also confirms that natural pesticides are easily degradable and not persistent in the environment (Ahmed *et al.* 2011; Sarwar 2012). The study also shows that *G.arborea* were least attacked of all the treated wood samples subjected to the field test and *T. sclereloxylon* was most attacked. The results also show that the effectiveness of Palm kernel oil in preserving wood is mixed.

CONCLUSION

The results of this study demonstrate that the use of natural oils such as Neem oil and Shea Butter oil can be effective in preserving wood and protecting it from termite degradation. The findings also suggest that the effectiveness of Palm kernel oil in preserving wood is mixed and requires further investigation. These results have important implications for the preservation of wood, especially in areas with high termite infestation. The use of plant based oils as a wood preservative offers a sustainable and environmentally friendly alternative to chemical treatments.

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