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Potentials of *Azadirachta indica* seed oil as bio-preservative against termite attack on wood

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ABSTRACT

In order to contribute to the efforts aimed at achieving sustainable environmentally benign methods of treating and preserving lignocellulosic materials, the potential of neem (Azadirachta indica) seed oil as bio-preservative against termite attack on Aningeria robusta wood was investigated. Soxhlet apparatus was used to extract the oil using N-hexane as the solvent. The phytochemical screening of the oil revealed the presence of alkaloids, tannins, flavonoids, terpenoids, saponins and steroids. The wood samples of Aningeria robusta of dimensions 50x50 x 300mm were treated using dipping method with five different concentration levels (0%, 25%, 50%, 75%, and 100%) of the neem seed oil extract and untreated samples served as the control. The wood samples were exposed to termite attack for a period of 10 weeks and the percentage weight loss was determined. Data obtained were analyzed using Analysis of Variance (ANOVA) at 5% probability level. There were significant differences in the weight loss at different concentration levels. Maximum protection against the termites was obtained at the highest concentration level i.e. 100%. The weight loss ranged from 23.18±5.9 to 46.01±5.08 at concentrations of 100% to 0% of neem seed oil extract. However, all the treatments proved to be effective over the control (51.72%). From this investigation, it is established that Azadirachta indica seed oil extract is a potential bio-preservative against termites attack on Aningeria robusta wood.

Keywords: *Azadirachta indica*, weight loss, *Aningeria robusta*, alkaloids, termites

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INTRODUCTION

Wood is one of the most frequently used materials for construction purposes world-wide. In Nigeria, more than 80% of timber products are used for constructional purposes such as building, furniture, railway sleepers, transmission poles, pulp and paper, plywood, veneers, composites board, matches, fuel (coal industry) and fuel wood [1]. The fact that wood can be used for both in-door and out-door services and exposed to different weather conditions shows that wood can be used for many years if properly preserved. However, due to the nature and character of wood, exploitation of tree for structure and construction purposes were selective and limited to strong and durable wood species [2]. Wood products in use throughout the world are subject to infestation by insects and out of these insects, termites have the greatest economic importance. Termites destroy wood by feeding on its components, thereby reducing its structural ability and appearance [3]. Because cellulose is the principal food of termites, wood structures, wood and wood products are avidly consumed, and hence, a constant effort is directed towards their control [4].The conventional wood preservatives used to protect wood from insects and micro-organisms damage are presently of major concerned to human health and the environment. Although, these conventional wood preservatives are effective against bio-deterioration agents, however, they are costly, toxic and hazardous to the environment [5].Nigeria, like many other West African countries, loses valuable wood as a result of attack by insect and other biodegrading agents. There should be a concerted effort at stemming this trend through development of eco-friendly preservatives which should not only be effective, but also be affordable. Most reported works on the use of ecofriendly wood preservatives is on extractives

from heartwood, leaf, bark, root and oil from herbaceous plants [5, 6, 7, 8]. Recently, great interest has been focused on some wood preservatives that are relatively cost – effective and have minimal toxicity to mammals and the environment. Ability of wood and natural plant extractives to protect wood against wood degrading fungi and insects has been one possible approach for developing new wood preservatives [9].Neem tree (*Azadirachta indica*) is an evergreen tree; it belongs to Meliaceace family, and grows rapidly in the tropic and semi-tropic climate [10]. It is properly known as village pharmacy as all parts of this plant are used for several types of diseases since centuries. Extracts of leaves and seeds exhibit the property of antibacterial, antifungal, antiviral [11]. Neem wood is known to be durable against wood rotters [12], therefore, neem seed oil with the main constituent of Azadirachtin has been evaluated to find out its effectiveness as wood preservatives against termite attack.

MATERIALS AND METHODS

Preparation of Wood Samples: Test samples were prepared from defect-free air-dried *Aningeria robusta* wood. The wood sample was cut into dimensions 50 x 50 x 300 mm. The initial weight of the samples were taken and then oven dried for 24 h at 103±2^{0}C to constant weight. After oven drying, the weights of the samples were taken and percentage moisture content was estimated using the equation (1).

$$\% \text{ M. C.} = \frac{W_1 - W_2}{W_2} \text{ X } 100 \quad (1)$$

Where, W_1 = weight of wood samples before oven drying
W_2 = weight of wood samples after oven drying

Collection of *Azadiracta indica* (neem) seeds and Extraction of the oil: Matured fresh neem fruits were collected from neem stands within the premises of Polytechnic of Ibadan, Ibadan, Oyo state, Nigeria. The seed coats were removed and sun dried for seven days to reduce the moisture and ground with an electric blender. The oil in the seed was extracted with N-hexane in a Soxhlet apparatus. The extract obtained was stored in a sterilized bottle prior to use.

Phytochemical Analysis of Neem Seed Oil Extract
Phytochemical screening of Neem seed oil was done following the standard procedure by the method of [13]. The seed oil extract was subjected to phytochemical screening for the presence of alkaloids, tannins, flavanoids, fats, saponins, phenolic compounds, steroids and terpenoids.

Preparation of Test Preservative: The volume-to-volume method was used to dissolve the neem oil in kerosene. This implies that, 1ml of neem oil in 99ml of Kerosene (diluent) is equivalent to 1% dilution. Hence, 0%, 25%, 50%, 75% and 100% as well as the control were used for the study. For each concentration five replicates were used.

Treatment of Test Blocks: Dipping impregnation method [14] was used for treatment of the wood test blocks with the preservatives. They were completely immersed in the prepared extract for 12 hours so as to obtain a desirable level of maximum absorption. After treatment the blocks were removed from the treatment solution, drained and weighed as $W_3$to determine the rate and level of absorption.

The absorption rate was calculated using equation (2)

$$\text{Absorption, (kg/m}^3\text{)} = \frac{\text{Total absorption} \times \text{Concentration} \times 10}{\text{Volume of wood} \times \text{Number of pieces}} \quad (2)$$

Grave yard test: The grave yard experiment was carried out for 10 weeks. The test wood blocks and control wood blocks were buried around a termitarium located at Federal College of Forestry, Ibadan, where it remained for 10 weeks.

Weight Loss Determination: At the end of exposure period, test blocks were carefully removed, cleaned and oven dried and reweighed to determine weight loss.

$$\% \text{ weight loss} = \frac{W_3 - W_4}{W_3} \times 100 \quad (3)$$

W_3 =weight of test block after treatment.
W_4 = weight of test block after exposure to fungi attack.

Statistical Analysis: The data obtained were analyzed using Analysis of Variance (ANOVA). Means were separated with the aid of Duncan Multiple Range Test at 5% level of significance.

RESULTS AND DISCUSSION

The results of phytochemical analysis of *Azadirachta indica* seed oil extract are presented in Table 1. The phytochemical tests performed were of quantitative type and the results revealed that alkaloids, tannins, flavonoids, terpenoids, saponins and steroids are present in the oil extracts.

Table 1: Phytochemical analysis of *Azadirachta indica* seed oil extract

Parameters	Value (mg/100g)
Saponins	43.3
Flavonoids	1418.3
Tannins	975.0
Alkaloids	2141.7
Steroids	218.3
Terpenoids	826.7

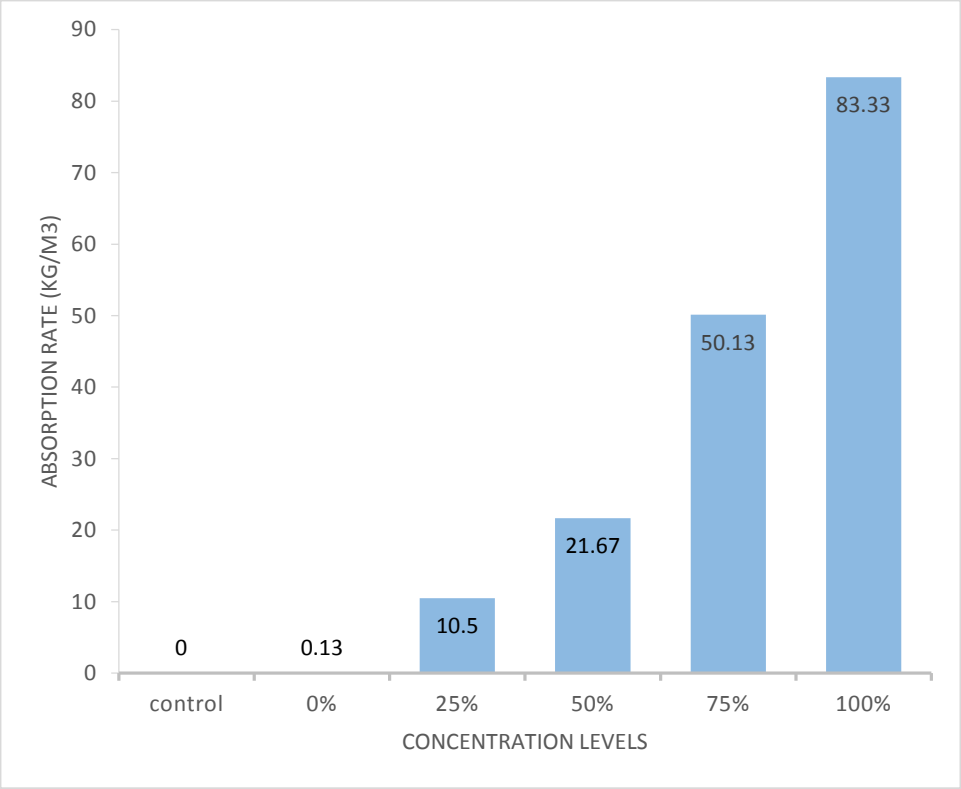

Figure 1: Absorption rate of *Aningeria robusta* wood samples treated with Neem seed oil extract (NSOE)

Phytochemical constituents of plants are commonly used for medicinal purposes against number of diseases such as analgesic, antimalarial, bactericidal and antiseptic [15]. Out of all the phytochemicals that were screened in neem seed oil, high content of alkaloids and flavonoids were observed, 2141.7and 1418.3 mg/100g respectively. The content of terpenoids and tannins were also high but not as what observed in alkaloid and flavonoids. The content of steroids and saponins were low, 218.3 and 43.3 mg/100g respectively. Alkaloids and tannins in neem seed oil extract have been reported to have antitermitic activity and can also act as deterrent [16] and also possess antifungal properties. Flavonoids, steroids and terpenoid have antioxidants and antimicrobial properties. Saponins are produced by plants as a defense mechanism to stop attacks by foreign pathogens, which makes them natural antibiotics [17]. Saponins have also been reported as deterrent for biological activity against insects Terpenoids are also used as flavoring agents,

insect repellents, fungicides and for medicinal purposes [16]. Several researchers have reported efficacy of plants extracts as bio-preservative against fungi and termite attacks [18, 19, 20, 21, 22]. [20] reported that *Azadirachta indica* seed oil showed a promising termiticidal and repellent activity due to the phytochemical constituents.

The results of the absorption rate of *Aningeria robusta* wood samples after immersion in the preservative at different treatment levels are presented in Figure 1. However, the results showed that the absorption of preservative by the wood samples at different concentration levels is significantly different. For all the treatments, absorption was highest in 100% concentration level and lowest in 0% concentration level. The absorption rate at 100% concentration level was significantly higher than all other treatments. Based on these findings, absorption rate were dependent on solution concentration, as such, absorption increases as concentration level increases. The result revealed that the wood samples were easily impregnated without difficulty with Neem seed oil extract due to low viscosity of the oil and addition of diluent which consequently lowered the viscosity of the extract. This result is in consonance with the work of [23]. The least absorption was recorded in the test blocks treated with kerosene i.e 0% concentration level. The difference in the absorption rate may be due to the viscosity of the preservative or by some features in wood like pores, cell lumen etc. This is in line with the findings of [24], who reported the absorption rate of 0.1382-82.3334 kg/m^{3}for *Ceiba pentendra* using Neem oil.

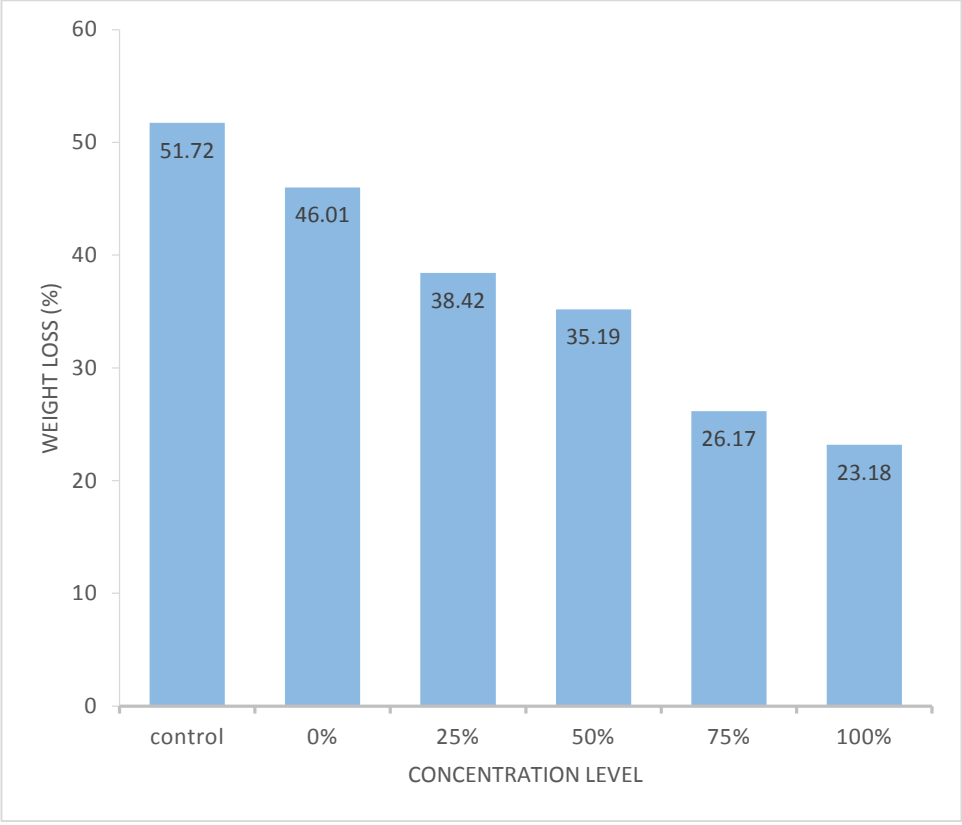

Figure 2: Weight loss of *Aningeria robusta* wood samples at different concentration level

The mean values for the percentage weight loss of *Aningeria robusta* treated at different concentration levels are presented in Figure 2. The control samples had the highest weight loss of 51.72 % while the samples (100% concentration level) had the lowest weight loss of 23.18%. Generally, there is significant difference between the control and all other treatment levels ($p<0.05$), termite attack was less in all the treated samples compared to the control samples. However, the effects of 100% and 75% concentration levels on percentage weight loss of the wood after termite attack were not significantly different ($p>0.05$) from each other. Also, the effects of 50% and 25% concentration level were not significantly different from each other. This confirms effectiveness of the oil extract solution in enhancing decay resistance of wood [25]. The results of this study corroborate the findings of [26,27] who reported that seeds extracts of medicinal plants such as *Azadirachta indica* could be used as termite controlling agents

and this activity is antitermitic with the presence of phytochemicals of diverse chemical structures that have toxic effects on termite. High alkaloids and tannins content in the neem seed oil may be responsible for antitermitic property observed in the treatments with lower weight loss.

CONCLUSION

Based on the findings of this study, it was observed that *Azadirachta indica* seed extract has the efficacy and possesses wood preservative potentials. In terms of weight loss, wood sample treated with this selected bio-preservative performed more favourably than the control. The results of this experiment revealed the potential and the efficacy of the solution of *Azadirachta indica* seed oil extract as bio-preservative for *Aningeria robusta* and more effective at 100% concentration.

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