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Efficacy of Neem Oil against Termite [*Odontotermes obesus* (Rambur)] (Blattodea: Termitidae)

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Botanical pesticides are of great importance in Integrated Pest Management (IPM). Extracts of different plant parts are used for deterring and killing the various life stages of insects. Most of the oils produced by plants contain bioactive compounds with insecticidal properties. Neem oil containing azadirachtin is an established insecticide and insect repellent. Use of synthetic pesticides for wood preservation leads to environmental pollution and health hazards to human beings and other living organisms. To avoid these problems neem, *Azadiracta indica* (A.Juss.) plant oil was used in this study and gave better results. The weight loss of card boards treated with neem was less like chlorpyrifos treated cardboards. Gravimetric measurements of cardboards shown 18.34gm and 16.85 gm weight which after 30 and 60 days of exposure to *A. indica* oil indicated that plant oil has potential effects like conventional pesticides like chlorpyrifos which showed the18.72

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and 18.63 gm of weight in cardboards after 30 and 60 days of exposure. The P values was 0.036457 and 0.016527 for cardboards exposed to two treatments after 30 and 60 days respectively which is highly significant.

Keywords: Azadirachta indica; botanical pesticide; plant oils; Odontotermes obesus; toxicity.

1. INTRODUCTION

Termites are the most troublesome pests of plants, trees and wooden structures. They severely damage crops and urban infrastructure. There are about 2,5000 species of termites in the world and only 10 percent have pest status. Out of 300 species in India, about 35 have been reported as damaging crops and timbers in buildings. Economic loss due to termites in terms of expenditures for repairing the damage and preventative treatment costs on wooden structures in the USA exceed of 2 billion dollar US annually as surveyed by United Nations Environment Programme / Food and Agricultural Organisation [1,2]. Economic loss on agriculture crops by termites is not well documented, although reports showed that termites attack various crops, such as cereals, pulse crops, oil crops, sugar cane, vegetable, fruit trees, and horticulture crops [1].

A number of control measures are used to prevent termite attacks on buildings as well as on crops. These are physical, chemical and biological. The chemical method is the most important and most widely used prevention measure to reduce the infestation of termites. Several synthetic pesticides such as Bifenthrin, Chlorpyrifos and Imidacloprid have been approved by Environmental Health Directorate, [3] to be used against termites. The chemical termiticides are toxic to humans and environment [4]. Hence identifying environmentally friendly alternative termiticides, such as botanicals is given priority [5].

Chemical constituents and biological properties of pesticides produced from natural products have been recently attracted the attention of many scientists to avoid the problems caused by synthetic compounds [6]. Secondary chemicals produced by plants have a significant impact on insects. Since these chemicals are biodegradable and non-toxic to plants, warm-blooded animals and environment [7].

Several plants have been tested to exhibit termiticide activities, either in laboratory experiments or in field studies. Serit et al. [8] found that a methanol extract of *Citrus netsudaidai* Hayata seed effectively deterred nymphs of *Reticulitermes speratus* Kolbe. Sumarni [9] showed that several botanicals like neem seed (*A. indica*), jeringau rhizome (*Acorus calamus* (L.)), custard apple seed (*Annona squamosa* (L.)) and bengkaung seed (*Pachyryzus erosus* (L.) Urb.) could be used as effective termiticides. Many plants have been found to contain bio-active compounds and their potential has been explored for field use [10,11,12] The reduction in infestation of termites in sugar cane with neem and *Calotropis* extracts has been reported [13]. Cashew Nut Shell Liquid (CNSL) obtained by extraction in hot oil, solvent or by mechanical expulsion from the shells of *Anacardium occidentale* (L.) is reported to accord protection against termites [14,15]. Neem has been already chalked out and is being used in the field at different levels. But neem only cannot fulfil the requirement commercially so there is a need to search out new plant-origin pesticides [16].

Preservation of woods and wooden materials from termite infestation is a challenging task all over the world. The chemical preservatives now used are harmful to the environment and living organisms. The plant extracts used as wood preservatives will be a better option. In the present study, an attempt was made to evaluate the plant oil-based spray solution as a preservative against termites.

In the present study, *A. indica* seed kernel oil was extracted and the toxic effect of the plant oil against the termite, *Odontotermes obesus* (Rambur) were analyzed.

2. MATERIALS AND METHODS

2.1 Procurement of Materials for Oil Formulation

Neem seeds (*A. indica)*, are the raw materials for the preparation of the oil pesticide. Neem oil was purchased from a nearby oil mill, and neem seeds from the local market.

2.2 Preparation of Materials for Oil Extraction

The neem seeds were sundried. The *A. indica* seeds were ground in an electric blender and the ground materials were stored in large plastic containers.

2.3 Extraction of Oil by Soxhlet Method

Exactly 50 g each of ground neem seeds were weighed in a sensitive electronic balance wrapped in white muslin cloth and tied with a twine. The packed materials were placed in a 1 lit Sohxlet extraction apparatus and the extraction was made at 60-80^{o}C with petroleum ether and acetonitrile solvents separately. After extraction of the oil, the solvent was recovered using a rotary

2.4 Toxicity on Termite (*O. obesus*)

The toxic effect of the oil-based pesticides on termites was studied on the basis of the oil acting as a wood preservative. The card board pieces measuring about 21.5 cm length and 14 cm width were cut for the present study. The weight of the cut pieces ranged from 18.24 to 18.77 gm. The *A. indica* oil of 2, 4, 6, 8 and 10 ml was dissolved in petroleum ether solvent in the following concentrations 8, 6, 4, 2 ml respectively and sprayed on the cardboard sheets with a hand sprayer. The control sheets were sprayed with the solvent only. The synthetic pesticide, chlorpyrifos was also sprayed in the above said concentrations. The pesticide-treated cardboard sheets were placed in termite bound areas of Scott Christian College campus. The weight loss the sheets was measured every 15 days interval up to 60 days. The percentage of weight loss was calculated. Six replicates were maintained. All the data were statistically analysed using ANOVA.

3. RESULTS AND DISCUSSION

The cardboard sheets protected with *A. indica* oil showed 18.88 percent weight loss at 2ml concentration. After 60 days the weight loss was 45.28 percent. At 6ml concentration, a 32.42 percent weight loss of cardboard sheet was observed. The weight loss was 1.18fm percent after 30 days while it was 9.21 percent after 60 days at 10 ml concentration. in Chlorpyrifos treated cardboard sheets, the weight loss was 41.68 percent in 60 days at 2 ml concentration. The weight loss decreased to 11.54 percent after 30 days at 6 ml concentration. The percent of weight loss was 0.85 after 60 days of termite interaction at 10 ml concentration (Table 1 and Figs. 1 & 2).

Two way ANOVA comparison of the damage caused by *O. obesus* on cardboard sheets protected by different concentrations of the *A. indica* oil as well as the Chlorpyrifos revealed significant differences between the three different treatments. The P values were 0.036457 and 0.016527 for cardboards exposed to two treatments after 30 and 60 days respectively which is highly significant (Tables 2 & 3).

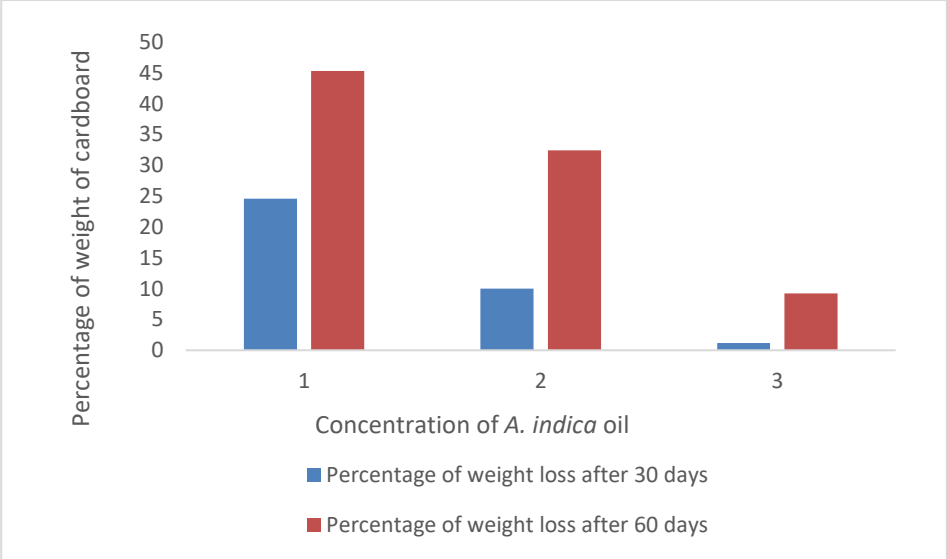

Fig. 1. Percentage of weight loss after 30 and 60 days of treatement with *A. indica* oil at 2ml, 6ml and 10 ml concentrations

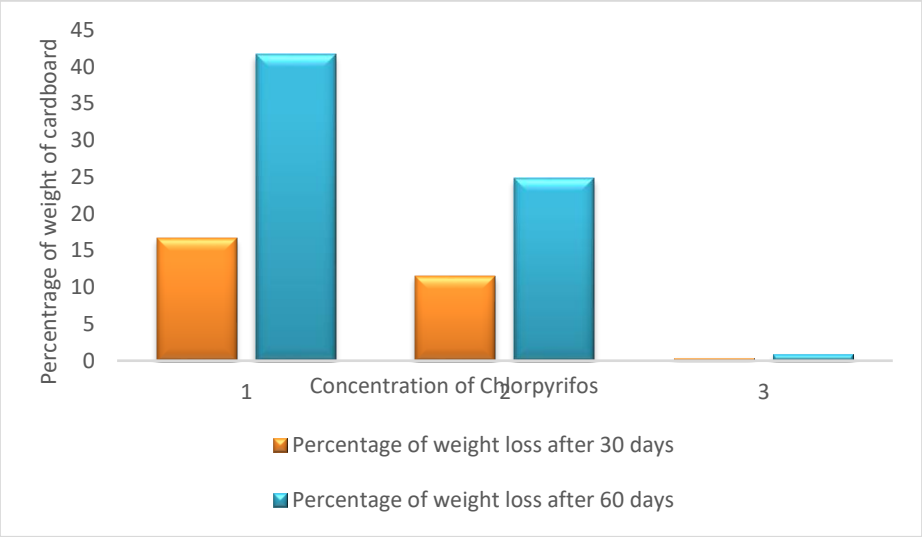

Fig. 2. Percentage of weight loss after 30 and 60 days of treatment with Chlop[yrifos at 2 ml, 6 ml and 10 ml concentrations

Table 1. Gravimetric measurements of cardboards treated with different treatments made accessible to *O. obesus*

Different treatments	Different concentrations (in ml)	Initial weight of cardboard (in gm)	Period of termite attack (in days)	
			30	60
Control	-	18.81	13.12	7.21
A. indica	2	18.75±0.03	14.14±0.012 (24.58)	10.26±0.023 (45.28)
	6	18.6±0.15	16.74±0.012 (10)	12.57±0.033 (32.42)
	10	18.56±0.18	18.34±0.023 (1.18)	16.85±0.010 (9.21)
Chlorpyrifos	2	18.59±0.11	15.48±0.013 (16.72)	10.84±0.010 (41.68)
	6	18.62±0.01	16.47±0.014 (11.54)	14.00±0.017 (24.81)
	10	18.79±0.06	18.72±0.007 (0.34)	18.63±0.012 (0.85)

Table 2. ANOVA shows the Gravimetric measurements of cardboards treated after 30 days

Source of Variation	SS	df	MS	F	P-value	F crit
Rows	7.4054	5	1.48108	0.988736	0.504808	5.050329
Columns	12.04003	1	12.04003	8.037656	0.036457	6.607891
Error	7.489767	5	1.497953			
Total	26.9352	11				

Table 3. ANOVA shows the Gravimetric measurements of cardboards treated after 60 days

Source of Variation	SS	df	MS	F	P-value	F crit
Rows	28.0311	5	5.60622	1.020401	0.491429	5.050329
Columns	68.92813	1	68.92813	12.54577	0.016527	6.607891
Error	27.47067	5	5.494133			
Total	124.4299	11				

The weight of cardboard sheets was taken as the index of termite attack. The termites fed on cardboard biomass, using it for producing energy. The cellulose found in cardboard is used for generating energy by digesting it with the help of symbiotic organisms found on its gut [17]. Cardboard treated with different types of oils were avoided by the termites or they used only very little quantity of cardboard biomass, that too, after several days when the oil molecules have evaporated to a large extent [18]. Neem oil and its constituents seemed to be very effective in all the field trials conducted.

The weight loss of cardboard sheet after 30 days in 2 ml concentration of neem oil treatment was 18.88 percent. But after 60 days, the percentage of weight loss was only 9.21 percent at 10 ml concentration of neem oil. The reduced termite activity may be due to the avoidance of feeding (anti-feedant), on the cardboard sheets due to repellency or toxicity of the oil at this highly enhanced concentration. This finding is supported by Balandrin et al. [19], Saxena [20] and Lee et al. [21] who reported that the insecticidal properties of neem are governed by its volatile and non-volatile components, the former playing a major role in determining the repellency (generally at a distance, without contact) of neem extractives towards many insects. Tindo et al. [22] in their studies showed that the repellent activity of *Carapa procera* (DC.) seed oil is higher than that observed for *A. indica* seed oil. Mulatu and Gebremedhin [23] reported that the oils of *Milletia ferruginea* (Hochst.)

Some authors worked on plant extracts as wood preservatives. Oluyege et al. [24] indicated that *Anchonames difformis* (Blume) Engl. root extract is a potent wood preservative against termites. Burkill [25] indicated that the tuber of the plant *A. difformis* is caustic in nature. Alkaloids, considered to be natural attractants, found in the *A. difformis* tuber are toxic to the termites [26]. Serit et al. [27] stated that studies on natural antitermite compounds are still very rare. Many new antitermites remain to be identified since more than 95 percent of the plants already identified to have resistance to termites have not been subjected to proper chemical identification [28]. A number of limonoids have been isolated and their anti-termitic activity has not been fully established [28,29].

Besides plant extracts, clove bud and garlic oils are toxic against Japanese termite, *Reticulotermes speratus* (Kolbe) [30], Patchouly oil was found to be effective against *Coptotermes formosanus* (Shiraki) [31]. The fumigant toxicity of essential oils like rose mary (10 μl) and lemon grass (10 μl) per 553 cm^3 air caused 100 percent mortality after 24 hrs in a coated container [5]. In wooden surface test, geranium, lemon grass and tea oils caused 95-100 percent mortality due to the presence of toxic fumigant volatiles [2]. Mashek and Quarles [32] stated that orange oil formula is effective in controlling dry wood termites either by contact or by fumigant action [33-36]. The oil kills by dissolving the chitinaceous exoskeleton of dry wood termites living in hollows inside wood galleries [37,38].

4. CONCLUSION

In our study, the plant oils exerted slow reactions than the chemical pesticides. This may be because of the vapourisation of phytochmicals. If we find a way to increase the shelf-life of phytochmicals in the environment we can better results.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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