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Efficacy of *Mentha piperita* (Peppermint), *Azadirachta indica* (Neem), *Syzygium aromaticum* (Clove), *Brassica nigra* (Mustard) oils on termites

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Abstract

Termites are detritophagous insects feeding on plant parts and wood component of building causing great loss thus, they are important to be managed. The use of pesticides of plant origin in pest management is considered to be environment friendly unlike synthetic pesticides that poses great threat to the environment. In this research, efficacy comparison of different Botanical oils (*Mentha piperita, Azadirachta indica, Syzygium aromaticum, Brassica nigra*) regarding their anti-termite activity was calculated. The Botanical oils were tested for their insecticidal activity by exposing termites to oil. The study involves four treatment groups with varying concentration of oils (0.5 ml, 1 ml), each group consisted of 15 termites. The number of mortalities (mean± S.E.) after treatment was calculated and analyzed. The Botanical oils were effective in killing termites. 1 ml Botanical oil of *Mentha piperita* shows highest average mortality. The results suggested that these essential oils had beneficial activities of economic value for the development of new or latest and safe termite control product.

Keywords: Pest Management; Peppermint; Botanical Oils; Termite; Mortality, Termite control product

1. Introduction

Termites, often referred to as "silent destroyers," pose a significant threat to both residential and commercial structures worldwide. Some of the deleterious termite species belong to the family Termitidae, which comprises of four subfamilies namely, Macrotermitinae, Nausititermitinae, Termitinae, and Apicotermitinae [6]. These tiny insects feed on cellulose-based materials such as wood, causing extensive damage to buildings, furniture, and other wooden structures. Different Methods have been used by local farmers in control of termites. These include destruction of termite mound, application of wood ash, and animal excreta. Synthetic pesticide remain the primary method used to prevent termite attack. They are directly applied to termite mound, plant or wood materials and also directly to soil, but concerns over their environmental impact and potential health hazards have prompted the exploration of alternative approaches. Many plants are tested to have anti-termite activities [2,8,9] or repellent to termites [1,12] This introduction provides an overview of the effectiveness of botanical oils in termite management, exploring their mechanisms of action, potential advantages and limitations (Figure-1).

1.1. Plant Sources of Botanical Oil

- ***Mentha piperita***- Peppermint (*M. piperita*) oil is one of the most sought for and widely used essential oils, mainly due to presence of menthol and menthone [3]. Studies have shown that plants of the genus *Mentha* has unique antimicrobial behaviour, primarily due to the presence of oxygenated monoterpenes in their chemical composition. Spearmint is reported to have insecticidal and insect repellent properties [4].

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- ***Azadirachta indica***- Neem Buds (*Azadirachta indica*) have long been used in traditional medicine and pest control due to their natural insecticidal properties. Neem leaves contain several compounds, including azadirachtin, which is known to have insecticidal effects.[10]
- ***Syzygium aromaticum*** – Clove (*Syzygium aromaticum*) is a perennial tropical plant that it is widely cultivated in Indonesia, Srilanka, Madagascar, Tanzania and Brazil. The essential oil of clove has been widely applied in medicines, food and cosmetics industries.
- ***Brassica nigra*** - Commonly called as Black Mustard. *B. nigra* seed (black mustard) has been used in the therapeutic preparations for times unknown in different parts of the world. It contains allyl isothiocyanate.

2. Materials and methods

2.1. Collection of termites

Lucknow is the capital and largest city of the Indian state Utter Pradesh the district covers an area 2,528 square kilometers. Lucknow city is located on the northwestern shore of the Gomti River. The Termites are collected from an infested piece of wood log in Gram Panchayat Banauga of District Lucknow (Figure-2 and Figure-3).

2.2. Collection of Oils

Botanical oil of *Azadirachta indica* and *Syzygium aromaticum* has been obtained from a shop in Amaniganj, District Lucknow and *Mentha piperita* and *Brassica nigra* has been field prepared from Village Banauga, District Lucknow.

2.3. The instruments used in Experiments

Boxes measuring cm in 6.1 cm length and 6.5 cm diameter, equipped with covers. These boxes contained 30 holes with diameter 20 mm to allow for termite respiration. Additionally brush, filter paper, thermometer, needle was employed. The material used included the *Mentha piperita* (Peppermint), *Azadirachta indica* (Neem), *Syzygium aromaticum* (Clove), *Brassica nigra* (Mustard) botanical oils.

2.4. Experimentation

Plastic boxes were prepared with Whatman no.1 filter paper. Two different volumes 0.5 ml and 1 ml of botanical oils were applied to separate boxes in a piece of cotton for 30 minutes. Each box was randomly populated with 10 Workers and 5 Soldier Termite. Insects were observed and recorded daily for mortality within 24, 48 and 72 hrs. Any insect that remained immobile and unresponsive to 3 probing attempts with a blunt dissecting probe during a five-minute recovery period was considered dead.

2.5. Statistical Analysis

The statistical analysis of data was done. Calculated the mean and standard error of data. (mean ±S.E.).

Figure 1 Damage caused by Termites to a part of wood furniture in domestic

Figure 2 Termites in experiment collected from this wooden log

Figure 3 Termites collected and kept in a porous plastic box

Figure 4 Experiment performed in boxes

Figure 5 Instrument and Botanical oil used in the Experiment

3. Results and discussion

The application of botanical pesticides in the management of termites and other insects in agriculture and forestry holds a promise for reducing threats posed to the environment by synthetic pesticides. From this study, application of *Mentha piperita*, *Syzygium aromaticum*, *Azadirachta indica, Brassica nigra* showed that mortality response of termite is Dose and Time dependent. Mortality of termite increased with increase in oil concentration and with increase in the period of exposure to oil [7]**.** Direct contact between the toxicants or active ingredients presents in the test plants and the bodies of insects contributed to the mortality of adult insects. When insects come into contact with these substances it results in harmful effect that led to their death [11].

- ***Mentha piperita***– The mortality of Termites after 0.5 ml concentration of *Mentha piperita* botanical oil (mean ± S.E.) for 24 hrs. are 4±0.38, for 1 ml (mean ±S.E.) is 4.25±0.39 for 24 hrs. of exposure. For 48 hrs. of exposure of 0.5 ml concentration of *Mentha piperita* the mortality (mean± S.E.) is4.25±0.38 and for 1 ml concentration mortality (mean± S.E.) is 5±0.39. And in 72 hrs. of exposure of 0.5 ml of concentration of *Mentha piperita* the mortality of termites (mean± S.E.) is 5±0.38 and for 1 ml exposure the concentration of *Mentha piperita* for termite (mean ± S.E.) is 5.25±0.39). (Table1 and Figure-6).
- ***Syzygium aromaticum***– The mortality of Termites after 0.5 ml concentration of *Syzygium aromaticum* botanical oil (mean ± S.E.) for 24 hrs. are 3.5±0.31, for 1 ml (mean ±S.E.) is 4±0.43 for 24 hrs. of exposure. For 48 hrs. of exposure of 0.5 ml concentration of Syzygium *aromaticum* the mortality (mean± S.E.) is4±0.31 and for 1 ml concentration mortality (mean± S.E.) is 4.5±0.43. And in 72 hrs. of exposure of 0.5 ml of concentration of *Syzygium aromaticum* the mortality of termites (mean± S.E.) is 4.75±0.31 and for 1 ml exposure the concentration of *Syzygium aromaticum* for termite (mean ± S.E.) is 5.25±0.43). (Table1 and Figure-6).
- ***Azadirachta indica–*** The mortality of Termites after 0.5 ml concentration of *Azadirachta indica* botanical oil (mean ± S.E.) for 24 hrs. are 3.5±0.25, for 1 ml (mean ±S.E.) is 4.25±0.41 for 24 hrs. of exposure. For 48 hrs. of exposure

of 0.5 ml concentration of *Azadirachta indica* the mortality (mean± S.E.) is4.25±0.25 and for 1 ml concentration mortality (mean± S.E.) is 4.5±0.41. And in 72 hrs. of exposure of 0.5 ml of concentration of *Azadirachta indica* the mortality of termites (mean± S.E.) is 4±0.31 and for 1 ml exposure the concentration of *Azadirachta* indica for termite (mean ± S.E.) is 5±0.41). (Table1 and Figure-6).

- ***Brassica nigra*** – The mortality of Termites after 0.5 ml concentration of *Brassica nigra* botanical oil (mean ± S.E.) for 24 hrs. are 2.25±0.25, for 1 ml (mean ±S.E.) is 3.5±0.27 for 24 hrs. of exposure. For 48 hrs. of exposure of 0.5 ml concentration of *Brassica nigra* the mortality (mean± S.E.) is 2.75±0.25 and for 1 ml concentration mortality (mean± S.E.) is 4±0.27. And in 72 hrs. of exposure of 0.5 ml of concentration of *Brassica nigra* the mortality of termites (mean± S.E.) is 3.5±0.25 and for 1 ml exposure the concentration of *Brassica nigra* for termite (mean ± S.E.) is 4±0.27). (Table1 and Figure-6).

Table 1 The mortality (Mean± S.E.) of Termite after treatment with Botanical oils

Botanical oil	**Number of Termites introduced in each replica**	**Doses (In ml)**	**Mortality (mean± S.E.) of Termites after treatment application**		
			Day1 (24 hrs.)	Day2 (48 hrs.)	Day3 (72 hrs.)
Mentha piperita	15	0.5 ml	4±0.38	4.25±0.38	5± 0.38
	15	1 ml	4.25±0.39	5±0.39	5.25±0.39
Syzygium aromaticum	15	0.5 ml	3.5±0.31	4±0.31	4.75±0.31
	15	1 ml	4±0.43	4.5±0.43	5.25±0.43
Azadirachta indica	15	0.5 ml	3.5±0.25	4±0.25	4.25±0.25
		1 ml	4.25±0.41	4.5±0.41	5±0.41
Brassica nigra	15	0.5 ml	2.25±0.25	2.75±0.25	3.5±0.25
	15	1 ml	3.5±0.27	4±0.27	4±0.27

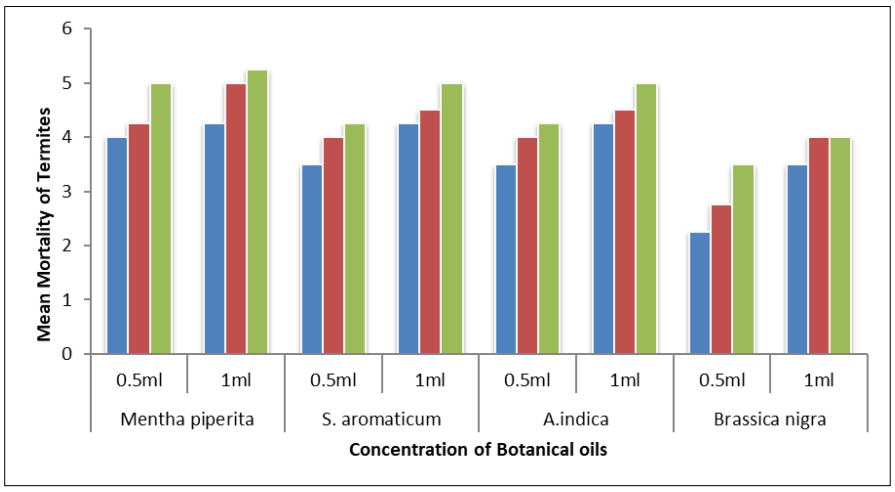

Figure 6 Mean Mortality of Termites due to effect of Botanical oils

4. Conclusion

The use of synthetic chemicals put undesirable and detrimental effects on the environment. Besides this, their indiscriminate use made food chains highly poisonous. These synthetic pesticides are also proved highly toxic and lethal to non-targeting organisms. However, essential oil-based formulations showed strong anti-termite potential and acted as natural pesticides. Apart from being highly effective for management of various field pest these are biodegradable and have no residual effect. This plant based natural pesticides are highly effective against insect pest such as termites. These are less hazardous, non-persistent, eco-friendly and provide long lasting insect control. The exploration of botanical oils as alternatives for termite management reveals promising findings and potential avenues for sustainable pest control. Extensive research demonstrates the efficacy of botanical oils such as Neem oil, Clove oil, and Peppermint oil in repelling, killing, or inhibiting the growth of termite populations. Their natural origin and biodegradability offer environmental benefits over chemical pesticides, aligning with the growing demand for eco-friendly pest control solutions. However, challenges such as variability in efficacy, cost considerations, and regulatory hurdles underscore the need for further research and collaboration. Integrating botanical oils into integrated pest management (IPM) strategies holds promise for enhancing overall effectiveness and sustainability in termite management practices. Future efforts should focus on optimizing formulations, evaluating long-term ecological impacts, and addressing barriers to widespread adoption to realize the full potential of botanical oils in mitigating termite infestations while minimizing environmental harm. By leveraging the benefits of botanical oils and embracing interdisciplinary approaches, we can pave the way for more eco-conscious and effective solutions in termite management.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors have no any conflict of interest for publishing this article.

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