**Efficacy of non-edible oil seedcakes against termite (Odontotermes obesus)**

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This study evaluates termiticidal potential of non-edible oil seedcakes (jatropha, karanja, neem and mahua) and their crude active components (phorbol esters, karanjin, saponins and azadirachtin) *in vitro* and *in vivo*. Cold water extracts of neem cake showed better results than hot water extracts of same cake and caused 100% mortality of termites in 72 h. Crude karanjin extract induced 83.3% mortality after 2 h in petriplate (diam, 4.5 cm) and 100% after 4 h in petriplates (diam, 9.5 cm). *In vivo*, combination of all cakes was most effective with 1.59% weight loss.

**Keywords:** Insecticidal, Jatropha, Karanja, Mahua, Neem

**Introduction**

Termites*¹* (*Odontotermes* sp.) that reduce crop yield and destroy stored grains are serious pest of various crops*²* (wheat, sugarcane, groundnut and paddy) and cause significant yield losses in annual and perennial crops and damage wooden structures in buildings, especially in semi-arid and sub-humid tropics*³*. Termites are responsible for plant mortality (5-50%) and pod damage (46%) in groundnut*⁴*. Control of termites has largely relied on broad spectrum and persistent organochlorine insecticides⁵. To avoid environmental pollution and health problems caused by traditional wood preservatives or synthetic pesticides, there is an increasing search for naturally occurring toxicants from plants⁶. Extractives of phytobiomass (wood, bark, leaves etc.) having antitermite activity can be used as low hazard termite control agents⁷. Leaves of *Ricinus communis*, *Tagetus erecta* and *Pongamia glabra* are effective against *Odontotermes obesus*⁸–⁹. Flavonoids, terpenoids and fatty acids present in biomass control termites⁹–¹¹. Jatropha oil or defatted seed meal caused death of rats within 6-8 days¹². Extracts from *Jatropha curcas* seeds and leaves showed molluscicidal, insecticidal and fungicidal properties¹³–¹⁵. Karanja oil possesses insecticidal and nematicidal activity¹⁶. Neem controls insect pests¹⁷. Neem extracts and azadirachtin had significant effects on nymphs of *Nilaparvata lugens¹⁸*. Neem cake is most effective in reducing reproduction rate of nematode, *Pratylenchus thornei¹⁹*.

This study assesses termiticidal potential of jatropha, neem, karanja and mahua oil seedcakes and their crude active fractions.

**Experimental Section**

**Cold and Hot Water Extracts of Oil Seedcakes**

Non edible oil seedcakes of jatropha and karanja were procured from CRDT, IIT, Delhi, India. Mahua and neem cakes were obtained from Pratapgarh, UP, India. Cakes were dried in hot air oven to remove moisture. Cold water extracts (1.25, 2.5 and 6.25%) were prepared by leaving 1.25, 2.5 and 6.25 g respectively of each cake in 100 ml cold water overnight and filtering them through Whatmann no. 1 filter paper. Hot water extracts (1.25, 2.5 and 6.25%) were prepared by adding 1.25, 2.5 and 6.25 g respectively of each cake in 100 ml cold water overnight and filtering them through Whatmann no. 1 filter paper.

**Extraction of Crude Active Components from Oil Seedcakes**

Oil seedcakes were defoiled in soxhlet apparatus as solvent. Cold extraction of defoiled cakes was done by methanol: water and concentrated under reduced pressure in rotary evaporator. Extract left after evaporation was further separated using diethyl ether in separating funnel. Diethyl ether layer was collected and evaporated. Crude extract of phorbol esters left after

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evaporation. For separation of azadirachtin, concentration from methanol: water extract was done using ethyl acetate. Ethyl acetate layer was collected and evaporated. Extract left was rich in crude azadirachtin. For saponin, partitioning of methanol: water extract was done using butanol. Butanol layer was collected and evaporated. Extract left was rich in crude saponins. For karanjin, extract left after evaporation of methanol water was used as crude karanjin extract. Concentration of each crude fraction was 0.5 g/ml of methanol as solvent.

Termites

Subterranean termite (O. obesus), collected from IIT Delhi campus and acclimatized for 24 h in laboratory conditions before use\(^2\), was maintained at 25 ± 1°C and 80 ± 5% relative humidity (RH) in plastic container with dried pine wood and filter paper as food source.

Lab Testing (in vitro)

No-choice bioassay\(^2\) was employed to evaluate antitermitic activity of cold and hot aqueous extract of oil seedcakes and crude fractions of active components of these cakes. Cold and hot aqueous extracts (conc. 1.25, 2.5 and 6.25%) and crude fractions (conc. 10%) were tested for termite mortality. Experiments were set up in two set of Petri dish (diam 4.5 cm & 9.5 cm) to assess effect of contact area of treatment to their mortality. Three replicates were made for each concentration and 500 µl extract of each concentration was loaded on filter paper. A moistened extract treated cellulose filter paper disc (diam 4.5 cm) was placed at the bottom of each Petri dish. A piece of filter paper treated with only solvent was used as control. Solvent was removed from treated filter paper by air drying at room temperature (RT). Active termites (10 adult workers) were then put in each Petri dish. Dishes with covers were placed in an incubator at 25 ± 1°C and 80 ± 5% RH. A few drops of water were periodically dripped on filter paper disc kept inside Petri dish. Mortality was recorded after regular intervals.

Field Testing (in vivo)

Seedcakes mixed with 1% jaggery solution were applied on pre-weighed wooden blocks (size, 26 cm x 4 cm x 1 cm). Blocks were dried and inserted into termite infested soil. After three months, blocks were collected, cleaned, dried and weighed.

Statistical Analysis

Analysis of variance (ANOVA) was performed on experimental data and means were compared by Duncan’s multirange test with SPSS 10.0 software. Significance level was p<0.05.

Results and Discussion

Termiticidal Activity of Oil Seedcakes in Lab Conditions

Table 1—Effect of cold water extract of oil seed cakes on termite mortality

<table>
<thead>
<tr>
<th>Treatment (Cakes)</th>
<th>Conc. (%)</th>
<th>2 h</th>
<th>4 h</th>
<th>6 h</th>
<th>12 h</th>
<th>24 h</th>
<th>48 h</th>
<th>72 h</th>
<th>1 Week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jatropha</td>
<td>1.25</td>
<td>0.0±0.0d</td>
<td>0.0±0.0d</td>
<td>6.7±0.0gh</td>
<td>16.7±0.0f</td>
<td>20.0±0.0cde</td>
<td>26.7±4.7d</td>
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<td>0.0±0.0d</td>
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<td>10.0±0.0gh</td>
<td>20.0±0.0ef</td>
<td>23.4±4.7cd</td>
<td>26.7±4.7d</td>
<td>50.0±0.0c</td>
<td>100.0±0.0a</td>
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<tr>
<td></td>
<td>6.25</td>
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<td>30.0±0.0ab</td>
<td>50.0±0.0ab</td>
<td>50.0±0.0ab</td>
<td>50.0±0.0ab</td>
<td>70.0±8.2a</td>
<td>83.3±12.5ab</td>
<td>100.0±0.0a</td>
</tr>
<tr>
<td>Karanja</td>
<td>1.25</td>
<td>0.0±0.0d</td>
<td>0.0±0.0d</td>
<td>10.0±0.0gh</td>
<td>10.0±0.0fg</td>
<td>23.4±4.7cd</td>
<td>33.3±4.7cd</td>
<td>66.7±12.5bc</td>
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<td>16.7±4.7efg</td>
<td>20.0±0.0ef</td>
<td>26.6±4.7cd</td>
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<td>83.3±12.5ab</td>
<td>100.0±0.0a</td>
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<td>0.0±0.0d</td>
<td>13.3±9.4c</td>
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<td>50±16.3c</td>
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<td>83.3±12.5ab</td>
<td>100.0±0.0a</td>
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<td>Mahua</td>
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<td>33.3±12.5cd</td>
<td>33.3±12.5cd</td>
<td>50±16.3ab</td>
<td>70.0±8.2a</td>
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<td>2.5</td>
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<td>Neem</td>
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<td>6.7±4.7de</td>
<td>50±0.0bc</td>
<td>100.0±0.0ab</td>
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<tr>
<td>Control</td>
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<td>0.0±0.0h</td>
<td>0.0±0.0e</td>
<td>0.0±0.0e</td>
<td>10.0±0.0d</td>
<td>16.7±4.7b</td>
<td></td>
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</table>

Values (means of 3 replicates) in each column not sharing a common letter differ significantly (p<0.05) from each other (Duncan’s multi range test)
56.7% of termites followed by neem and jatropha (50% each) at 6.25% concentration after 6 h; while after 48 h, maximum mortality (70%) was observed with mahua (conc. 1.25%) and jatropha (conc. 6.25%). All cakes showed 100% mortality after a week. Mortality observed with control was 16.7%.

**Termiticidal Activity of Hot Water Extracts of Oil Seedcakes**

Hot water extracts were not as effective as cold water extracts. Maximum mortality was observed after 72 h with 6.25% extracts of neem (100%) followed by karanja (86.7%). Among all extracts, hot water extract of neem (conc. 6.25%) caused maximum mortality at both 24 h (63.3%) and 48 h (83.3%). All cakes showed 100% mortality after one week (Table 2).

**Termiticidal Activity of Crude Active Components of Oil Seedcakes**

Termiticidal activity of crude active components of all cakes was evaluated in petriplate (diam 4.5 cm). Crude fractions of all cakes caused 100% mortality after 6 h. Extracts of karanjin and saponin were most potent, causing 100% mortality after 4 h. Mortality (10%) was observed in solvent control after 48 h (Fig. 1). Mortality caused by phorbol esters was 80% after 4 h. In case of azadirachtin, mortality was 100% after 6 h and 86.7% after 4 h.

Effect of crude fractions on termites was also conducted in petriplate (diam 9.5 cm). All crude fractions caused 100% mortality after 12 h (Fig. 2). Maximum

### Table 2—Effect of hot water extract of oil seed cakes on termite mortality

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Conc. (%)</th>
<th>2 h</th>
<th>4 h</th>
<th>6 h</th>
<th>12 h</th>
<th>24 h</th>
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</tr>
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<tbody>
<tr>
<td>Jatropha</td>
<td>1.25</td>
<td>0.0±0.0c</td>
<td>0.0±0.0c</td>
<td>0.0±0.0d</td>
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<td>11±0.0e</td>
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<tr>
<td>Karanja</td>
<td>1.25</td>
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<td>0.0±0.0c</td>
<td>0.0±0.0d</td>
<td>0.0±0.0d</td>
<td>10±0.0e</td>
<td>10±0.0e</td>
<td>100.0±0.0a</td>
<td></td>
</tr>
<tr>
<td></td>
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<td>0.0±0.0c</td>
<td>10±0.0c</td>
<td>20.0±0.0b</td>
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<td>0.0±0.0c</td>
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<td>0.0±0.0d</td>
<td>10±0.0e</td>
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<td>Neem</td>
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<td>0.0±0.0d</td>
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<td>83.3±4.7a</td>
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<tr>
<td>Control</td>
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<td>0.0±0.0d</td>
<td>0.0±0.0d</td>
<td>0.0±0.0f</td>
<td>6.7±4.7e</td>
<td></td>
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</tbody>
</table>

Values (means of 3 replicates) in each column not sharing a common letter differ significantly (p<0.05) from each other (Duncan’s multi range test)
mortality (100%) was observed with karanjin and saponin after 6 h. Karanjin extract induced death of 73.3% population of termites after 2 h. Phorbol ester fraction effectively killed 100% termites after 12 h. Azadirachtin fraction caused maximum mortality (100%) after 12 h.

Discussion

Crude extracts showed promising results as compared to hot/cold water extracts. Termites died after 6 h where area of contact is less than twice, suggesting that forced and maximum exposure of termites to extract is required to achieve maximum mortality in lesser time period. Crude fraction of karanja was most potent of all. Aqueous extract of karanja cake was not as effective as other cakes, may be due to insolubility of karanjin in water. The results are in accordance with nematicidal activity of water extract of karanja cake found to be inferior as compared to neem and mahua cakes. Alcohol extract of karanjin was effective against mustard aphid (Lipaphis crysimi Kalt.) Effect of karanjin against cockroach (Periplanata americana) is also reported. In field, combination of all cakes was most effective followed by neem cake, may be due to synergistic action of all active components (phorbol esters, karanjin, saponins and azadirachtin). Combined formulation of neem and karanja showed synergism by providing 100% protection against aphids and mites. Formulation (EC$_{50}$ of neem seed extract) was feeding deterrent to aphids.

Conclusions

Crude active components of all seedcakes were effective. Karanjin fraction was most potent. It may be beneficial to further purify and characterize active components and develop commercial formulation for termite management. Long term field level studies are also required.

Acknowledgement

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References


15 Solsoloy A D & Solsoloy T S, Pesticidal efficacy of formulated *J. curcas* oil on pests of selected field crops, in *Biofuels and Industrial Products from Jatropha curcas*, edited by G M Mittelbach *et al* (Dbv-Verlag fur die Technische Universitat Graz, Austria) 1997, 216-226.


