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Efficacy of Plant Extracts Against Subterranean Termites i.e., *Microtermes obesi* and *Odontotermes lokanandi* (Blattodea:Termitidae)

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Abstract

Leaf and seed crude extracts at three concentrations (high, medium and low) of *Euphorbia helioscopia L.*, *Cannabis sativa L.*, and *Calotropis procera* (Ait.) were tested against workers and soldiers (4-5th instar) of *Microtermes obesi* Holmgren and *Odontotermes lokanandi* Chatarjee and Thakur (Blattodea: Termitidae). Results revealed that all extracts showed moderate toxic effect. 100% mortalities were found in *M. obesi* and *O. lokanandi* on day 11 and 7 respectively. Our results showed that Mortalities in both species were concentration depended. Maximum mortalities were observed in high concentration, followed by medium and low. Our results also indicated that *M. obesi* was more resistant than *O. lokanandi*.

Keywords: *M. obesi*; *O. lokanandi*; *E. Helioscopia*, *C. Sativa*; *C. Procera*; Concentration; Seed; Leaf

Introduction

Subterranean termites are highly destructive polyphagous insect pests [1], which largely damage house hold materials. They damaged goods, plants and agricultural crops such as sugarcane, millet, barley and paddy [2]. It is estimated that billions of dollars are spent annually to control termites worldwide [3]. In the past, the control of termites has been totally based on chemicals, especially synthetic insecticides such as persistent organo-chlorine (OC) and organophosphate (OP) insecticides [4,5]. The maximum residual effects as well as the development of insecticide resistance in target pests along with adverse effects on human health and concerns for environmental deterioration are some of disadvantages that hinder widespread use of pesticides [6].

Replacement of synthetic insecticides with bio-pesticides is a universal acceptable and practical approach worldwide [7]. Plant extracts offer a vast, virtually untapped reservoir of chemical compounds with many potential uses. One of these uses is in agriculture to manage pests with less risk than with synthetic compounds that are toxicologically and environmentally undesirable. Various experiments using plant extracts in human and animal health protection, agriculture and household pest management have been particularly promising [8,9]. The plant extracts with complex mixtures of such compounds have been investigated for their insecticidal, repellent, and anti-feedant properties [10-13]. The deleterious effects of photochemical or crude plant extracts on insects are manifested in several ways, including suppression of calling behaviour [14], growth retardation [15], toxicity [16], oviposition deterrence [17], feeding inhibition [18] and reduction of fecundity and fertility [19].

Plants contain chemicals such as terpenoids, flavonoids, saponins, etc. or mixtures of chemicals that repel or kill termites or interfere with their gut flora [20-24]. In the past for termite control few plant species such as *Pseudotsuga menziesii* (Mirb.), *Lysitoma seemnii* L., *Tabebuia guayacan* (Seem.), *Diospyros sylvatica* Roxb. [25], *Curcuma aromatica* Salisb. and *Euphorbia kansuii* GanSui. [26], *Eucalyptus globules* L., lemmon grass, *Eucalyptus citrodora* (Hook.), cedar wood, clove bud and vetiver grass [11], *Taiwania cryptomerioides* Hay. [27], *Dodonaea viscose* (L.) Jacq. (Purple hop bush) a termite resistant shrub [28], *Ocimum basilicum* L., *Cymbopogon winterianus* Jowitt, *Cinnamomum camphora* (L.) Nees and Eberm., *Rosmarinus officinalis* L. [29] and *Coleus ambionicus* (Lour.) [30] have been explored for their anti-feedant and insecticidal activities. Researchers reported that many plants have been recognized to have anti-termitic activities [23,31-35].

The present study was focused to find out the insecticidal potential of *Euphorbia helioscopia L.*, *Cannabis sativa L.*, and *Calotropis procera* (Aiton) against *Microtermes obesi* and *Odontotermes lokanandi*.

Materials and Methods

Collection of Experimental Termites

The experimental termites were collected from an infested termites building situated in Rawal Town, Islamabad by trapping technique used by [36] and these termites were acclimatized in Entomological laboratory of National Agriculture Research Center, Islamabad. These termites were identified by using the taxonomic keys designed by Chaudhry et al.

Extracts preparation

Three fresh and healthy plants of *Euphorbia heliocsopia* L. (Sun spurge), *Calotropis procera* (Ait.) (Ak) and *Cannabis sativa* L. (Bhang) were collected from Islamabad. These plants were brought in the Entomological Laboratory of National Agriculture Research Center, Islamabad. Aqueous extracts of leaves and seeds of each plant were prepared in three levels i.e., 50, 33 and 25% (high, medium and low) by using the methodology of [37] with some modifications.

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Bioassay

Force-feeding tests were conducted following the procedure adopted by [38]. Petri dishes having (dia. 5.5 cm) were used as experimental units. These were sterilized in the oven at 200°C. Circular filter papers were cut and the bottom of each sterilized glass Petri dish was provided with two of them and the lid of each Petri dish with one. Each filter paper in the bottom was soaked with 0.2 mL of the respective extracts concentrations to the extent that it was fully absorbed. Soaking was carried out with the help of a syringe. For each concentration a new syringe was used. Distilled water was used for control. Each treatment was replicated three times. Then populations of 50 termites (45 workers and 05 soldiers) of 4^{th} -5^{th} instar (as determined by size) were added to each Petri dish. The Petri dishes were placed in the desiccators having 92% relative humidity. These desiccators were kept in laboratory at temperature (27 ± 30°C) and relative humidity (60 ± 5%). Daily observations were taken and the dead individuals in each Petri dish were removed through forceps.

Statistical Analysis

The data was converted to percentage by using the following formula:

Percent Mortality = Total number of dead termites after treatment x 100/ Total number of termites before treatment

Then the percent mortality was corrected by using Abbots formula [39]. The experiment was designed as a completely randomized experiment. Statistical computing was performed by using Co-Stat. Means were separated by using Least Significant Difference (LSD) at P<0.05

Results

Euphorbia helioscopia

Microtermes obesi

Results (Table 1) showed percent mortalities in *M. obesi* was 100.00 ± 0.00, 91.06 ± 3.16 and 85.82 ± 2.17 at high, medium and low concentrations of leaf extract of *E. helioscopia*, respectively in 11^{th} day. The analysis revealed that the percent mean mortality recorded at medium and low concentrations was found non-significant (P>0.05), but significantly differed from high aqueous concentration; whereas percent mean mortalities in *M. obesi* by using seed extracts at high, medium and low concentrations of *E. helioscopia* were 100.00 ± 0.00, 100.00 ± 0.00 and 94.17 ± 3.06, respectively, which was statistically similar (P>0.05).

Leaf				Seed		
After day's	High	Medium	Low	High	Medium	Low
1	3.40 ± 0.68a	3.40 ± 0.68a	2.72 ± 0.68a	2.05 ± 1.18a	2.07 ± 0.01a	1.37 ± 0.69a
2	6.25 ± 1.20a	5.56 ± 0.69a	4.39 ± 0.69b	5.59 ± 1.37a	4.89 ± 0.68a	2.79 ± 0.69a
3	18.70 ± 0.67a	15.09 ± 1.14b	11.49 ± 1.82c	11.03 ± 1.29a	9.55 ± 1.44a	5.86 ± 1.91b
4	27.99 ± 1.64a	24.22 ± 1.23b	21.94 ± 1.26c	19.82 ± 1.89a	16.01 ± 1.22b	12.19 ± 1.44c
5	38.98 ± 1.96a	34.93 ± 1.24ab	32.47 ± 1.69b	36.00 ± 0.29a	31.20 ± 1.40b	25.61 ± 0.92c
6	53.42 ± 1.86a	48.29 ± 1.13ab	45.77 ± 0.38b	52.87 ± 1.62a	36.36 ± 1.42b	33.88 ± 0.27b
7	57.01 ± 1.65a	53.26 ± 0.92ab	50.45 ± 0.94b	64.99 ± 1.27a	53.04 ± 1.57b	49.59 ± 1.11c
8	66.61 ± 2.05a	62.62 ± 0.12b	58.54 ± 1.16c	79.46 ± 1.74a	72.90 ± 0.82b	69.08 ± 2.11b
9	74.68 ± 1.32a	69.21 ± 2.01ab	64.61 ± 2.54b	88.91 ± 2.44a	83.69 ± 0.82b	79.61 ± 0.55b
10	87.83 ± 3.50a	76.14 ± 1.04b	72.75 ± 2.09b	95.70 ± 2.15a	92.40 ± 2.08b	86.87 ± 1.67c
11	100.00 ± 0.00a	91.06 ± 3.16b	85.82 ± 2.17b	100.00 ± 0.00a	100.00 ± 0.00a	94.17 ± 3.06a

Table 1: Mean percent mortality in *Microtermes obesi* at leaf and seed extracts of different concentrations of *Euphorbia helioscopia* Different letters within a row indicate differences of P<0.05.

Odontotermes lokanandi

Results (Table 2) showed percent mean mortality in *O. lokanandi* were 100 ± 0.00, 93.32 ± 3.35 and 78.83 ± 5.29 at high, medium and low concentrations of leaves of E. helioscopia, respectively in 7^{th} day. Results indicated that percent mean mortalities were non-significant (>0.05) at high and medium concentrations, but significantly differed (P<0.05) from mean percent mortality at low concentration; while percent mortalities were 100.00 ± 0.00, 76.58 ± 4.12, 75.15 ± 7.08 at high, medium and low concentrations of seeds, respectively in 6th day. Statistically the percent mortality at medium and low concentrations was found non- significant (P>0.05), while significantly different (P<0.05) from percent mean mortality recorded at high concentration (Table 2).

Leaf				Seed		
After day's	High	Medium	Low	High	Medium	Low
1	8.97 ± 0.72a	8.97 ± 0.72a	6.55 ± 0.30a	8.99 ± 2.46a	6.19 ± 2.33ab	2.75 ± 1.37b
2	15.67 ± 0.11a	16.41 ± 0.69a	11.94 ± 0.70b	24.96 ± 2.45a	13.89 ± 2.43b	8.81 ± 1.25c
3	19.99 ± 1.31a	16.67 ± 0.87ab	12.48 ± 1.38b	37.46 ± 2.07a	31.21 ± 2.60b	20.30 ± 1.48c
4	34.55 ± 0.82a	31.82 ± 0.81a	25.63 ± 1.34b	60.40 ± 2.43a	41.96 ± 2.87b	37.66 ± 2.62b
5	54.52 ± 1.55a	48.54 ± 0.85ab	40.48 ± 2.62b	68.88 ± 4.50a	52.42 ± 1.64b	51.13 ± 4.34b
6	80.07 ± 3.04a	68.80 ± 2.92b	61.22 ± 0.89b	100.00 ± 0.00a	76.58 ± 4.12b	75.15 ± 7.08b
7	100 ± 0.00a	93.32 ± 3.35a	78.83 ± 5.29b			

Table 2: Mean percent mortality in *Odontotermes lokanandi* at leaf and seed extracts of different concentrations of *Euphorbia helioscopia*. Different letters within a row indicate differences of P<0.05.

Cannabis sativa

Microtermes obesi

Results (Table 3) indicated that percent mean mortalities in *M. obesi* at high, medium and low aqueous concentrations of leaf extracts of *Cannabis sativa* were 100.00 ± 0.00, 98.01 ± 0.10 and 95.00 ± 0.98, respectively in 11th day. Statistically the percent mean mortality at high concentration was found non-significant (P<0.05) from percent mean mortality at medium, but significantly higher (P<0.05) from observation recorded at low concentration; while 100% mortality was recorded at high concentration of seed extracts of *Cannabis sativa* in 11th day, which is statistically non-significantly different (P>0.05) from percent mean mortality recorded at medium concentration and significantly higher (P<0.05) from percent mean mortality recorded at low concentration.

Leaf				Seed		
After day's	High	Medium	Low	High	Medium	Low
1	4.75 ± 0.62a	4.74 ± 1.32a	3.39 ± 0.65a	8.05 ± 0.05a	7.37 ± 0.63a	7.36 ± 1.74a
2	9.07 ± 0.56a	6.95 ± 1.74ab	6.27 ± 1.13b	12.33 ± 0.09a	10.94 ± 1.30a	9.58 ± 1.33a
3	19.26 ± 1.00a	17.12 ± 1.02ab	15.67 ± 1.66b	21.50 ± 1.19a	19.41 ± 1.60ab	18.03 ± 1.19b
4	27.21 ± 2.27a	24.22 ± 1.23ab	21.18 ± 1.30b	25.07 ± 3.65a	25.15 ± 0.98a	22.23 ± 2.25a
5	40.69 ± 2.49a	38.42 ± 1.50ab	35.32 ± 2.28b	38.04 ± 2.04a	34.35 ± 2.15a	29.05 ± 2.21a
6	49.19 ± 1.75a	46.03 ± 0.39ab	40.42 ± 2.19b	47.66 ± 2.31a	43.04 ± 2.35ab	38.38 ± 2.53b
7	64.17 ± 2.10a	62.61 ± 0.44a	56.04 ± 2.03b	58.63 ± 2.00a	52.91 ± 0.47b	49.59 ± 1.11b
8	78.23 ± 2.44a	74.76 ± 1.07a	69.55 ± 1.12b	67.31 ± 0.81a	60.97 ± 1.55b	58.19 ± 2.06b
9	90.18 ± 0.85a	85.73 ± 0.76b	80.38 ± 1.71c	85.97 ± 1.16a	77.02 ± 0.55b	72.92 ± 3.29b
10	97.17 ± 17a	89.63 ± 0.90b	87.75 ± 0.82b	94.76 ± 1.00a	89.48 ± 1.00b	85.28 ± 2.02c
11	100.00 ± 0.00a	98.01 ± 0.10ab	95.00 ± 0.98b	100.00 ± 0.00a	96.70 ± 1.92ab	91.18 ± 2.89b

Table 3: Mean percent mortality in Microtermes obesi at leaf and seed extracts of different concentrations of *Cannabis sativa*. Different letters within a row indicate differences of P<0.05.

Odontotermes lokanandi

Maximum (100 ± 0.00) percent mean mortalities in *O. lokanandi* were recorded at high concentration of leaf extract of *Cannabis sativa* in 7th day, which was found similar (P>0.05) to percent mean mortalities (94.21 ± 3.22) recorded at medium concentration and significantly different (P<0.05) from percent mean mortality (81.58 ± 2.30) noted at lower concentration (Table 4); whereas percent mean mortalities in *O. lokanandi* were 100.00 ± 0.00, 93.31 ± 3.35 and 80.13 ± 2.32 at high, medium and low concentrations of seed extracts of

Cannabis sativa in 7th day, respectively. The result indicated that the percent mean mortality recorded at high and medium concentrations were found non-significant (P>0.05), but significantly different (P<0.05) from percent mean mortality noted at low concentration.

Leaf				Seed		
After day's	**High**	**Medium**	**Low**	**High**	**Medium**	**Low**
1	9.15 ± 1.38a	7.03 ± 1.39a	2.80 ± 0.68b	7.85 ± 1.40a	6.43 ± 0.05a	2.13 ± 1.23b
2	17.04 ± 0.58a	12.40 ± 0.79b	10.04 ± 1.45b	21.18 ± 1.30a	19.69 ± 0.56a	15.17 ± 0.93b
3	28.70 ± 2.73a	21.15 ± 1.40b	16.87 ± 1.91b	29.47 ± 2.59a	25.12 ± 3.13b	16.41 ± 2.84c
4	41.55 ± 0.67a	32.54 ± 2.60b	26.59 ± 2.76c	43.61 ± 2.68a	38.73 ± 2.82b	30.94 ± 3.72c
5	57.87 ± 2.10a	47.86 ± 3.93b	39.29 ± 2.79c	65.00 ± 3.83a	57.64 ± 0.72a	45.54 ± 2.13b
6	80.73 ± 2.69a	65.16 ± 3.31b	46.48 ± 3.59c	83.41 ± 3.00a	76.17 ± 2.41b	66.72 ± 1.86c
7	100 ± 0.00a	94.21 ± 3.22a	81.58 ± 2.30b	100.00 ± 0.00a	93.31 ± 3.35a	80.13 ± 2.32b

Table 4: Mean percent mortality in *Odontotermes lokanandi* at leaf and seed extracts of different concentrations of *Cannabis sativa*. Different letters within a row indicate differences of P<0.05.

Calotropis procera

Microtermes obesi

Results (Table 5) showed that percent mean mortalities in *M. obesi* were 100.00 ± 0.00, 100.00 ± 0.00 and 95.80 ± 1.03 at high, medium and low concentrations of leaf aqueous extracts of *Calotropis procera* in day 11 of the trial. The analysis revealed that percent mean mortality at high and medium concentrations was found non-significant (P>0.05), but significantly differed (P<0.05) from percent mean mortality found at low concentration (Table 5); while using seed aqueous, percent mean mortality in *M. obesi* was 100.00 ± 0.00, 96.04 ± 1.05 and 94.14 ± 1.63 at high, medium and low concentrations in 10th day, respectively. Percent mean mortality recorded at high concentration was found similar (P>0.05) to medium concentration and significantly different (P<0.05) from percent mortality noted at low concentration.

Leaf				Seed		
After day's	**High**	**Medium**	**Low**	**High**	**Medium**	**Low**
1	4.11 ± 0.03a	3.42 ± 0.67a	2.73 ± 0.67a	4.10 ± 1.17a	4.10 ± 1.17a	3.42 ± 0.67a
2	7.74 ± 0.68a	7.03 ± 0.65a	6.34 ± 0.04a	8.56 ± 1.19a	7.85 ± 0.66a	6.41 ± 1.20a
3	13.85 ± 1.86a	11.66 ± 1.38ab	8.76 ± 0.06b	18.37 ± 0.60a	16.91 ± 0.69a	16.89 ± 1.34a
4	18.68 ± 2.44a	17.93 ± 1.26a	15.62 ± 0.70a	32.03 ± 2.44a	29.76 ± 1.13ab	25.18 ± 1.16b
5	28.71 ± 2.18a	23.92 ± 1.97ab	19.97 ± 1.95b	46.86 ± 1.05a	42.97 ± 0.67b	35.94 ± 0.68c
6	43.33 ± 0.43a	36.62 ± 1.70b	32.51 ± 0.47b	58.48 ± 1.99a	52.79 ± 2.21b	52.03 ± 0.41b
7	62.89 ± 1.30a	55.13 ± 1.41b	50.79 ± 2.24c	71.91 ± 0.98a	67.55 ± 0.51ab	64.09 ± 1.80b
8	80.37 ± 0.71a	75.91 ± 1.36b	71.43 ± 0.80c	89.14 ± 1.73a	80.17 ± 0.94b	79.32 ± 1.51b
9	87.87 ± 0.69a	82.21 ± 1.14b	80.31 ± 1.92b	98.09 ± 0.95a	91.50 ± 1.61b	87.75 ± 0.84b
10	97.03 ± 1.70a	95.12 ± 0.92a	89.24 ± 0.84b	100.00 ± 0.00a	96.04 ± 1.05ab	94.14 ± 1.63b
11	100.00 ± 0.00a	100.00 ± 0.00a	95.80 ± 1.03b			

Table 5: Mean percent mortality in *Microtermes obesi* at leaf and seed extracts of different concentrations of *Calotropis procera*. Different letters within a row indicate differences of P<0.05.

Odontontermes lokanandi

The results (Table 6) on the effects of leaf aqueous extracts of *Calotropis procera* when offered to workers and soldiers of *Odontotermes lokanand* for seven days in the form of soaked filter paper, percent mean mortality was 100.00 ± 0.00, 93.71 ± 1.83 and 87.43 ± 2.03 at high, medium and low concentrations respectively. The analysis showed that the percent mean mortality recorded at high concentration was found significantly different (P<0.05) from percent mean mortality noted at medium and low concentrations; while by force fed them on aqueous seed extracts of *Calotropis procera*, percent mean mortality was 100.00 ± 0.00, 100.00 ± 0.00 and 91.16 ± 1.15 at high, medium and low concentrations respectively. Results revealed that mortality recorded at high and medium concentrations was found similar, but significantly high (P<0.05) from mortalities found in low concentration.

Leaf				**Seed**		
After day's	**High**	**Medium**	**Low**	**High**	**Medium**	**Low**
1	8.26 ± 1.14a	4.12 ± 1.17b	3.43 ± 1.35b	10.88 ± 0.68a	9.52 ± 0.68a	5.44 ± 0.68b
2	20.71 ± 1.35a	17.85 ± 0.66a	16.42 ± 1.37a	22.31 ± 0.81a	19.41 ± 1.12a	10.05 ± 1.85b
3	29.85 ± 1.93a	28.35 ± 1.39a	24.63 ± 0.19a	32.04 ± 0.93a	28.11 ± 1.17a	17.16 ± 1.44b
4	50.00 ± 1.19a	45.20 ± 1.84b	40.47 ± 1.19c	46.11 ± 2.03a	43.57 ± 0.83a	4.97 ± 2.57b
5	66.37 ± 2.35a	61.95 ± 1.57a	55.79 ± 0.97b	68.89 ± 2.71a	62.11 ± 1.81b	52.35 ± 2.54c
6	87.70 ± 1.98a	82.06 ± 1.04b	74.52 ± 1.67c	91.90 ± 4.23a	80.97 ± 3.37b	68.65 ± 3.25c
7	100.00 ± 0.00a	93.71 ± 1.83b	87.43 ± 2.03c	100.00 ± 0.00a	100.00 ± 0.00a	91.16 ± 1.15b

Table 6: Mean percent mortality in *Odontotermes lokanandi* at leaf and seed extracts of different concentrations of *Calotropis procera*. Different letters within a row indicate differences of P<0.05.

Discussion

Different concentrations of leaf and seed extracts of *Euphorbia helioscopia* were tested against *Microtermes obesi* and *O. lokanandi* for eleven and seven days, respectively. Our results showed that percent mean mortality of both species were directly proportion to the concentrations of treatments. Maximum mortalities in both species were observed at higher concentration. Toxicity ranged *in M. obesi* 2.72 ± 0.68 to 100 ± 0.00 and 1.37 ± 0.69 to 100.00 ± 0.00 by using aqueous leaf and seed extracts of *E. helioscopia*, respectively; while toxicity ranged in *O. lokanandi* by using leaf and seed extracts of *E. helioscopia* 6.55 ± 0.30 to 100 ± 0.00 and 2.75 ± 1.37 to 100 ± 0.00, respectively. Our results showed that *O. lokanandi* was more sensitive that *M. obesi*. Essential oils and plant extracts are still an important natural resource of pesticides/ insecticides [40,41] or larvicides [42-44] or insect repellents [45-47]. The neem insecticide formulation and Margosan-O are observed toxic against the *C. formosanus* [48,49]. Park and Shin [23] report that garlic oil caus 100% mortality of Japanese termite, *Reticulitermes spertus* Kolbe after 24 h of treatment. Verena and Hertel [50] also indicate that some plant extracts are used for termites control. Several higher plants have been tested to be effective against insect pests and diseases of various crops in the field as well as in store [51]. Our study indicated that extracts of the selected tropical herbal plants possess some insecticidal properties against *M. obesi*, but several variations occurred, based on the concentration of the extracts as these influenced the efficacy or biocidal activities of the plant materials. *Euphorbia helioscopia* is common weed almost every where in Islamabad. Being very chief source further studies are needed for the isolation of the factor (alkaloids) in the said plant.

Toxicity in *M. obesi* ranged from 3.39 ± 0.65 to 100.00 ± 0.00 and 7.36 ± 1.74 to 100.00 ± 0.00 by using leaf and seed extracts of *Cannabis sativa* respectively; while 2.80 ± 0.68 to 100.00 ± 0.00 and 2.13 ± 1.23 to 100.00 ± 0.00 when *O. lokanandi* were force fed on leaf and seed extracts of *C. sativa*, respectively. The results showed that aqueous extract of *C. sativa* contains insecticidal activities and percent mean mortality of both species were directly proportion to the concentrations of treatments. Our results also showed that seed extracts were more toxic that leaf extract of *C. sativa*. McPartlandC [52] indicates that *C. sativa L.* is used as a pest repellent. Seed extracts of *Polygonum hydropiper L.* and *Cannbis sativa L.* against *Heterotermes indicola* and *Coptotermes heimi* are effective more than leaf extracts in both species [53]. Thomas et al. [54] studies that *Cannabis sativa* caus 100% mosquito larvae mortality. Parihar and Singh [55] report that the aqueous extracts of Cannabis sativa are most effective against larval mortality of *Heliothis armigera*. Hiremath and Ahn [56] conclude that *Cannabis sativa* is effective against pest of rice, the paddy brown plant hopper (*Nilaparvata lugens*). The efficacy of *Capparis deciduas* and its combinatorial mixtures against Indian white termite *Odontotermes obesus* was studied and the results indicate that all the treatments had successfully controlled the ascending and descending movements of the termites and prohibited the tunnel formation by the workers [57]. Jalees et al. [58] determine the insecticidal properties of Cannabis sativa against the larvae of *Anophles stephensi*, *Culex quinquefasciatus* and *Aedes aegypti* in the laboratory.

Similarly, percent mean mortalities by using aqueous leaf and seed extracts of *Calotropis procera* ranged 2.73 ± 0.67 to 100.00 ± 0.00 and 3.42 ± 0.67 to 100.00 ± 0.00 in *M. obesi* respectively. However, percent mean mortality in *O. lokanandi* by forced feeding on leaf and seed extracts of *Calotropis procera* ranged 3.43 ± 1.35 to 100.00 ± 0.00 and 5.44 ± 0.68 to 100.00 ± 0.00 respectively. Results showed that the insecticidal activities of leave extracts of *Calotropis procera* were significantly lower when compared with insecticidal potency of seed extracts. The results also indicated that *O. lokanandi* was more sensitive than *M. obesi*. Mortalities in both species were observed directly proportion to concentrations of plant extracts. Our work tallied with the findings of Ahmed et al. [59] who reports that the crude extracts of *Calotropis procera* (Ait.) and *Datura alba* Nees are effective against the termites. Crude extracts of various reproductive and vegetative parts of *Calotropis procera* (Ait.) has toxic effects on *H. indicola* [53]. *Datura alba* Nees, *D. stramonium* L. and *Calotropis procera* (Ait.) are the most effective against the termites [60,61]. Subterranean termites are successfully controlled by using leaves extracts of *Calotropis procera* [62,63], *Diospyros sylvatica Roxb* [25], *Polygonum hydropiper* (L) and *Pogostemon paviflorus* (Benth) [64] *Aleurits fordii Hemsl*. (Tung tree) extracts [65] garlic *Allium sativum L*. and *Euphorbia kansuii GanSui* [26]. Manzoor et al. [66] report that activity of crude plant extracts against termites is often attributed to complex mixture of active compounds and that Ethyl acetate extract of *Ocimum sanctum L*.

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References

1. Hickin NE (1971) Termites: A World Problem. Hutchinson, London.
2. Manzoor F, Mir N (2010) Survey of Termite Infested Houses, Indigenous Building Materials and Construction Techniques in Pakistan. Pakistan J. Zool 42: 693-696.
3. Tsunoda K (2003) Economic importance of Formosan termite and control practices in Japan. Sociobiology 41: 27-36.
4. Hertel (2000) Finding Alternatives to Persistent Organic Pollutants (POPS) forTermite Management. Global IPM Facility Expert Group Termite Biology Management Stockholm Convention, FAO, Rome, Italy: 118- 168.
5. Venkateswara Rao J, Parvathi K, Kavitha P, Jakka NM, Pallela R (2005) Effect of chlorpyrifos and monocrotophos on locomotor behaviour and acetylcholinesterase activity of subterranean termites, Odontotermes obesus. Pest Manag Sci 61: 417-421.
6. Coats JR (1994) Risks from natural versus synthetic insecticides. Annu Rev Entomol 39: 489-515.
7. Logan JWM, Cowie RH, Wood TG (1990) Termite (Isoptera) control in agriculture and forestry by non-chemical methods: a review. Bulletin of Entomological Research 80: 309-330.
8. Pascual-Villalobos M, Robledo A (1999) Anti-insect activity of plant extracts from the wild flora in south-eastern Spain. Biochemical Systematics and Ecology 27: 1-10.
9. Scott IM, Jensen H, Nicol R, Lesage L, Bradbury R, et al. (2004) Efficacy of Piper (Piperaceae) extracts for control of common home and garden insect pests. J Econ Entomol 97: 1390-1403.
10. Saxena RC (1998) In: Critical issues in Insect Pest Management. Botanical pest control: 115-179.
11. Zhu BC, Henderson G, Chen F, Fei H, Laine RA (2001) Evaluation of vetiver oil and seven insect-active essential oils against the Formosan subterranean termite. J Chem Ecol 27: 1617-1625.
12. Blaske VU, Hertel H (2001) Repellent and toxic effects of plant extracts on subterranean termites (Isoptera: Rhinotermitidae). J Econ Entomol 94: 1200-1208.
13. Isman MB (2006) Botanical insecticides, deterrents, and repellents in modern agriculture and an increasingly regulated world. Annu Rev Entomol 51: 45-66.
14. Khan ZR, Saxena RC (1986) Effect of steam distillate extracts of resistant and susceptible rice cultivars on behaviour of Sogatella furcifera (Homoptera: Delphacidae). Journal of Economic Entomology 79: 928-935.
15. Breuer M, Schmidt GH (1995) Influence of a short period treatment with Melia azedarach extract on food intake and growth of the larvae of Spodoptera frugiperda (Lepidoptera;Noctuidae). Journal of Plant Diseases and Protection 102: 633-654.
16. Hiremath IG, Ahn YJ (1997) Parthenium as a source of pesticide. First international conference on Parthenium management. Dharwad, India 6: 86-89.
17. Zhao B, Grant GG, Langevin D, MacDonald L (1998) Deterring and inhibiting effects of quinolizidine alkaloids on the spruce budworm (Lepidoptera: Tortricidae) oviposition. Environmental Entomology 27: 984-992.
18. Wheeler DA, Isman M (2001) Antifeedant and toxic activity off Trichilia Americana extract against the larvae of Spodoptera litura. Entomologia Experimentalis et Applicata 98: 9-16.
19. Muthukrishnan J, Pushpalatha E (2001) Effects of plant extracts on fecundity and fertility of mosquitoes. Journal of Applied Entomology 125: 31-35.
20. Adams RP, Mcdaniel CA, Carter FL (1998) Termiticidal activities in the heartwood, bark/ sapwood and leaves of juniperus species from the United States. Biochem Syst Ecol 16: 453-456.
21. Boué SM, Raina AK (2003) Effects of plant flavonoids on fecundity, survival, and feeding of the Formosan subterranean termite. J Chem Ecol 29: 2575-2584.
22. Cheng SS, Wu CL, Chang HT, Kao YT, Chang ST (2004) Antitermitic and antifungal activities of essential oil of Calocedrus formosana leaf and its composition. J Chem Ecol 30: 1957-1967.
23. Park IK, Shin SC (2005) Fumigant activity of plant essential oils and components from garlic (Allium sativum) and clove bud (Eugenia caryophyllata) oils against the Japanese termite (Reticulitermes speratus Kolbe). J Agric Food Chem 53: 4388-4392.
24. Verma M, Sharma S, Parshad R (2009) Biological alternatives for termite control. Intern Biodeterior Biodegrad 63: 959-972.
25. Ganapaty S, Thomas PS, Fotso S, Laatsch H (2004) Antitermitic quinones from Diospyros sylvatica. Phytochemistry 65: 1265-1271.
26. Shi J, Li Z, Izumi M, Baba N, Nakajima S (2008) Termiticidal activity of diterpenes from the roots of Euphorbia kansui. Z Naturforsch C 63: 51-58.
27. Chang ST, Cheng SS, Wang SY (2001) Antitermitic activity of essential oils and components from Taiwania (Taiwania cryptomerioides). J Chem Ecol 27: 717-724.
28. Anonymous (2001) Termite control without chemicals. HDRA-the organic organization: 10.
29. Sbeghen AC, Dalfovov V, Serafini LA, De-Barros NM (2002) Repellence and toxicity of basil, citronella, ho-sho and rosemary oils for the control of the termite,Cryptotermes brevis (Isoptera: Kalotermitidae). Sociobiology 40: 585-594.
30. Singh G, Singh OP, Prasad YR, De-Lampasona MP, Catalan C (2004) Chemical and insecticidal investigations in leaf oil of Coleus amboinicus Lour. Journal of Flavour and Fragrance 17: 440-442.
31. Sakasegawa M, Hori K, K Yatagi K (2003) Composition and anti-termite activities of essential oils and Melaleuca species. Journal of Wood Science 49: 181-187.
32. Jembere B, Getahun D, Negash M, Sevoum E (2005) Toxicity of Birbira (Milletia ferruginea) seed crude extracts to some insect pests as compared to other botanical and synthetic insecticides. Astanarivo, Madagaskar: 88-96.

33. Cheng SS, Chang HT, Wu CL, Chang ST (2007) Anti-termitic activities of essential oils from coniferous trees against Coptotermes formosanus. Bioresour Technol 98: 456-459.
34. Ding W, Hu XP (2010) Antitermitic effect of the Lantana camara plant on subterranean termites (Isoptera: Rhinotermitidae). Insect Science 17: 427–433.
35. Supriadi and Ismanto A (2010) Potential Use of Botanical Termiticide. Perspektif 9: 12-20.
36. Salihah Z, Khatoon R, Khan A, Alamzeb, Sattar A (1993) A termite trap, NIFA Termap for capturing large number of field population of Heterotermes indicola. Proc Pakistan Congr Zool 13: 395-400.
37. Aboaba OO, Smith SI, Olude FO (2006) Antibacterial effect of edible plant extract on Escherichia coli 157:H7. Pak J of Nutr 5: 325-327.
38. Smith VK (1979) Improved techniques designed for screening candidate termiticides on soil in the laboratory. J Econo. Entomol 72: 877-879.
39. Abbott WS (1987) A method of computing the effectiveness of an insecticide. 1925. J Am Mosq Control Assoc 3: 302-303.
40. Raguraman S, Singh D (1997) Biopotentials of Azadirachta indica and Cedrus deodara oils on Callosobruchus chinensis. J. Pharmacol 35: 344-348.
41. Gbolade A A (2001) Plant-derived insecticides in the control of malaria vector. J. Tropicl Med Plants 2: 91-97.
42. Jacobson M (1983) Plants–The potentials for extracting protein, medicines, and other useful chemicals. Workshop Proceedings Congressional Office of Technology, Washington DC: 138-146.
43. Adebayo TA, Gbolade AA, Olaifa JI (1999) Comparative study of toxicity of essential oils to larvae of three mosquito species. Niger J Nat Prod Med Plant 3: 74-76.
44. Murty US, Jamil K (1987) Effect of south Indian vetiver against immatures of Culex quinquefasciatus. Inter Pest Control 29: 8-9.
45. Sadik F (1973) Handbook of Non-prescription Drugs. Washington D C: American Pharmacology Association.
46. Thorsell W, Mikiver A, Malander I, Tunón H (1998) Efficacy of plant extracts and oils as mosquito repellents. Phytomedicine 5: 311-323.
47. Oyedele AO, Orafidiya LO, Lamikanra A, Olaifa JI (2000)Volatility and mosquito repellency of Hemizygia welwitschii oil and its formulations. Insect Sci Appl 20:123-128.
48. Hostettman K (1989) Plant-Derived Molluscides of Current Importance in Wagner H. Hikino H., Farnsworth N.R. Econ. Med. Plant Res 3:73-102.
49. Grace J, KYates JR (1992) Behavioural effects of a neem insecticide on Coptotermes formosanus (Isoptera: Rhinotermitidae). Trop Pest Manag 38:176–180.
50. Verena UB, Hertel H (2001) Repellent and toxic effects of plant extracts on subterranean termites (Isoptera: Rhinotermitidae). J. econ Ent 94: 1200-1208.
51. Stoll G (2001) Natural crop protection in the tropics. Letting Information come to life E and T. Mullerbader Fildstadt Publishers, Germany: 208.
52. McPartland C JM (1997) Cannabis as repellent and pesticide. Journal of the International Hemp Association 4: 89-94.
53. Badshah H, Farmanullah, Salihah Z, Saljoqi A, Shakur M (2004) Toxic effects of AK (Calotropis procera) plant extracts against termites Heterotermes indicola and Coptoternes heimi (Isoptera: Rhinotermitidae). Pakistan Journal of Biological Science 7: 1603-1606.
54. Thomas TG, Sharma S K, Anand P, Sharma BR, Prakash A (2000) Insecticidal properties of essential oil of Cannabis sativa linn., against mosquito larvae. National Institute of Communicable diseases, Delhi, India, Ento 25: 21-24.
55. Parihar SBS, Singh OP (1992) Role of the host plants in development and survival of Heliothis armigera (Hubner). Central potato Research Station, India, Bulletin of Entomology 33: 74-78.
56. Hiremath IG, Ahn YJ (1997) Parthenium as a source of pesticide. First international conference on Parthenium management, Dharwad, India 6: 86-89.
57. Upadhyay R K, Jaiswal G, Ahmad S (2010) Antitermite efficacy of Capparis decidua and its combinatorial mixtures for the control of Indian white termite Odontotermes obesus (Isoptera: Odontotermitidae) in Indian soils. Journal of Applied Sciences and Environmental Management 14: 101-105.
58. Jalees S, Sharma SK, Rahman, Verghese T (1993) Evaluation of insecticidal properties of an indigenous plant, Cannabis sativa Linn, against mosquito larvae under laboratory conditions. Journal of Ento Research 17: 117-120.
59. Ahmed S, Mustafa T, Riaz MA, Hussain A (2006) Efficacy of insecticides on subterranean termites in sugarcane. International Journal of Agriculture and Biology 8: 508-510.
60. Bajwa GA, Rajpar MN (2001) Biological activity of extact of different plants against termites, nettle tree leaf beetle and amaltas leaf stitcher. Pakistan Journal of Forestry 51: 31-41.
61. Ayodele, MS, Oke OA (2003) Studies on the potential of some plant-based community pest management strategies in Southwest Nigeria. An investigation of the antitermite potency of Datura stramonium L. An International Journal of Agricultural Science, Science, Environment and Technology 2: 153-159.
62. Giridhar G, Santosh S, Vasudevan P (1988) Antitermites properties of Calotropis latex. Pesticides 22: 31-33.
63. Parihar DR (1994) Termite management in arid zone of rajasthan, India. Pest management and Econ and Zool 2: 81-84.
64. Rahman I, Gogoi I, Dolui AK, Handique R (2005) Toxicological study of plant extracts on termite and laboratory animals. J Environ Biol 26: 239-241.
65. Hutchins RA (2006) Evaluation of the natural antitermitic properties of Aleurites fordii (Tung tree) extracts. U.S. Patent : 682.
66. Manzoor F, Beena W, Malik S, Naz N, Naz S, et al. (2011) Preliminary evaluation of Ocimum sanctum as toxicant and repellent against termite, Heterotermes indicola (Wasmann) (Isoptera: Rhinotermitidae). Pakistan Journal of Science 63: 59-62.