AJAB

Asian J Agri & Biol. 2018;6(3):295-299.

Original Research Article

# Influence of some plant oils *Eugenia caryophyllata*, *Elettaria cardamomum* and *Citrus sinensis* on the termite species *Coptotermes heimi*

**Ayesha Aihetasham*, Aysha Anayat, Muhammad Xaaceph**
Department of Zoology, University of the Punjab, Lahore, Pakistan

*Received:*
*December 23, 2017*
*Accepted:*
*March 26, 2018*
*Published:*
*September 30, 2018*

**Corresponding author email:*
misswaqar@yahoo.com

## Abstract

Termites are one of the most troublesome pest of plants, trees, wooden infrastructure and agricultural crops. The aim of the present study is to evaluate the population of some plant oils using *Eugenia caryophyllata*, *Elettaria cardamomum* and *Citrus sinensis* against *Coptotermes heimi* (Wasmann) at Punjab University, New Campus Lahore, Pakistan. All plants were effectively toxic against *C. heimi* as 100 % mortality was observed at 62.5, 125 and 250 µl/ml doses within three to four days of exposure. All plant oils extracts proved to be highly repellent to the termites even in the low concentrations. These plant oils can be used for effective termite control being less expensive and biodegradable, hence environmentally suitable.

**Keywords**: Termites, Plant extracts, Repellency

## Introduction

Termites are the most abundant pests of plants, trees and wooden structure. They severely damage agricultural crops and urban infrastructure. Although termites feed on dead wood and cellulose rich sources, they only become problematic when they attack on trees, crops and logs (Pearce, 1997; Manzoor et al., 2011; Balachander et al., 2013). They cause serious damage to different crops causing to unhealthy growth of crops (Sheikh, 2009), even almost 2800 species of the termites were found with approximately 185 possible pest's species (Lewis, 1997; Balachander et al., 2013). More than one hundred species belong to the group of the subterranean termites and just 28 species are of economic importance (Lewis, 1997). In Pakistan, there are almost 50 species which cause damage (Akhtar, 1974) but eleven species have been found destructive and need serious attention (Akhtar, 1983). As termites have become a major threat to human economy, economical and ecofriendly alternative biological control strategies such as the use of seeds extracts, essential oils, wood extracts, fruits, leaves and barks oil (Adams et al., 1998; Sakasegawa et al., 2003; Cheng et al., 2004; Jembere et al., 2005; Park and Shin, 2005; Verma et al., 2009; Ding and Hu, 2010; Rasib and Aihetasham, 2016). Their mode of action is upon causing interference in gut flora in order to repel or kill the termites (Adams et al., 1998).

Many Plant's oil extracts showed their activity even as an anti-termite activities or has a repellent effect. They were such as *Pinus roxburghii*, *Eucalyptus camaldulensis* and *Morus alba* (Rasib and Aihetasham, 2016), lemongrass, *Eucalyptus citrodora*, cedar wood, vetivergrass and clove bud (Zhu et al., 2001), *Taiwania cryptomerioides* (Chang et al., 2001) purple hop brush; *Dodonaea viscose* (Anonymous, 2001). *Cymbopogon winterianus*, *Ocimum basilicum*, *Rosmarinus officinalis* and *Cinammomum campho* (Sbeghen et al., 2002) and *Coleus ambionicus* (Singh et al., 2004) Plants oils and powder have been used extensively in the control of insect pests because they are believed to contain myriads of natural chemical that could be insecticides (Adeyemo et al., 2015).

The present research work aimed to present the antitermitic and antifeedant activities of clove (*Eugenia caryophyllata*), Elachi (*Elettaria cardamomum*) and Citrus (*Citrus sinensis*) plants essential oils against a subterranean termites *Coptotermes heimi* (Wasmann).

## Material and Methods

**Termite collection**

*Coptotermes heimi* (workers and soldiers) were collected from *Populus euramericana* (populous) trees of University of the Punjab, Lahore, Pakistan. Termites were separated from the tree barks and debris in the laboratory and were kept at ±27°C only healthy individuals were taken for experiments. The apparatus used in the experiment was autoclave. Moist filter paper were placed in Petri plates for termite's survival.

**Extracts of plants oil**

The essential oil samples were extracted from the collected plant material like peel of oranges (*C. sinensis*), fruits of Clove (*E. caryophyllata*) and seeds of Elachi (*E. cardamomum*) by hydro distillation for 5 hours using the process of Guenther (1949). After that these extracts were kept in glass vials and held air tight at 4°C.

**Experimental soil preparation**

Soil was collected from lawn of Department of Zoology, University of the Punjab, Lahore. It was free of contamination by insecticides as there has been no known application of any chemical. The soil was used to maintain termites like natural environment. Soil was sieved through a 10- mesh oven dried at 72°C for 24 h. Petri plates were washed and sterilized at 180°C for 2h for accuracy of experiment and for avoidance of contaminants growth.

**Mortality test**

For mortality test Petri dishes, filter paper and soil were sterilized. Twenty grams of sterilized soil were taken in each Petri plate and sprayed with distilled water. In each Petri plate 300 termite workers and 5 soldiers were released in arena with treated filter paper with respective dilutions. Then Petri plates were covered with black cloth. Dead termites were removed and counted after 24 hour interval to avoid fungal growth. Each experiment was replicated three times.

**Repellency test**

Repellency test was performed following the method of Aihetasham et al., 2018. Filter papers cut according to the size of Petri plate and were divided into two equal halves in such a way that there was space between two halves. One half treated with oils dilutions (250, 125 and 62.5 µl/ml) and other half was served as a control using distilled water. Thirty workers were released in between treated and untreated filter paper. Numbers of termites were counted in treated and untreated zone after 60 minutes time interval.

**Data analysis**

Statistical analysis and General Linear Model (GLM) Tukey's comparison analysis were conducted using software Minitab 16.

## Results and Discussion

Termiticidal activity of different plants oils was tested against the workers of *C. heimi*. Many plants extracts have been used against termites to replace used insecticides (Ahmed et al., 2011; Addisu et al., 2014; Rasib et al., 2017). Oils of both *E. caryophyllata* and *C. sinensis* on 250 and 125 ul/ml doze killed all termites (100% mortality) in two days while the same results was achieved at 62.5 µl/ml three days post-treatment. Oils of orange peel was used in USA to overcome termite species (*Coptotermes formosanus* Shiraki) in past (Raina et al., 2007). Many different compounds such as d-limonene [(R)-4-isopropenyl-1-methylcyclohexene] which was extracted from citrus peel, caused 98% mortality (Hink and Fee, 1986) of termite population (Zhu et al., 2001; Osipitan and Oseyemi, 2012). General Linear Model was used to estimate the difference between plants, days and concentrations. All parameters showed significant difference i.e plants (d.f= 2, 74; p= 0.000); days (d.f= 2, 74; p= 0.000) and concentration (d.f= 2, 74; p= 0.003). In control no mortality was recorded during experiment (Table 1). Seven species of insects had been reported toxic to orange peel (Raina et al., 2007). The Limonene oil was used to exterminate house flies (*Musca domestica*) and red imported ants (*Solenopsis invicta*). According to Hollingsworth (2005) citrus extract was used to control mealy bug.

The d- limonene vapors were used to exterminate cat flea all life *Ctenocephalides felis* (Hink and Fee, 1986), German cockroach, (*Blattella germanica*) and rice weevils, (*Sitophilus oryzae*) (Karr and Coats, 1988). The *Eugenia caryophyllata* has been used as fever reduction and mosquito repellent (Medline Plus, 2014). The clove oil has mainly composition of Eugenol (Koul et al., 2008), that attached to benzene ring by hydroxyl and ether linkage. Within the compound the aldehyde group shows high level of termite's resistant activity (Chang and Cheng, 2002). The clove oil was excellent repellent to termites, fungus and nematodes (Gupta et al., 2011). The oil of *E. cardamomum* mainly consist of 1,8-cineol (29.7%) and α-terpineol acetate (26.1%) (Korikontimath et al., 1999; Olivero-Verbel et al., 2010) but basic cardamom aroma was produced by mixing of these two major component (Lawrence, 1979). According to Abbasipour et al. (2011), the *E. cardamomum* was use to eradicate the *Callosobruchus maculatus* (bruchid beetle), *Tribolium castaneum* (red flour beetle) and *Ephestia kuehniella* (flour moth). This oil was used to fumigant toxicity against *S. granarious* (Mahmoudvand et al., 2011). *E. cardamomum* also showed different responses on egg stages and active stages of stored product insects (Huang et al., 2000).

In the repellency test, the *E. cardamomum* was repellent (28.667) to termites than the other two *E. caryophyllata* and *C. sinensis* (28 and 27) at the dilution of 250 ug/ml. While at 125 ug/ml *E. cardamomum* (27.33) is more repellent than other two plants oils (26). *E. cardamomum* show equal termites repellent at even at low concentrations (d.f: 2, 6; F: 1.04; P: 0.410). In *E. caryophyllata* (d.f: 2, 6; F: 6.68; P: 0.030) and *C. sinensis* (d.f: 2, 6; F: 11.38; P: 009) repellency fades with decreases in concentration (Table. 2). The oil of *E. cardamomum* was most the effective oil extract with respect to other extracts and repellency remain constant even at low concentration. Many plants extracts was used to prevent the pest population and reported the extracts under laboratory conditions (Talukder et al., 2006; Aihetasham et al., 2016). This study shows that *E. cardamomum* was most effective once and after that *E. caryophyllata* was effective and in the end *C. sinensis* was least effective but these all plant oils can be used to suppress the termite population (*Coptotermes heimi*).

**Table 1. Average mortality of *C. heimi* (soldiers) caused by different concentrations of different plant oils**

| Plant Essential oils | Dilutions | No. of days | | | |
|---|---|---|---|---|---|
| | µl/ml | 1 [A] | 2 [B] | 3 [C] | 4 |
| *C.sinensis* [A] | 250 [A] | 59.33±5.54 | 213.33±10.36 | 300.00±0.00 | |
| | 125 [A] | 117.33±21.32 | 204.00±2.64 | 300.00±0.00 | |
| | 62.5 [B] | 99.33±11.83 | 224.00±19.52 | 300.00±0.00 | |
| *E. caryophyllata* [B] | 250 [A] | 76.66±11.56 | 166.00±18.58 | 300.00±0.0 | |
| | 125 [A] | 78.00±12.16 | 172.00±11.37 | 300.00±0.00 | |
| | 62.5 [B] | 53.33±13.96 | 130.66±16.01 | 242.00±16.23 | 300.00±0.00 |
| *E. cardamomum* [C] | 250 [A] | 87.12±1.91 | 96.01±1.27 | 300.00±0.00 | |
| | 125 [A] | 68.23±2.27 | 99.00±2.21 | 300.00±0.00 | |
| | 62.5 [B] | 59.23±2.13 | 98.01±2.31 | 187.67±1.23 | 300.00±0.00 |
| Control | | 0.00±0.00 | 0.33±0.33 | 1.66±0.33 | 2.66±0.33 |

**Table 2. Repellency test of termite from different plants oil extracts at different doses. n=30**

| Dozes | Plants | | | | | |
|---|---|---|---|---|---|---|
| | *E. caryophyllata* | | *E. cardamomum* | | *C. sinensis* | |
| | T | U | T | U | T | U |
| **250µl/ml** | 27.33 [A](0.667) | 2.667 | 28.667 [A](0.882) | 1.33 | 26.00 [A](0.577) | 4.00 |
| **125µl/ml** | 25.0 [AB](1.15) | 5.00 | 26.667 [A](0.882) | 3.33 | 24 [AB](0.577) | 6.00 |
| **62.5µl/ml** | 23[B](0.557) | 7.00 | 27.33 [A](1.20) | 2.67 | 21.33[B](0.882) | 8.667 |

Abbreviations: T: treated and U: untreated and (---): standard error

## References


Abbasipour H, Mahmoudvand M, Rastegar F and Hosseinpour MH, 2011. Fumigant toxicity and oviposition deterrency of the essential oil from cardamom, *Elettaria cardamomum*, against three stored product insects. J. Insect Sci. 11-165

Adams RP, McDaniel CA and Carter FI, 1998. Termiticidal activities in the heartwood, bark/sapwood and leaves of *Juniperus* species from the United States. Biochem. System. Ecol. 16: 453-456.

Addisu S, Mohamed D and Waktole S, 2014. Efficacy of Botanical extracts against termites, *Macrotermes* spp., (Isoptera: Termitdae) under laboratory conditions. Int. J. Agric. Res. 9(2): 60-73.

Adeyemo AC, Ogungbite OC and Agbola OP, 2015. Biocidal efficacy of two medicinal plant oil extracts used as termicides against Subterranean termites *Macrotermes subhyalinus* L. Zool. Ecol. 25(3): 257-261.

Ahmed S, Zafar MI, Hussain A, Riaz MA and Shahid M, 2011. Evaluation of plant extracts on mortality and tunneling activities of subterranean Termites in Pakistan. Pesticid. Mod. World. 3: 39-54.

Aihetasham A, Bilal N and Xaaceph M, 2016. Efficacy of Seed Extracts (*Mentha arvensis*, *Ocimum bacilicum*, *Psyllium ovata*, *Cichorium intybus*) against *Coptotermes heimi* (Wasmann). Biologia (Lahore). 62(1): 103-109.

Aihetasham A, Aziz H and Rasib KZ, 2018. Efficacy of slow acting toxicants on *Heterotermes indicola* (Wasmann) (Isoptera: Rhinotermitidae). Pak. J. Zool. 50(1): 373-375.

Akhtar MS, 1974. Zoogeography of termites of Pakistan. Pak. J. Zool. 6: 85-106.

Akhtar MS, 1983. Wood destroying termites (Isoptera: Rhinotermitidae) of Pakistan. Mater. Organ. 188:277–291.

Anonymous, 2001. Termite control without chemicals. HDRA-The organic organisation, pp: 1-14.

Balachander M, Ramadevi Ok and Sasidharan TO, 2013. Dissemination of *Metarhizium anisopliae* infection among the population of the *Odontotermus obesus* by augmenting the fungal conidia with attractant. J. Asia-Pacific Entomol. 16:199-208.

Chang ST, Cheng SS and Wang SY, 2001. Antitermitic activity of essential oils and components from Taiwania (*Taiwania cryptomerioides*). J. Chem. Ecol. 27(4): 1267-1274.

Chang ST and Cheng SS, 2002. Antitermitic/ activity of leaf essential oils and components from *Cinnamomum osmophleum*. J. Agric. Food Chem. 50:1389-1392.

Cheng MJ, Wu CC, Tsai IL and Chen IS, 2004. Chemical and antiplatelet constituents from the stem of *Zanthoxylum beecheyanum*. J. Chinese Chem. Society. 51:1065-1072.

Ding Wand Hu XP, 2010. Antitermitic effect of the *Lantana camara* plant on subterranean termites (Isoptera: Rhinotermitidae). Insect Sci. 7(5): 427-433.

Guenther E, 1949. The essential oils, Vol. 2, Van Nostrand, Princeton, 112.

Gupta A, Sharma S and Naik SN, 2011. Biopesticidal value of selected essential oils pathogenic fungi, termites and nematodes. Int. Biodeterior. Biodegrad. 10: 1-5.

Hink WF and Fee BJ, 1986. Toxicity of D-limonene, the major component of citrus peel oil, to all life stages of the cat flea, *Ctenocephalides felis* (Siphonaptera: Pulicidae). J. Med. Entomol. 23: 400–404.

Hollingsworth RG, 2005. Limonene, a citrus extract, for control of mealybugs and scale insects. J. Econ. Entomol. 98: 772–779.

Huang Y, Lam SL and Ho SH, 2000. Bioactivities of essential oil from *Elletaria cardamomum* (L.) Maton. To *Sitophilus zeamais* Motschulsky and *Tribolium castaneum* (Herbst). J. Stored Prod. Res. 36:107–117.

Jembere B, Getahun D, Negash M and Sevoum E, 2005. Toxicity of Birbira (*Milletia ferruginea*) seed crude extracts to some insect pests as compared to other botanical and synthetic insecticides. 11th NAPRECA (Natural Products and Drug Delivery) Symposium Book of Proceeding, Astanarivo, Madagaskar, pp. 88-96.

Karr LL and Coats JR, 1988. Insecticidal properties of d-limonene. J. Pest. Sci. 13: 287–289.

Korikontimath VS, Mulge R and Zachariah JT, 1999. Variations in essential oil constituents in high yielding selections of cardamom. J. Plant. Crops. 27: 230–232.

Koul O, Walia S and Dhaliwal GS, 2008. Essential oils as green pesticides: Potential and constraints. Biopesticides Int. 4: 63–84.

Lawrence BM, 1979. Major tropical spices cardamom (*Eletteria cardamomum*). Essential Oils. Allured Publishing Corporation. p. 104.

Lewis VR, 1997. Alternative Control strategies for Termites. J. Agric. Entomol.14:291-307.

Mahmoudvand M, Abbasipour H, Rastegar F, Hosseinpour MH and Basij M, 2011. Efficacy of some plants as a post-harvest protectant against some major stored pests. Arch. Phytopathol. Plant Protection. 45(7): 806-811.

Manzoor F, Chaudhary M, and Sheikh N, 2011. Diversity and proportion of termite species in garden trees and wheat crop in District Bhakkar, Pakistan. Pak. J. Zool. 43: 537-541.

MedlinePlus, U.S. National Library of Medicine and National Institutes of Health. 2014. Retrieved August 18, 2014.

Olivero-Verbel J, González-Cervera T, Güette-Fernandez J, Jaramillo-Colorado B and Stashenko E, 2010. Chemical composition and antioxidant activity of essential oils isolated from Colombian plants. Rev. Bras. Farmacogn. 20: 568–574.

Osipitan AA and Oseyemi AE, 2001. Evaluation of the Bio-insecticides potential of some trophical plant extracts against termites (Termitidae: Isoptera) in Ogun state, Nigeria. J. Entomol. 9: 257-265.

Park IK and 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: 4388-7392.

Pearce MJ, 1997. Termites biology and pest management. CAB International. pp: 172.

Raina A, Bland J, Doolittle M, Lax A, Boopathy R, and Folkins M, 2007. Effect of Orange Oil Extract on the Formosan Subterranean Termite (Isoptera: Rhinotermitidae). J. Econ. Entomol. 100(3): 880-885.

Rasib KZ and Aihetasham A, 2016. Constituents and termiticide potential of some wood extracts against *Coptotermes heimi* (Wasmann) (Isoptera: Rhinotermitidae). Türk. Entomol. Derg. 40(2): 165-174.

Rasib K, Hidayat W and Aihetasham A, 2017. Feeding Preferences and Control of a Pakistani Termite *Odontotermes obesus* (Rambur) (Isoptera, Rhinotermitidae). Annu. Res. Rev. Biol. 18(5): 1-13.

Sakasegawa M, Hori K and Yatagi M, 2003. Composition and anti-termite activities of essential oils and Melaleuca species. J. Wood Sci. 49:181-187.

Sbeghen AC, Dalfovov V, Serafini LA and De-Barros NM, 2002. Repellency and toxicity of basil, citronella, ho-sho and rosemary oils for the control of termite, *Cryptotermes brevis* (Isoptera: Kalotermitidae). Sociobiol. 40(3): 585-594.

Sheikh N, Irfan S and Naz N, 2009. Effect of the *Nerium oleander* to the subterranean termites; *Coptotermes heimi* (Wasmann). Pak. J. Sci. 61:29-31.

Singh G, Singh OP, Prasad YR, De-Lampasona MP and Catalan C, 2004. Chemical and insecticidal investigations on leaf oil of *Coleus amboinicus* Lour. J. Flav. Frag. 17(6): 440-442.

Talukder FA, Islam MS, Hossain MS, Rahman MA and Alam MN, 2006. Toxicity effects of botanicals and synthetic insecticides on *Tribolium castaneum* (Herbst) and *Rhyzopertha dominica* (F.). Bangladesh J. Environ. Sci. 10(2): 365-371.

Verma M, Sharma S and Prasad R, 2009. Biological alternatives for termite control: A review. Int. Biodeterior. Biodegrad. 63(8): 959-972.

Zhu BC, Henderson G, Chen F, Fei H and Laine RA, 2001. Evaluation of vetiver oil and seven insect-active essential oils against the Formosan subterranean termite. J. Chem. Ecol. 27(8):1617-1625.