Punjab Univ. J. Zool., Vol. 32 (1), pp. 051-056, 2017

ISSN 1016-1597(Print)
ISSN2313-8556 (online)

Original Article

Effect of *Carica papaya*, *Helianthus annus* and *Bougainvillea glabra* aqueous extracts against termite, *Heterotermes indicola* (Isoptera: Rhinotermitidae)

Ayesha Aihetasham[1]* Khalid Zamir Rasib[2], Syeda Rida Hasan[1], Imran Bodlah[3]

[1]*Department of Zoology. University of the Punjab, Lahore, Pakistan*
[2]*Biological Sciences, FC College University, Ferozepur Road, Lahore, Pakistan*
[3]*Department of Entomology, PMAS- Arid Agriculture University, Rawalpindi, Pakistan*

(**Article history:** Received: March 11, 2017; Revised: June 01, 2017)

Abstract
The present study involves the entomocidal efficacy of different concentrations of aqueous leaf extracts of three medicinal plants *viz., Carica papaya* (paw paw), *Helianthus annus* (Sunflower) and *Bougainvillea glabra* (Paper flower) against *Heterotermes indicola*. The leaf extract of *C. papaya* caused highest mortality i.e. 100% of 10%, 5% and 3% concentration. *Bougainvillea glabra and H. annus* caused 100% mortality at 10% and 5% concentration while 96.4% mortality on 3% concentration after exposure period of 10 hours. *B. glabra* extracts also caused 100% mortality on 10% and 5% concentration while 96.4% mortality on 3% concentration. *C. papaya* showed the minimum LT_{50} of 3.03, 3.8 and 4.86 hours at 10, 5 and 3% concentrations respectively. LT_{50} of *B. glabra* was 3.58, 4.17 and 5.07 hours at 10, 5 and 3% concentrations respectively whereas, *H. Annus* showed LT_{50} of 3.8, 4.75 and 6.55 hours at 10, 5and 3% concentrations respectively. It can be concluded from the present findings that the tested plant extracts can be used for the management of *H. indicola.*
Keywords: *Heterotermes indicola*, plant extracts, LT_{50}, Mortality

To cite this article: AIHETASHAM, A., RASIB, K.Z., HASAN, S.R. AND BODLAH, I., 2017. Effect of *Carica papaya, Helianthus annus* and *Bougainvillea glabra* aqueous extracts against termite, *Heterotermes indicola* (Isoptera: Rhinotermitidae). *Punjab Univ. J. Zool.,* **32**(1): 51-56.

INTRODUCTION

Termites are social insects that live in highly systematized colonies (Peterson *et al.,* 2006). Approximately 2600 species of termites have been reported worldwide, out of which 300 species are economically significant (Engel and Krishna, 2004; Ibrahim and Adebote, 2012). In Pakistan, so far, 50 species of termites have been reported (Akhtar and Shahid, 1993).

The most destructive pests of wood and other wood related products are subterranean termites. They attack wood throughout the world. Mostly warmer regions are prone to their attack (Peterson *et al.,* 2006). They cause damage to furniture, household goods, timber and forest vegetation (Aihetasham *et al.,* 2015). Subterranean termites mostly construct earthen, shelter tubes to be protected from direct sun light, dry weather, low humidity and Predation. (Manzoor and Mir, 2010). The destruction caused by termites cannot be ignored (Ibrahim and Adebote, 2012). They mainly attack agricultural crops, timbers in houses, post, hurdles, clothes, books, earth dams and irrigation canals (Abe *et al*., 2000; Ibrahim and Adebote, 2012). As they remove plant cover, reduces water absorbent capacity of the soil thus promoting corrosion (Lee and Wood, 1971; Ibrahim and Adebote, 2012). It has been estimated that termites cause more than $ 3 billion damage to wood annually in the United States, with at least 80 % of that is caused by subterranean termites (Donald *et al*., 1979; Ahmed *et al.*, 2016). Millions of dollars are spent each year to control termites all around the world (Tsunoda, 2003).

Many techniques have been adopted to control termites. Natural insecticides have been used by humans for centuries to combat insect pests like termites that compete for our food and fiber and also affect public health. Plant extracts of roots, stem and leaves having antifeedant properties are used for the control of insect pests (Forschler and Townsend, 1996; Saljoqi *et*

164-PUJZ-71021130/17/0051-0056
*Corresponding author: misswaqar@yahoo.com

al., 2012). In the twentieth century, these natural insecticides were replaced by synthetic insecticides for controlling insects, ticks and mites. Chemical control was the most commonly used to control termites for a long time (Forschler and Townsend, 1996; Saljoqi *et al.*, 2012). Synthetic insecticide was proved effective but with risk too (Coats, 1994).

Many plant extracts possess toxic properties against a variety of insect pests, and they also affect the behavior of the targeted pests (Zubair *et al.,* 2012; Abbas *et al.*, 2013). The plants having insecticidal and repellent properties are considered to be most effective for termite control. The bioactive components of plants are safe for use (Zhu *et al.*, 2001; Isman, 2006). Plant extracts have been used as a protector for the grains and other foodstuffs (Dales, 1986; Isman, 2000; Oyedokun *et al.*, 2011). Plants are environmentally friendly since they are biodegradable and have no negative impact on our health and environment. These plant products regulate the growth and development of insects, possess insecticidal and antifeedant properties. They also have negative effect on small organisms (Saxena, 1998; Edori and Ekpeti, 2015).

Heterotermes indicola are structure-invading termites that cause a great destruction. Individual species of *Heterotermes indicola* are limited to their particular climatic zones which are limited by soil moisture and temperature (Emerson, 1971; Saljoqi *et al.*, 2012). *Helianthus annus* L. is an erect annual plant and its height is up to 3 meters (Dwivedi and Sharma, 2014). Kamal (2011) checked the allelochemicals in, stems, roots and leaves of sunflower. The amount of allelochemicals was highest in the leaves. The study showed that the leaves contained flavonoids, alkaloids and terpenoids which are essential for antitumor and antimicrobial activities (Dwivedi and Sharma, 2014). The papaya plant also possesses powerful anti-dengue, anti-trichomonal, anti-parasitic and antiseptic properties (Asamoah *et al.*, 2011). In the same trend, Saljoqi *et al.* (2012) detected the effectiveness of five different plants extracts *viz*. garlic (*Allium sativum*), turmeric (*Curcuma longa*), black tea (*Camellia sinensis*), green chilies (*Capsicum annum*) and ginger (*Zingiber officinale)* against *H. indicola.* and found them very effective in causing mortality.

The present research was designed to evaluate the potential of aqueous extracts of leaves of *Carica papaya, Bougainvillea glabra* and *Helianthus annus* against *Heterotermes indicola* workers and soldiers. Furthermore, the efficacy of plant extracts of *C. papaya, B. glabra* and *H. annus* was checked as safe alternative to synthetic chemicals.

MATERIALS AND METHODS

Collection of termites, Seeds and soil

Termite collection was made from the roots of *Populus euramericana* trees, University of the Punjab, Lahore, Pakistan. The termites were identified in the laboratory following the keys described by Akhtar (1972). Both workers and soldiers were collected. Only healthy termites were used in the experiment. The termites were stored in an incubator at 28±2°C and high humidity (70-80%) was maintained. The termites were stored in Petri plates.

Leaves of *C. papaya*, *H. annus* and *B. glabra* were taken from a garden of Wapda Town, Lahore. They were thoroughly washed with distilled water to remove dust and were dried under the shade for two days.

The sandy loam soil obtained for performing the experiment was taken from the lawn of Department of Zoology, University of the Punjab, Lahore. It was then sieved, sterilized and dried at 70°C in oven for overnight for make it free of any fungal contamination.

Extraction method

The plant extracts were made following the procedure adopted by Adedire and Akinneye (2003). Dried leaves of *C. papaya*, *H. annus* and *B. glabra* were crushed into a fine powder by using HR 2118 Philips grinder. Aqueous extracts were prepared by weighing 10 grams of each of the leaves and dissolving in 100 ml of distilled water. The solution was allowed to settle down for 24 hours and then heated at 60^{o}C in a water bath for 45 minutes. It was the shaken and sieved with the help of filter paper.

Toxicity assay

The bioassay was performed according to the procedure adopted by Abbas *et al*. (2013). Petri plates and soil (for bioassay) was sterilized at 70^{o} C in drying oven for 24 hours. Circular filter papers were placed in each Petri plate. Four grams of sterilized soil were added in each Petri plate and filter paper was placed on it. 0.5 ml of 10%, 5% and 3% solution was poured on each filter paper with the help of micropipette. Then the population of 25 live and active

workers including five soldiers of *H. indicola* was provided to each petri plate. Observations were taken after every 1 hour up to 10 hours.

$$\text{Mortality Rate} = \frac{\text{Number of dead termites after test}}{\text{Total number of termites used in test}} \times 100$$

Statistical Analysis

The Statistical Software Minitab 16.1 was used to evaluate differences in mortality percentages for the antitermitic tests by Probit analysis.

RESULTS AND DISCUSSION

Carica papaya proved to be highly effective as 100% mortality was recorded within 5 h at 10% concentration, 7 h at 5% and 8 h at 3% concentration (Fig.1). *Carica papaya* showed the minimum LT_{50} of 3.03 at 10%, 3.8 at 5% and 4.86 at 3% concentration, and caused 100% mortality of the tested insects within 8 hours at all evaluated concentrations (Table I). Asamoah *et al.* (2011) studied the effect of aqueous extracts of heartwood of *Azadirachta indica* (Neem), leaves of *Persea americana* (avocado) and *Carica papaya* (pawpaw) at 0.24% on *Alstonia* wood. *C. papaya* extract applied to *Alstonia* wood at 0.24 and 0.72% respectively, resisted termite attack in furniture. *C. papaya* extract improved the longevity of *Alstonia* wood at 0.72% (treated three or over) more significantly than wood treated with 0.24%. The results in accordance with our findings as *C. papaya* extract showed maximum mortality at 10%, 5% and 3% concentrations.

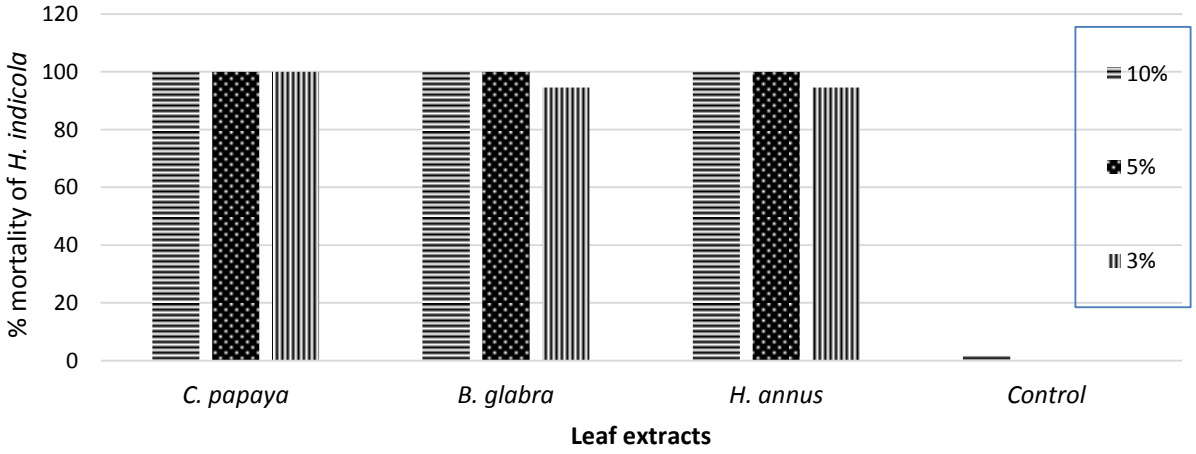

Figure 1. % Mortality of three plant extracts against *H. indicola.*

Bougainvillea glabra was also found effective against *H. indicola* but showed less toxicity than *C. papaya.* As 100% mortality was recorded within 6 h at 10 %, after 7 h at 5% and 96.4% mortality was recorded within 10 h at 3% (Fig.1). LT_{50} of *B. glabra* were shown at Table (1). LT_{50} of (Table I). LT_{50}s were 3.58, 4.17 and 5.07 at 10%, 5% and 3% concentration (Table. 1). LT_{50} of *B. glabra* was not reported earlier by any scientist, so it is a new finding that this plant also carries insecticidal properties and it proved to be toxic. Enciso-Díaz *et al.* (2012) found *B. glabra* extract slightly active against *Streptococcus agalactiae*, *Staphylococcus aureus*, *Salmonella typhi* and *Escherichia coli*, having MIC values of 500-3000 µg/mL (Microdilution), 1000-1500 µg/mL (Macrodilution) showing that it has insecticidal properties. Leaf extract of *H. annus* caused 100% mortality after7 hours at 10%, 8 hours at 5% and 94.6% mortality within 10 hours at 3%. But it is less toxic than *C. papaya* and *B. glabra* (Fig.1). *H. annus* extracts were considered moderately toxic as they showed LT_{50} of 3.8 at 10%, 4.75 at 5% and 6.55 at 3% concentration (Table I). Osipitan and Oseyemi (2012) studied the toxic effects of aqueous extracts of *Citrus sinensis* (Citrus), *Theobrama cocao* (Cocao), *Tithonia diversifolia* (sunflower) and *Anacardium occidentale* (cashew) against *Macrotermes bellicosus*. All these extracts caused 80-100% mortality after 10 hours of application. The mean mortality of termites by extracts of *T. diversifolia* (sunflower) was 66.67% after 10 h of application. Hence sunflower (*T. diversifolia*) was found slightly effective as compared to other plants. Which is closer to our findings as *H. annus* (Sunflower) was least toxic as

compared to *C. papaya* and *B. glabra.* Badshah *et al.* (2004) reported the toxic effects of *Polygonum hydropipper* L. (Palpoluck) and *Cannabis sativa* L. (Bhang) against *H. indicola* and *C. heimi.* Lethal time LT_{50} of *C. sativa* leaf extract had lower limit 7.73 and upper limit 9.69, LT_{50} of that of *P. hydropipper* had lower limit 6.73 and upper limit of 8.79. The effectiveness of the aqueous extracts of three medicinal plants against *H. indicola* could be arranged in a descending order as follows according to their toxicity. *Carica papaya* > *Bougainvillea glabra* > *Helianthus annus.*

Table I: LT_{50} values of three plant extracts against *H. indicola*

Plants for leaf extracts	LT_{50s} (Hours) Used Concentrations		
	10%	5%	3%
Carica papaya	3.03	3.80	4.86
Bougainvillea glabra	3.58	4.17	5.07
Helianthus annus	3.80	4.75	6.55
Control	34.7		

Table II: Analysis of variance for the effect of 3 different leaf extracts on *H. indicola*

Leaf extracts	Variation source	Degree of freedom	Sum of squares	Mean squares	F- value
Carica papaya	Between groups	2	126	63	0.6*
	Within groups	27	2853	106	
Bougainvillea glabra	Between groups	2	89.3	44.6	0.46*
	Within groups	27	2613.7	96.8	
Helianthus annus	Between groups	2	244.1	122	1.26*
	Within groups	27	2610.9	96.7	

*= Significant at P<0.05

CONCLUSION

These extracts caused significant mortality and their concentrations were very effective against *H. indicola*. Further investigations are needed to investigate the efficacy of tested plant products against other termite species for getting better and safer control.

REFERENCES

ABBAS, M., SHAHID, M., IQBAL, M., ANJUM, F., SHARIF, S., AHMED, S. AND PIRZADA, T., 2013. Antitermitic activity and phytochemical analysis of fifteen medicinal plant seed. *J. Med. Plant Res.,* **7**(22): 1608-167

ABE, T., BIGNELL, D.E. AND HIGASHI, M., 2000. *Termites: Evolution, Socially, Symbioses, Ecology*. Kluwer Academic Publishers, Berlin, Germany. pp.256.

ADEDIRE, C.O. AND AKINNEYE, J.O., 2003. Biological activity of tree marigold, *Tithonia diversifolia* on cowpea seed bruchids, *Callosobruchus maculates* (Coleoptera: Bruchidae). *Ann. Appl. Biol.,* **144**: 185-189.

AIHETASHAM, A., QAYYUM, F. AND XAACEPH, M., 2015. Pathogenicity of *Aspergillus parasiticus* against *Coptotermes heimi* (Wasmann). *Punjab Univ. J. Zool*., **30**(2): 51-55.

AHMED, N., HUMA, Z., HAQ, M. U., SAIF-UR-REHMAN, ULLAH, M. AND AHMED, S., 2016. Effect of different plants extracts on termite specie (*Heterotermes indicola*). *J. Bioresource Manag.,* **3**(2): 9-16.

AKHTAR, M.S., 1972. *Studies on the taxonomy and zoogeography of termites of Pakistan.* Ph.D. Thesis, University of the Punjab, Lahore.

AKHTAR, M.S. AND SHAHID, A.S., 1993. Termites as pest of agricultural crops in Pakistan. *Pakistan J. Zool.*, **25**(3): 187-193.

ASAMOAH, A., ATTA-BOATENG, A., FRIMPONG-MENSAH, K. AND ANTWI-BOASIAKO, C., 2011, February.

Efficacy of extractives from parts of Ghanaian pawpaw, avocado and neem on the durability of *alstonia*. *Afr. J. Environ. Sci. Technol*., **5**(2): 131-135.

BADSHAH, H., FARMANULLAH, Z., SALIHAH, SALJOQI, A. AND SHAKUR, M., 2004. Toxic effects of AK (*Calotropis procera*) plant extracts against termites (*Heterotermes indicola* and *Coptotermes heimi*) (Isoptera: Rhinotermitidae). *Pakistan J. Biol. Sci.,* **7**(9):1603-1606.

COATS, J.R., 1994. Risks from natural versus synthetic insecticides. *Annu. Rev. Entomol.,* **39**: 489-515.

DALES, M.J., 1986. *A review of plant materials used for controlling insect pests of stored products*, National Resources Institute, UK. pp. 1-84.

DONALD, J.B., DELONG, D.M., TRIPILEDS, A.A., 1979. *An introduction to study of insects*. Saunders College Publishing Holt, Rinchert and Winston, the Dry Press, New York. pp. 240-241.

DWIVEDI, A. AND SHARMA, G.N., 2014. A Review on Heliotropism Plant: *Helianthus annuus* L. *J. Pharmacol.*, **3**(2): 149-155.

EDORI, O.S. AND EKPETE, O.A., 2015. Phytochemical screening of aqueous extract of *Icacina trichantha* roots and its effect on mortality of wood termite. *World J. Pharm. Res.,* **4**(10): 213-224.

EMERSON, A.E., 1971. Tertiary fossil species of the Rhinotermitidae (Isoptera) phylogeny, and reciprocal phylogeny of associated Flagellata (Protozoa) and the Staphylinidae (Coleoptera). *Bull. Am. Mus. nat. Hist.,* **146**: 243 –304.

ENCISO-DÍAZ, O.J., MÉNDEZ-GUTIÉRREZ, A., HERNÁNDEZ DE JESÚS, L.,SHARMA, A., VILLARREAL, M. L. AND TAKETA, A.C., 2012. Antibacterial Activity of *Bougainvillea glabra*, *Eucalyptus globulus*, *Gnaphalium attenuatum*, and *Propolis* Collected in Mexico. *J. Pharm. Pharmacol.,* **3**: 433-438.

ENGEL, M.S. AND KRISHNA, K., 2004. Family-group names for Termites (Isoptera). *American Museum Novitates*, **3432**: 1-9.

FORSCHLER, B.T. AND TOWNSEND, M.L., 1996. Mortality of eastern subterranean termites (Isoptera: Rhinotermitidae) exposed to four soils treated with termiticides. *J. Econ. Ent.,* **89**: 678–681.

IBRAHIM, B. U. AND ADEBOTE, D. A., 2012. Appraisal of the economic activities of termites: a review. *Bayero J. Pure Appl. Sci.,* **5**(1): 84 - 89.

ISMAN, M., 2000. Plant essential oils for pest and disease management. *Crop Prot.*, **19**(8-10): 603-608.

ISMAN, M.B., 2006. Botanical insecticides, deterrents, and repellents in modern agriculture and an increasingly regulated world. *Ann. Rev. Entomol.*, **51**: 45-66.

KAMAL, J., 2011. Quantification of Alkaloids, Phenols and Flavonoids in Sunflower (*Helianthus annuus* L.).*Afr. J. Biotechnol.,* **10**(16): 3149-3151.

LEE, K.E. AND WOOD, T.G., 1971. *Termites and Soils*. CABI Publishing, New York. pp. 1-24, 65-71.

MANZOOR, F. AND MIR, N., 2010. Survey of termite infested houses, indigenous building materials and construction techniques in Pakistan. *Pakistan J. Zool*., **42**: 693-696.

OSIPITAN, A.A. AND OSEUEMI, A.E., 2012. Evaluation of the bio insecticidal potential of some tropical plant extracts against Termite (Termitidae: Isoptera) in Ogun State, Nigeria. *J. Entomol*., **9**(5): 239-247.

OYEDOKUN, A.V., ANIKWE, J.C., OKELANA, F.A., MOKWUNYE, I.U. AND AZEEZ, O.M., 2011. Pesticidal efficacy of three tropical herbal plants' leaf extracts against *Macrotermes bellicosus,* an emerging pest of cocoa, *Theobroma cacao* L. *J. Biopest.,* **4**(2): 131-137.

PETERSON, C., WAGNER T.L., MULROONEY, J.E. AND SHELTON, T.G., 2006, October. *Subterranean Termites— Their Prevention and Control in Buildings*. United States Department of Agriculture, US. pp.1-4.

SALJOQI, A.R., KHAN, M.A., HUMA, Z., SATTAR, A., ULLAH, M. AND KHAN, F., 2012. Behavioral changes of *Heterotermes indicola* (Isoptera: Rhinotermitidae) against some natural products. *Pakistan J. Zool*., **44**(6): 1613-1622.

SAXENA, R.C., 1998. Botanical pest control. In: *Critical issues in Insect Pest Management*, (Eds. G. S. Dhaliwal and E. A. Heinrichs), New Delhi, India. pp. 115-179.

TSUNODA, K., 2003. Economic importance of Formosan termite and control practices in Japan. *Sociobiology,* 41: 27-36.

ZHU, B.C., HEDERSON, G., CHEN, F., FEI, H. AND LAINE, R.A., 2001. Evaluation of vetiver oil and seven insect active essential oils against the formosan subterranean termites. *J. chem. Ecol*., **27**: 1617-25.

ZUBAIR, M., MEHMOOD, N., RIZWAN, K., RASOOL, N., JAMIL, M., SHAHID, M. AND AHMAD, V.U., 2012. Antioxidant, Antimicrobial and Phytochemical analysis of *Cichorium intybus* seeds extract and various organic fractions. *Iran. J. Pharm. Res.,* **11**(4):1145-1151.