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Full Length Research Paper

Insecticidal activities of some plant extracts against subterranean termites, *Psammotermes hybostoma* (Desneux) (Isoptera: Rhinotermitidae)

Abdullah Z. Alshehry, Ahmed A. Zaitoun and Refaat A. Abo-Hassan

Department of Arid land Agriculture, Faculty of Meteorology, Environment and Arid land Agriculture - King Abdulaziz University, Jeddah, Saudi Arabia

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The present study was carried out to determine the toxicity of four local plants extracts *Rhazya stricta* Decne, *Lantana camara* L., *Ruta chalepensis* L. and *Heliotropium bacciferum* Forssk. against subterranean termites *Psammotermes hybostoma* (Desneux). All extracts demonstrated remarkable toxicities due to hexane extracts. Of the four extracts, the hexane extract from *R., stricta* has shown a relatively more pronounced toxic effect , having an acute (24 hr) and chronic (48hr) LC50s of 194.8 and 147.4 ppm comparing to 221.7 and 149.9; 288.9, 185.6 ; and 391.3 and 244.5 ppm for *L. camara*, *R. chalepenesis* and *H. bacciferum*, respectively. Toxic effect was found to be both dose and exposure-time. No significant differences were observed between *Rh. stricta* , *L. camara* and positive control (Fipronil (Agenda® 2.5 EC). These safe materials could have promising practical application in protection against attacks by subterranean termites *Psammotermes hybostoma*.

Key words: Plant extract, Subterranean termites, Bioassay, Mortality, Insecticidal activity.

INTRODUCTION

Termites are highly destructive polyphagous pests, which largely damage plants agricultural and fodder crops in Saudi Arabia. Biodegradation of wood caused by termites is recognized as one of the most serious problem for wood utilization. Termites are known to cause tremendous losses to finish and unfinished wooden structures in buildings, besides loss in agriculture and forestry crops (Sen-Sarma *et al*., 1975). The injudicious use of pesticides for the control of termites has generated a number of biological and environmental hazards in air, water, soil and food. These man-made problems have further resulted in phytotoxicity, mammalian toxicity, pesticides residues, insect resistance, insect outbreaks and increased cost of production (Elango *et al*.,2012). Continuous use of synthetic termiticides for soil as well as crop treatment has been allowed for the present time due to lack of any effective substitute. Moreover, research is going on for an effective formulation, which can reduce the damage by termites, at the same time being environmentally acceptable. Biopesticides utilization is based on the fact that these compounds are plant origin and thus, contain no phototoxic properties (Schmutterer, 1990 and Senthil *et al*., 2005). Recently, there has been increasing interest for the development of environment friendly and botanical pesticides, microbial sprays and insect growth regulators (Senthil *et al*., 2004, 2005). Many plant extracts and essential oils (Chang and Cheng, 2002; Arihara *et al*., 2004; Cheng *et al*., 2007) may be alternative sources of termite control agents because they constitute a rich source of bioactive chemicals. Recent studies have focused on natural plant products as alternatives for disease control. Several natural insecticides are used in agriculture; systematic investigations on antifeedant and other physiological, pharmacological and antibiotic activity of plant-based compounds have been initiated. On the other hand therapeutic plants are cheaper and more accessible in the world. Manzoor *et al*., 2011, found that *Curcuma longa* plant extract was found to be more efficient in soil treatments to protect food substrate against termites. *Capparis deciduas* and its combinatorial mixtures were eva-

*Corresponding author. E-mail: a_zaitoun2000@yahoo.com

luated to observe the anti-termite efficacy against Indian white termite *Odontotermes obesus*.

These compounds have shown very high termiticidal activity and wood protection in the soil (Upadhyay *et al*., 2010).

Several researchers have documented the toxic effect of plant extracts such *as Lantana camara, Rhazya stricta, Ruta chalepensis, Heliotropium bacciferum* and essential oils in controlling some pests (Tiwarya *et al*., 2007 and Ghosh *et al* ., 2012). These plants are widely distributed in the Kingdom of Saudi Arabia (Mossa, *et al*., 1987).

The objective of this study is to examine alternative, effective and environmental safe control agent methods and to test the effect of common plants natural compounds against subterranean termites in Saudi Arabia.

MATERIALS AND METHODS

Termite

The test termite species, *Psammotermes hybostoma* (Desneux) were collected from infested dry trees found at the arid area of the university research station at Hada Alsham, Saudi Arabia.

Termites were kept in plastic enamel trays and were safely kept in the laboratory. Water and newspaper were used as food sources. Termites were maintained in some dark glass jars at 25^{0} C, 75±5 RH following (Upadhyay *et al*., 2010). The experiments were carried out at the Faculty of Meteorology, Environment and Arid Land Agriculture, King Abdulaziz University, Jeddah, Saudi Arabia.

Plant collection

Plant materials of *Lantana camara, Rhazya stricta, Ruta chalepensis and Heliotropium bacciferum* were collected from central parts of Saudi Arabia and taxonomically identified.

Plant Extracts

Leaves of the tested plants were air-dried for 8 days in the laboratory. The dried leaves were grounded to fine powder (mesh No 20, 0.0331 inches) using electrical blender and extracted with hexane at ambient temperature. A gentle warming to 35-40 ˚C was sometimes found necessary. The mixture was stirred for 30 minutes with magnetic stirrer and left for 24 hours. This mixture was condensed in rotary vacuum evaporator of solvent in a water bath at 55 ˚C according to (Chitra *et al*., 1993). The obtained residue was stored at 4^{0}C until further use.

Test procedure

Stock solutions of the four plant hexane extracts were prepared by dissolving 0.5 gram of crude extracts in 100 ml warm distilled water. Different concentrations of 200,400, 600, 800 and 1000 ppm were prepared from stock solution. A piece of filter papers (Whatman No. 1) were treated with 1 ml of the prepared concentrations and dried at the room temperature. Fipronil (Agenda® 2.5 EC Bayer France) was used as a positive control. Twenty termites above the third in star were put on each piece of filter paper in a Petri dish (9cm in diameter, 1.5cm in height). The dishes with leds were then placed in an incubator at 28±2˚C, 75±2 RH. A few drops of water were periodically dripped onto the bottom edge of each Petri dish according to (Elango *et al*., 2012). Four replicates were made for each test concentration, and the mortality percentage of the termites was counted for 24 h and 48 h of the desired plant extract concentration after treatment. However, at the end of 24 h and 48 h the selected test samples turned out to be equal in their toxic potential.

Statistical analysis

The average termite mortality data were analyzed using probit analysis for calculating LC50s and other statistics at CL95%, slope and chi-square values were calculated according to Finney, 1972. Results with $p < 0.05$ were considered to be statistically significant. Abbott,'s formula was used when necessary (Abbott, 1925).

RESULTS AND DISCUSSION

In the present study, four plant species from different families were evaluated for their activity against termites in Saudi Arabia. The mortality percentage of *Psammotermes hybostoma* nymph treated with four plant extracts in hexane in addition to positive control with recommended dose with Agenda® 2.5 EC were presented in table 1. Significant differences were observed between *Rh. stricta* , *L. camara* and other plant extracts. All test materials were toxic to *Psammotermes hybostoma* nymph in a dose dependent manner, although the toxic action was relatively slow for *Heliotropium bacciferum* and *Ruta chalepensis* , and their effectively variedly depending on the dose of exposure. *Rh. stricta* was the most effective, where its 1000 ppm of hexane extract caused 96.3 and 100 % mortalities, 24 hr and 48 hr after treatment , respectively, and the hexane extract of *Lantana camara* (1000 ppm) , produced 90.0 and 97.5% mortalities, 24 hr and 48 hrs after treatment , respectively. No significant different were observed between *Rh. stricta* and *L.camara* at concentration of 1000 ppm. Also, there was no significant difference between both and Agenda pesticide

Table 1. Mortality percentage of *Psammotermes hybostoma* nymph in media containing hexane plant extracts at different exposure times.

Plant Material	Conc. (ppm)	% Mortality after 24hr	48hr
Rhazya stricta	200	56.3	66.25
	400	66.3	80.0
	600	78.8	86.3
	800	88.8	97.5
	1000	96.3 a	100.0a*
Lantana camara	200	51.3	62.5
	400	61.3	76.3
	600	73.8	81.3
	800	85.0	91.3
	1000	90.0 a	97.5a
Ruta chalepensis	200	46.3	55.0
	400	52.5	68.8
	600	60.0	73.8
	800	71.3	83.8
	1000	78.75b	92.5b
Heliotropium bacciferum	200	41.3	46.3
	400	48.8	61.3
	600	52.5	62.5
	800	61.3	67.5
	1000	70.0c	76.3c
control		1.3 d	2.5 d
Agenda	2.5 EC	95.0a	100.0a

*Means not sharing the same letter with columns are significantly different (P<0.05) according to Duncan׳s multiple ran.

Table 2. LC50 values and 95% confidence limits of *Psammotermes hybostoma* nymph in media containing hexane plant extracts at different exposure times.

Plant extract	Assay Time (hours)	Slope	LC50 (95% CL)
Rhazya stricta	24	1.95	194.8(144.29-262.66)
	48	2.29	147.4(105.53-205.43)
Lantana camara	24	1.73	221.7(164.07-299.29)
	48	1.84	149.9(100.73-221.66)
Ruta chalepensis	24	1.22	288.9(205.85-405.02)
	48	1.59	185.6(127.31-270.14)
Heliotropium bacciferum	24	0.98	391.3(282.08-542.17)
	48	1.02	244.5(153.19-389.05)

which was used as a positive control. *H. bacciferum* had significantly lower mortalities than the other hexane plant extracts.

The range of acute (24 hr) and chronic (48) for *Rh. stricta* and *L. camara* LC50 values were 194.8, 147. 4 and 221.7149. ppm for hexane extracts, respectively (Table 2). Both R. *stricta* and *L. camara* hexane extracts had significantly lower LC50s (24 and 48 hr) than the hexane extracts from both *R. chalipensis* and *H. bacciferum*. The hexane extracts of the two plant materials (*Rh. stricta* and *L. camara*) were generally more toxic than other plant extracts. The toxic effect of *R. stricta* was previously reported on mosquito larvae (Elhag *et al*., 1996), *Agrotis ipsilon* Hufn. and *Hypera brunneipennis* (Elhag *et al*., 1998) and *Oryzaephilus surinamensis* L. (Madkour, *et al*., 2013). Although the toxic mode of action of *R. stricta* in insects is not yet known, it might be attributed to its high content of biologically active alkaloids (Hassan *et al*., 1997). *Lantana camara* possess a strong anti-microbial activity (Shrestha. and Bhattarai, 2009). Moreover, *Lantana camara* was effective in reducing insect damage to stored maize grains (Ogendo *et al*., 2004).

H. bacciferum showed lower toxic effects, compared with *Rh. stricta, L*. *camara* and *Ruta chalepensis*. Highest mortality values, 70 and 76.3 % were obtained after 24 and 48 hrs at the 1000 ppm hexane extract, respectively. This herb is widely distributed throughout the Central and Eastern parts of Saudi Arabia (Migahid, 1988). Its aerial parts contain alkaloids, flavonoids, tannins, sterols and/or triterpenes, volatile oils and volatile bases; and are moderately toxic to brine shrimp and mosquitoes (Al-Yahya *et al*., 1990 and Elhag *et al*., 1996).

CONCLUSIONS

The materials investigated in this study could have practical application in protection from attacks of subterranean termites, *Psammotermes hybostoma* (Desneux), by virtue of merit inherent in plant extracts such as their environmental safety, low mammalian toxicity, low cost and easy handling.

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