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Insecticidal effect of plant extracts on two termite species

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The insecticidal contact activity of two desert plant extracts, *Withania somnifera* and *Solanum incanum* (Tubiflora: Solanaceae) was tested against the workers of the two species, *Amitermes messinae* and *Microtermes najdensis* (Isoptera: Termitidae). The insects were exposed to the plant extracts on Petri dishes (10 cm diameter) for 30 min. Mortality was calculated after 24 h. Crude extract of *S. incanum* leaves was more toxic to the two species of termites than *W. somnifera*.

Keywords: crude extract; desert plants; Solanaceae; termites; bioassay; mortality

Introduction

Termites, mainly occurring in the tropics and subtropics, are considered as one of the most damaging insect groups in warmer regions of the world, due to their potential to cause structural damage to human buildings. However, termites also play a key role in decomposing dead plant tissues and thereby form the basis of a grazing food chain in tropical terrestrial ecosystems (Higashi and Abe 1996). Some termite species do not attack dried wood but feed on fresh plant material instead. *A. messinae* feeds on the trunk of mango trees (*Mangifera indica*), whereas *M. najdensis* attacks the roots of maize plants (*Zea mays*). Usually, synthetic insecticides are used for termite control. These have created a number of ecological problems, such as the development of resistant insect strains, ecological imbalance and damage to mammals. For this reason, there is the need for safe, locally available and less expensive methods for controlling termites. Natural products are usually recommended because of their less harmful nature to non-target organisms. Moreover, they reduce the hazards to humans by minimizing the accumulation of harmful residues in the environment. Plant allelochemicals have been shown to act as feeding deterrents or to be toxic to generalist and to non-adapted specialist insects (Francis et al. 2001). *Lantana camara* caused a significant reduction in the percentage survival of the root-feeding flea beetle *Longitarsus bethae* (Simelane 2006). Larvae of *Henosepilachna yasutomii* also showed a significantly higher mortality on *Solanum tuberosum* (Naoyuki et al. 2005). *Solanum nigrum* extract caused maximum inhibition of larvae development and survival (Elsayed 1997). The percentage of

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mortality of *Anacridum aegyptium* treated with three desert plants (*Calotropis procera, Pulicaria crispa and Zygophyllum simplex*) was 100% (Elsayed 2004).

The aim of this study was to evaluate the possibility of using plant-derived extracts of two plant species for controlling termites and reducing the dependency on chemical insecticides.

Material and methods

Preparation of plant extracts

The leaves and fruits of *W. somnifera* and *S. incanum* were collected from the desert and then dried. Fifteen grams of dry materials were ground to powder, which was dissolved in 200 ml of hexane solvent by stirring for 48 h with a magnetic stirrer. The mixture was then filtered and the solvent was left to evaporate, by rotarying and using an electric pump (Elsayed 1997). The crude extract was weighed and dissolved in 10 ml hexane. Serial concentrations were prepared and assayed. Crude extract of leaves and fruits of *W. somnifera* was 90 and 45 mg, respectively and the crude extract of all leaves and fruits of *S. incanum* was 45 mg.

Collecting insects

A. messinae was collected from infected mango trees, whereas *M. najdensis* was collected from infected maize roots, at Taif city.

Plant extracts bioassay

To determine the contact action of plant extracts (Mi-Kyeong et al. 2006) and its effect on the mortality percentage, five workers from two species were exposed to four or six concentrations from plant extracts (22.5 μg (5 μl), 33. 7 μg (7.5 μl), 45 μg (10 μl), 67.5 μg (15 μl), 90 μg (20 μl), 112 μg (25 μl) and 135 μg (30 μl). Different concentrations from plant extracts (leaves or fruits) were put using a micro-pipette onto the surface of the Petri dish (10 cm diameter.) inside circular glass (1.5 cm in diameter and 2.5 cm in length), then the workers were exposed to the thin layer of the crude extract inside the circular glass to prevent it from movement. After 30 minutes, the treated insects were transferred to the glass jar (250 ml) containing the same natural food (bark wood from mango tree or maize roots) and covered by black tissue.

Treated termites with hexane only were used as control. Control and treatments insects were held under the same conditions. The treatments and control were repeated five times. Based on this, mortality percentages after 24 hours were calculated as described by Nathan et al. (2006). The percentage mortality was calculated as follows:

$$\text{Percentage mortality} = \frac{\text{number of dead termites}}{\text{number of termites introduced}} \times 100$$

Results

The toxicity of the fruit crude extract of *W. somnifera* and *S. incanum* on termite workers of *A. messinae* was calculated. The results showed that there are few differences on the mortality percentages at lower concentrations (Figure 1).

However, with higher concentration (135 μg), the crude extract of the two plants have an equal effect on the workers' mortality (96% mortality).

The percentage mortality of the termite workers *A. messinae* was higher after treatment with the crude leaf extract of *S. incanum* plant compared with *W. somnifera* leaf extract at the same concentrations tested (Figure 2). The percentage mortality of the termite was 100% with the highest concentration, 135 μg, from the crude extract of *S. incanum* leaves.

Comparison of the efficacy of the crude fruitvextract of *W. somnifera* and *S. incanum* on the survival of the termite *M. najdensis* indicates that the crude extract of *S. incanum* plant at the different concentrations tested was more effective on the survival of termite as compared with the fruit extract of *W. somnifera* plant (Figure 3).

The effect of different concentrations of the hexane leaf extract of *S. incanum* and *W. somnifera* on the termite workers of *M. najdensis* indicate that the crude extract of *S. incanum* caused higher mortality at all concentrations tested than the other extract of *W. somnifera* leaves (Figure 4). Some concentrations of the crude leaf extract of *S. incanum* have a double effect at least on the survival of the termite workers when compared with the crude extract of *W. somnifera* plant; the concentrations 22.5μg, 33.7 μg, 45 μg and 67.5 μg from the crude leaf extract of *S. incanum* caused mortality of 8%, 24%, 28% and 40% respectively, but the same concentrations from the crude leaf extract of *W.* somnifera caused mortality of 4%, 10%, 12% and 20% respectively. Hexane only as control caused 0.0% mortality at the lower concentrations (5, 7.5, 10 and 15 μl), 4% mortality at 20 and 25 μl and 8% mortality at the highest concentration (30 μl).

Discussion

The crude leaf extract of *S. incanum* was more toxic to two species of termites compared with crude leaf extract of *W. somnifera*. The allelochemicals which are

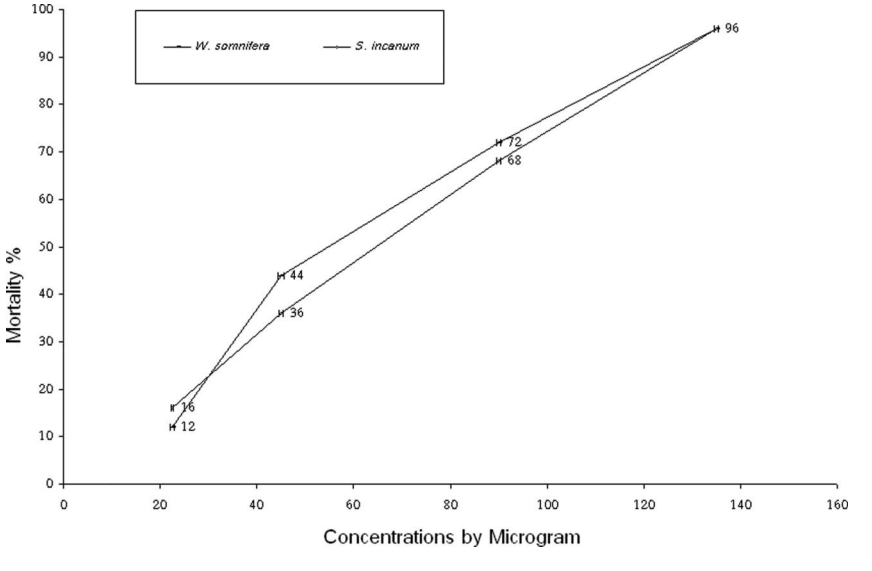

Figure 1. Effect of fruits extract of *Withania somnifera* and *Solanum incaum* on the survival of *Amiterms messinae*.

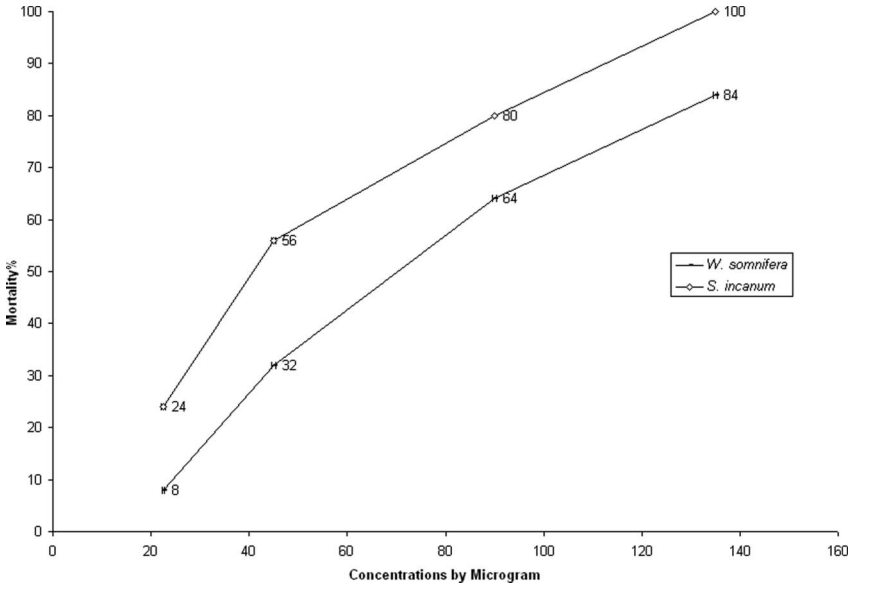

Figure 2. Effect of leaves extract of *Withania somnifera* and *Solanum incanum* on the survival of *Aminterms messine*.

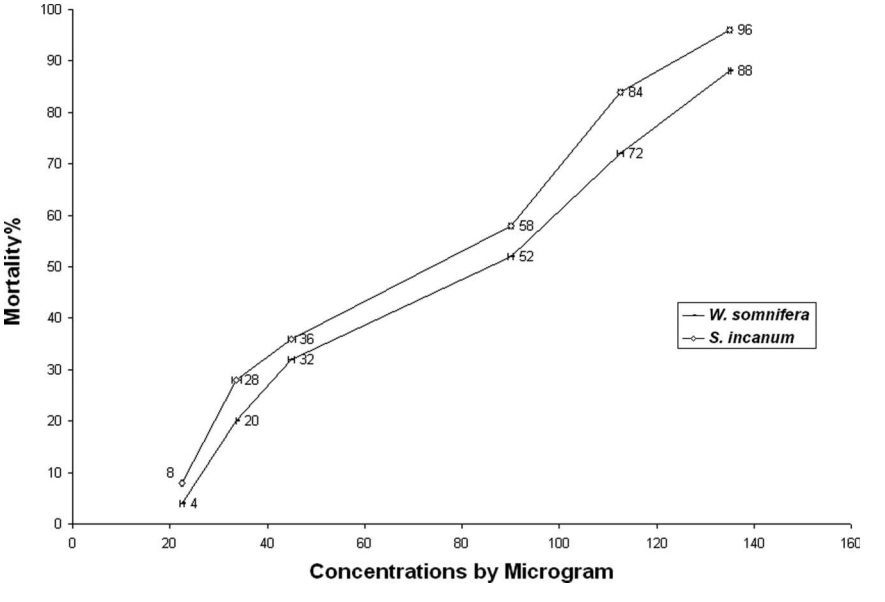

Figure 3. Effect of fruits extract of *Withania somnifera* and *Solanum incanum* on the survival of *Microtermes najdensis*.

known as solanidine and/or its derivative products which are known as ά-solanine and ß- chaconine yield higher concentrations in the leaves of *S. incanum* than in *W. somnifera*. Wild weed *Solanium nigrum* contain higher concentrations of solanidine which it has toxicity on the potato tuber moth (Elsayed 1997). Hexane leaf extract of

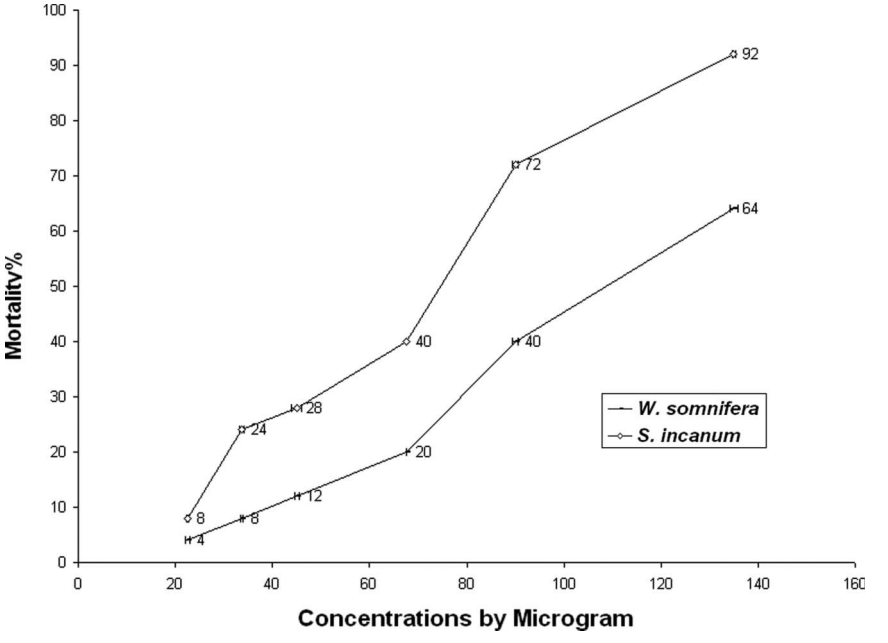

Figure 4. Effect of leaves extract of *Withania somnifera* and *Solanum incanum* on the survival of *Microtermes najdensis*.

S. incanum caused 100% mortality. These results are in line with other authors' conclusions such as Ganapaty et al. (2004) who noted that quinones extracted from the roots of *Diospyros sylvatica* caused higher mortality in the termite, *Odontotermes obesus*. Soon-II et al (2003) also showed that the extract from *Cinuamomum sieboldii* root bark resulted in 100% mortality in *Callosobruchis chinensis* and *Sitophilus oryzea* two days after treatment. Methanol extract of *Eugenia caryophyllata* bud (5.2 mg/cm^2) caused 100% mortality of *Attagenus unicolor japonicus* during seven days after treatment (Mi-Kyeong et al. 2006). The crude water extracts of *Larix leptolepis* wood containing flavonoids in large quantities exhibited potent termite, *Coptotermes formosanus*, feeding deterrent activities (Chen et al. 2004). Gut microbes in Formosan subterranean termite *Coptotermes formosanus* were affected when the neem extract was mixed with the food source (Doolittle et al. 2007). The 5% chloroform extract of *Lantana camara* was found to be significantly effective against termite workers (Rajesh and Suman 2006).

The efficacy of the fruit extract of the both plants as insecticidal to termites is nearly equal. This could be attributed to the fact that the fruits in both plants have the same concentrations of allelochemicals and i's degradation products.

On the basis of the results obtained, the crude extract of the leaves or fruits of *S. incanum* and *W. somnifera* are potentially useful as termite control agents in the termite breeding places in either the field or in infected houses.

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