Journal of Biopesticides, 2(2): 161-164 (2009) **161**

Toxic and antifeedant activities of *Sterculia Foetida* (L.) seed crude extract against *Spodoptera litura* (F.) and *Achaea Janata* (L.)

Pathipati Usha Rani* and Pala Rajasekharreddy

ABSTRACT

Toxic and antifeedant effects of the Wild Indian almond, *Sterculia foetida* L. seed crude extract on the two important lepidopteran pests- castor semilooper, *Achaea janata* L. (Noctuidae: Lepidoptera) and the Asian armyworm, *Spodoptera litura* (Fab.) (Noctuidae: Lepidoptera) on castor (*Ricinus communis* L.) plants were studied by leaf disc bioassay method. The acetone extract applied to the leaf disc showed toxicity to the *S. litura* and feeding deterrency to the *A. janata*. Insecticidal and feeding deterrent activities of the crude extract acted in a dose dependent manner against the test insects. At a higher dose of 2.5 mg/cm^2, 3rd instar larvae of *S. litura* died within 24h of treatment. The treated larvae were dehydrated and shrunken before death. Lower doses (0.5mg/cm^2) also exhibited toxic effects to *S. litura* but with time delayed process. However, the same compound has produced 100 % feeding deterrent activity to *A. janata* at 4.0 mg/cm^2. At lower doses employed, i.e. 2.0 mg/cm^2 a moderate percentage (20 %) of feeding deterrent action was found after 24h treatment. It is interesting to find that the seed extract of *S. foetida* acted as insecticide to *S. litura* and as an antifeedant to the semilooper, thus indicating the dual mode of action of the compound against the different pest larvae treated. However, a study on the mechanism of action is presumed to reveal interesting observations on the mode of action of this botanical pesticide.

Keywords: *Sterculia foetida, Spodoptera litura, Achaea janata*, toxicity, feeding deterrent activity, seed extract.

INTRODUCTION

Insect pests are mainly controlled with synthetic insecticides over the last 50 years. Because of their longer usage, there are problems of pesticide resistance and negative effects on non-target organisms, including humans, and the environment (Franzen, 1993). In addition to their deleterious influence on the environment, the synthetic insecticides are more hazardous to handle, toxic residues in food products, and are not easily biodegradable. Unlike synthetic ones that kill both pests and predators, natural insecticides are relatively safe against the latter. Therefore, now it has become necessary to search for an alternative means of pest control, which can minimize the use of these synthetic chemicals. The botanical pesticides or plant products usage in an agroecosystem is now emerging as one of the prime means to protect crops produce and the environment from pesticidal pollution.

The crude extracts obtained from plants are usually composed of terpenoids and compounds such as secondary metabolites. The plant secondary compounds have been the subject of thorough investigation for the past few years in an effort to discover new sources of botanical insecticides and other behaviour regulating chemicals. Among the plant families studied, the Meliaceae, Rutaceae, Asteraceae, Labiateae, Piperaceae and Annonaceae are perhaps the most promising (Schoonhoven, 1982; Jacobson, 1989; Isman, 1995). Several of these plant chemicals act as insect feeding deterrents and are promising as pest control agents. Neem (*Azadirachta indica* A.) is well known as plant for its insecticidal property (Lowery and Isman, 1995), and is reported to be effective against *Spodoptera litura* F. (Deota and Upadhyay, 2005). Azadirachtin, a limonoid from seeds of the neem tree possesses strong antifeedant and growth inhibitory effects against various insect pests (Isman, 1997).

The search for plant derived chemicals that have potential use as crop protectants insecticides, antifeedants, and growth inhibitors) often begins with the screening of plant extracts (Ho *et al.*, 1997; Klem *et al.*, 1997). Vasconcelos *et al.* (2006) recorded the insecticidal activity of *Sterculia foetida* L. on *Bemisia tabaci* biótipo B (Hemiptera: Aleyrodidae). Previously Peta Devanand and Usha Rani

(2008) evaluated the impact of *Syzygium cumini* L., *Ocimum basilicum* L., *Luffa aegyptica* Mill., *Eichhornia crassipes* Mart., *Tamarindus indica* L., *Terminalia catappa* L., *Limonia acidissima* L., *Murraya koenigii* L., *Breynia retusa* (Dennst.)., *Jatropha curcas* L., *Tectona grandis* L., *Momordica charantia* L., *Mangifera indica* L., *Ricinus communis* L., and the seed extract of *Madhuca indica* Gmelin., were evaluate against *Achaea janata* and tobacco caterpillar, *Spodoptera litura* F. In the present study, we report the results on laboratory bioassays of the seed extracts of *S. foetida* against certain major agricultural pests. Evaluation of antifeedant activity and toxicity of crude seed extracts of *Sterculia foetida* L. against the castor semilooper, *A. janata* and tobacco caterpillar, *S. litura* F. were carried out respectively. The seeds of *Sterculia foetida* L. (Sterculiaceae) also called as Java olives are oily and can be eaten raw or roasted. Since the plant materials used for the evaluation is of natural origin and also edible by nature, so their usage is not harmful to the humans and other animals.

MATERIAL AND METHODS

Test insects and its maintenance

Spodoptera litura and *Achaea janata* larvae used in this study were obtained from a laboratory colony maintained in the Biology and Biotechnology Division, IICT, Hyderabad, India. The culture has been continuously maintained on castor leaves (*Ricinus communis* L.) at room temperature (25 ± 20^{0}C), 65 ± 5% RH and 16: 8 L: D photo period in the laboratory.

EXTRACTION OF PLANT MATERIAL

The dried seeds (400g) of *S. foetida* were collected from the trees growing in the campus of Indian Institute of Chemical Technology (IICT) at Hyderabad, India. The seeds of *S. foetida* were brought to the laboratory. The clean seeds were air-dried for 3 weeks at room temperature (28 ± 2^{0}C) until all the moisture content was evaporated. The dried material (400 g) was milled to fine powder in an electric grinder, homogenized, and finally extracted with acetone at room temperature for 3 days. The resultant material was filtered, and concentrated in a rotary evaporator under reduced pressure. The resultant residue was stored at - 20 ^{0}C until use.

Antifeedant (choice) and toxicity bioassays

Antifeedant activity of crude seed extract was assayed by using leaf disc method. Healthy third-instar larvae of castor semilooper, *A. janata* were collected in the morning hours, and placed into clean plastic boxes with no food. The number of larvae taken was always greater than that needed, ensuring an adequate number of active insects for the bioassays. Larvae were starved 3 - 4 h prior to each bioassay. Using a cork borer, fresh leaf discs (21 cm^2) were cut (approximately 7-weeks old plants). Control leaf discs were treated uniformly on both sides with 50 ìl of acetone and test leaf disc with 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, and 4.0 mg/cm^2 of the seed crude extract in acetone. The treated discs was allowed for evaporation. The solvent by air drying and leaf discs without treatment, as control was placed in each compartment of a plastic petridish [4.2 cm x 3.0 cm (length x width)] on a wet filter paper disc to prevent desiccation. The distance between the two discs was approximately 1.0 cm. After four hours of starvation, a single larva was introduced gently into the centre of each compartment and the larvae were allowed to feed. There were ten replicates for each treatment and all the treatments were repeated on three times. The plastic petridishes with larvae and test discs were put into a clear plastic box [39 x 27 x 14 cm (length x width x height)] lined with moistened paper towel and the box was placed in an illuminated growth chamber at 26^0 C. The antifeedant effects were recorded. These insects were transferred to the normal diet in a separate container and were maintained and observed for the mortality, deformity, knockdown etc. The percentage antifeedant index was calculated following the formula reported by Lewis and Van Emden (1986). In some treatments the leaf discs were partially consumed, hence further the contact toxicity of these treatments were also recorded by transferring them on to fresh diet after the experimental period and observing the mortality of the exposed larvae.

Antifeedant index = [(C-T)\(C+T)] x 100.

Where “C” is the weight of leaf disc consumed in the control and “T” is the weight of leaf discs consumed in the treatment.

The toxic effects produced by the seed extract of *S. foetida* due to the contact with *S. litura* was measured by treating a set of 50 insects in the same manner as above, except that after exposure of the insects to the treated leaf disc for 24h, the insects were transferred to the normal diet in a separate container. Mortality and other toxic effects like knock down etc. were observed and recorded after every 24h. The data obtained revealed the contact toxicity of the extract.

Data analysis

Statistical analysis of the experimental data was performed using probit analysis to find out the LC_{50} (Finney, 1971). The data was analysed by completely randomized, one-way Analysis of Variance (ANOVA) and the means were separated using Tukey HSD test (Sigmastat V 3.1).

RESULTS AND DISCUSSION

Our results indicate that the seed extract of the *S. foetida* acts as potential insecticide to the third instar larva of *S. litura* as well as antifeedant to *A. janata*. The crude extracts of *S. foetida* seeds showed good antifeedant activity against *A. janata* and contact toxicity towards *S. litura*. The results obtained in the present investigation are interesting in the context of varied degree of activity of the botanical extract to the two different pests of castor. The extract applied on the leaf surface showed 100 % feeding deterrent activity to *A. janata* at a dose of 4.0 mg/cm^2 of leaf disc. And the larvae were visibly unable to feed on the treated leaf. A lower dose of 2.0 mg/cm^2 reduced the larval feeding up to a large extent. However, the toxic effects of the extracts on *A. janata* are almost negligible (Table 1).

The seed extract of *S. foetida* produced high mortality to the larvae of *S. litura*. At 2.5 mg/cm^2 dose the leaf surface application of the extract caused 100 % mortality in the exposed larvae. The extract acted in a dose dependent manner in producing the toxicity, LC_{50} occuring at 0.67 mg/cm^2 (Table 2). Soon after the exposure to the treatment, the larval death took place. The seed extract is very potent in penetrating the larval body through cuticle and cause lethal effects because in these treatments the feeding was absolutely prevented.

It appears, from the results, that the material extracted from the seed crude extracts of the *S. foetida* is toxic and also feeding deterrent. However, both the insects exposed to the treatments responded in different ways .The extract was highly toxic to *S. litura*, while it is highly antifeedant to the *A. janata* larvae. The treatments could cause desirable impact on larval growth and development and could totally achieve the management of these two major pests of castor in the laboratory conditions. Several plant secondary metabolites are known antifeedants and various chemicals such as triterpenes (Van Beek, 1986) sesquiterpene lactones and alkaloids (Nawrot, 1986), cucurbitacines, quinines and phenols (Norris, 1986). Some plants families include numerous species containing bioactive substances, amongst are volatile oils especially terpenes tansy (Wieczorek, 1996; Mwangi, 1988) are reported to contain antifeedant properties against various agricultural pests. The work on chemical isolation and identification of the active ingredient and the possible utilization in the field level are under progress. As the seed material is available plenty, commercial utilization of the extracts for the control of agricultural pests seems to be economical.

Table 1. Antifeedant activity of *S. foetida* seed extract against 3rd instar larva of *S. litura* and *A. janata* after 24h of feeding on treated leaf disc.

Dose (mg/cm^2)	Mean (%) antifeedant index ^{b}	
	Spodoptera litura	*Achaea janata*
2.0	100.0a	20.0
2.5	100.0a	43.0
3.0	100.0a	61.5
3.5	100.0a	80.0
4.0	100.0a	100.0

^{b}Antifeedant Index (AFI) percentages within a column followed by same letter are not significantly different (ANOVA, P< 0.05, Tukey HSD test).

Table 2. Toxic effects of *S. foetida* seed extract against third instar larva of *S. litura* and *A. janata* after 24h of feeding on treated leaf disc.

Dose (mg/cm^2)	Mean (%) Toxicity ± SD ^{b}	
	Spodoptera litura	*Achaea janata*
0.5	33.5 ± 1.4	2.5 ± 0.2
1.0	52.9 ± 1.1	5.2 ± 0.5
1.5	72.1 ± 0.8	10.0 ± 0.9
2.0	88.6 ± 1.8	14.5 ± 0.7
2.5	100.0	18.2 ± 0.6
LC_{50} (95% CL) (mg/21cm^2 larvae) ^{c}	0.67 (0.16-0.97)	15.7 (5.4-3852.4)

^{b}Toxicity percentages within a column followed by same letter are not significantly different (ANOVA, P< 0.05, Tukey HSD test).

^{c}From the concentration-response curves, LC_{50} values were calculated by probit-log analysis.

ACKNOWLEDGEMENTS

Thanks are due to Dr. J.S. Yadav, Director of Indian Institute of Chemical Technology, Hyderabad, for the facilities.

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Pathipati Usha Rani* and Pala Rajasekharreddy
Biology and Biotechnology Division, Indian Institute of Chemical Technology, Tarnaka, Hyderabad - 500 607, Andra Pradesh, India, ***E-mail: usharani65 @yahoo.com.