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Insecticidal activity of extract from *Datura stramonium* (F.) (Solanaceae) against *Callosobruchus maculatus*

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Abstract: Higher plants are a rich source of novel insecticides. Plant materials with insecticidal properties have been used traditionally for generations throughout the world. Botanical insecticides compared to synthetic ones may be safer for the environment, are, generally, less expensive, easily processed and used by farmers and small industries. However, many plant species, especially from tropical regions, have the potential to be used as botanical insecticide or as font of bioactive compounds. In this study, extract of powdered leaves, stems and seeds from *Datura stramonium* was obtained by a rotary evaporator apparatus and was tested under laboratory conditions for its ability to control some stored products from attack by *Callosobruchus maculatus.* The experiments were conducted at 27±1°C, 60±5 % R.H. and in dark condition. The mortality of adults was tested at different concentrations and two exposure times (24 and 48h). The effect of different concentrations on egg hatching was also tested after 6 days. Also sublethal effect of different concentrations was tested on oviposition rate. The results showed that the mortality increased with increases in concentration and exposure time. After 12h, high increases in mortality were seen. Data probit analysis demonstrated that lethal concentration to kill 50% of the population (LC_{50}) was estimated as 1680 and 16058ppm, for 24 and 48h, respectively. These results suggest that extract of *D. stramonium* may be of high value in grain storage against *C. maculatus*, especially in subsistence agriculture where the plants are locally available to farmers with little resources to meet the high cost of pesticides.

Key words: *Datura stramonium*, *Callosobruchus maculatus*, extract, insecticidal activity

Introduction

Stored insect pests are a problem throughout the world, because they reduce the quantity and quality of grain. Their damage to stored grains and grain products may amount to 5-10% in the temperate zone and 20–30% in the tropical zone (Nakakita, 1998). Such damage may reach up to 40%, in countries where modern storage technologies have not been introduced (Shaaya et al., 1997). Among stored product pests of the genus *Callosobruchus* (Col., Bruchidae) seriously damage beans or legume seeds especially in warm parts of the old world from which it originates (Borowiec, 1987; Udayagiri and Wadhi, 1989; Singal and Pajni, 1990). One of the most important insect pests of the cowpea [*Vigna unguiculuta* (L.)] is the bruchid beetle *Callosobruchus maculatus* (F.), which attack the seeds during storage, severely affecting the quality and storability of the product (Hall et al., 1997). The use of chemical agents to prevent or control insect infestations has been the main method of grain protection, since it is the simplest and most cost effective means of dealing with stored product pests (Hidalgo et al., 1998).

However, insecticides have serious drawbacks such as pest resurgence and resistance, lethal effects on non-target organisms, the risk of user's contamination, food residues, and environmental pollution (Tapondjou et al., 2002). In addition, the precautions necessary to work with traditional chemical insecticides (Fields et al., 2001), and the poor storage facilities of traditional farmers in developing countries, which are unsuitable for effective conventional chemical control (Tapondjou et al., 2002), emphasize the necessity of new and effective methods for insect pest control of stored products. Thus, there is an urgent need to develop safe alternatives to conventional insecticides and fumigants for the protection of grain products against insect infestations. Higher plants are a rich source of novel insecticides (Dev and Koul, 1997). Plant materials with insecticidal properties have been used traditionally for generations throughout the world (Belmain et al., 2001). Botanical insecticides compared to synthetic ones may be safer for the environment, are, generally, less expensive, easily processed and used by farmers and small industries (Belmain et al., 2001). Since these insecticides are often active against a limited number of species, are often biodegradable to nontoxic products, and are potentially suitable for use in integrated pest management, they could lead to the development of new classes of safer insect control agents (Kim et al., 2003). However, many other plant species, especially from tropical regions, have the potential to be used as botanical insecticide or as font of bioactive compounds (Saxena et al., 1992; Shaalan et al., 2005).

Datura stramonium (F.) is a plant belongs to the Solanaceae family that grows in many parts of world including Iran (Zargari, 1990). Previous studies have assessed fumigant activity of essential oils on adults and larvae and recently researcher have described the contact and fumigant toxicity of essential oils or their major components against eggs of stored product insects (Shaaya et al., 1993; Ho et al., 1997; Huang et al., 1997, 2000).

In this study, extract of powdered leaves, stems and seeds from *Datura stramonium* was obtained by a rotary evaporator apparatus and was tested under laboratory conditions for its ability to control some stored products from attack by *Callosobruchus maculatus.*

Material and methods

Insect culture

C. maculatus beetle was reared on mung bean seeds. The culture was maintained in the dark condition in growth chamber set at 27±2°C and 60±5% RH. Some samples of adult beetles of *C. maculatus* were taken from Nuclear Research Center of Medicine and Agriculture.

Plant materials

Samples of aerial parts of *D. stramonium* were collected from Medicinal Plants Research Center Field Station and shade dried on laboratory benches at room temperature (23-27°C) for 5 days before extraction.

Contact toxicity and mortality trend of adults

In the first bioassay, bioactive acetone extract of *Datura* plant with insecticide activity was evaluated against *C. maculatus*. Sample was placed in 1l Erlenmeyer flask for hexane extraction. The solvent was removed by filtration after 48 hours. Ethanol extraction was carried out by graining the samples with solvent and waiting for 48 hours. The hexane and ethanol extracts were concentrated under low pressure and reduced temperature (<50°C), and were diluted with the respective solvent at the different concentrations of 300, 500, 1000, 2500 and 4000ppm. The filter paper (7cm of diameter) received 1ccm of extract, and was placed on Petri dish (9cm of diameter). The control was treated with pure solvents. After the solvent evaporation, 10 nonsexed and 1 to 7 days old adult of *C. maculatus* were placed in each Petri dish, maintained under 27±1°C, 60±5% R.H. and dark condition. The experimental design was completely randomized, with four replicates. Insect mortality was evaluated after 24 and 48 hours of exposure to impregnated filter paper. Mortality data were subjected to analysis with SAS 6.12 software with Finney (1977) method and LC_{50} and LC_{90} was calculated. Also mortality trend of *C. maculatus* adult with above concentrations after 3, 6, 9, 12 and 24 hour of experiment was evaluated.

Ovicidal activity of test materials

Another experiment was designed to assess 50% lethal dose for eggs. Fifty pair of newly emerged beetles (i.e., a male and female, sexed as adults: Bandara and Saxena, 1995) was placed on 150g on infected mung bean and after 24 h, the insects were removed. Only one egg was left on each mung bean seed and others were deleted. Different concentrations (300, 500, 800, 1500 and 2000ppm) of *Datura* extract were prepared and the filter paper (7cm of diameter) received 1ccm of extract, and was placed on Petri dish (9cm of diameter). The control was treated with pure solvents. After the solvent evaporation, 10 mung beans (with 1 egg on each) were placed in each Petri dish, maintained under 27±1°C, 60±5% R.H. and dark condition. After 6 days mortality of eggs was calculated (unhatched eggs were counted as dead) and LC_{50} and LC_{90} was evaluated using SAS 6.12 software with Finney (1977) method.

Results and discussion

Adults

The *D. stramonium* extract had strong contact toxicity against *C. maculatus* adults (Table 1.). The mortality increased with rising concentration from 300 to 4000ppm and with exposure times of 24 and 48 h (Fig 1.). Table 1 show the LC_{50} and LC_{90} values for extract against adults. The LC_{50} value calculated was 1680 and 534.62 ppm for 24 and 48 h, respectively.

The present results indicated that the acetone extract of *D. stramonium* aerial parts was effective (Table 1). Result of the present study is not in agreement with the result of Mahfuz and Khanam (2007), who reported that *D. stramonium* leaf extract did not show any toxic effect on *Tribolium confusum* adult but it is in agreement with Deshmukh and Borle (1975) who reported the toxic effect of petroleum ether extract of *Datura alba* (*Datura fastuosa*) seed on *Dactynotus carthami*. Khalequzzaman and Islam (1992) reported that methanolic extract of *Datura metel* (*D. alba, D. fastuosa*) leaf was more toxic than other extracts on *T. castaneum*.

Further work on the identification of active ingredient of petroleum ether extract, which is more effective than other extracts and their bioassay, is utmost needed.

Eggs

LC_{50} and LC_{90} of 1 day old *C. maculatus* eggs were showed in Table 1. Data probit analysis showed that LC_{50} and LC_{90} values were 759.074 and 2656 ppm, respectively. At the highest tested concentration 2000 ppm, on 1 day old eggs had 90% mortality. Consequently, complete suppression of progeny production was observed at LC_{95} concentrations. At LC_{50} concentrations, progeny development was significantly reduced by acetone extracts.

The results obtained in this study suggest good potential for the use of *D. stramonium* aerial part extract as an insect mortality factor. Concentrations at LC_{50} of acetone extract are active as a toxicant against *C. maculatus* attacking grain and oviposition deterrents as well.

Considering the above results, *D. stramonium* extract has great potentiality in the management of an important stored grain pest.

Table 1. Calculated LC_{50} and LC_{90} of *Datura* extract on adult and egg stages of *Callosobruchus maculatus.*

Insect Stages	**n**	**df**	**LC_{50} (ppm) (lower-upper)**	**LC_{90} (ppm) (lower-upper)**	**Slope±SE**	**X^2**	**P-value**
Adult (24h)	300	3	1680 (1179-2574)	16058 (7615-79024)	1.307±0.255	0.473	0.924
Adult (48h)	300	3	534.62 (345.66-724.49)	3596 (2366-7491)	1.548±0.256	0.585	0.899
Egg	350	4	759.074 (636.29-888.29)	2656 (2012-4179)	2.356±0.323	2.208	0.697

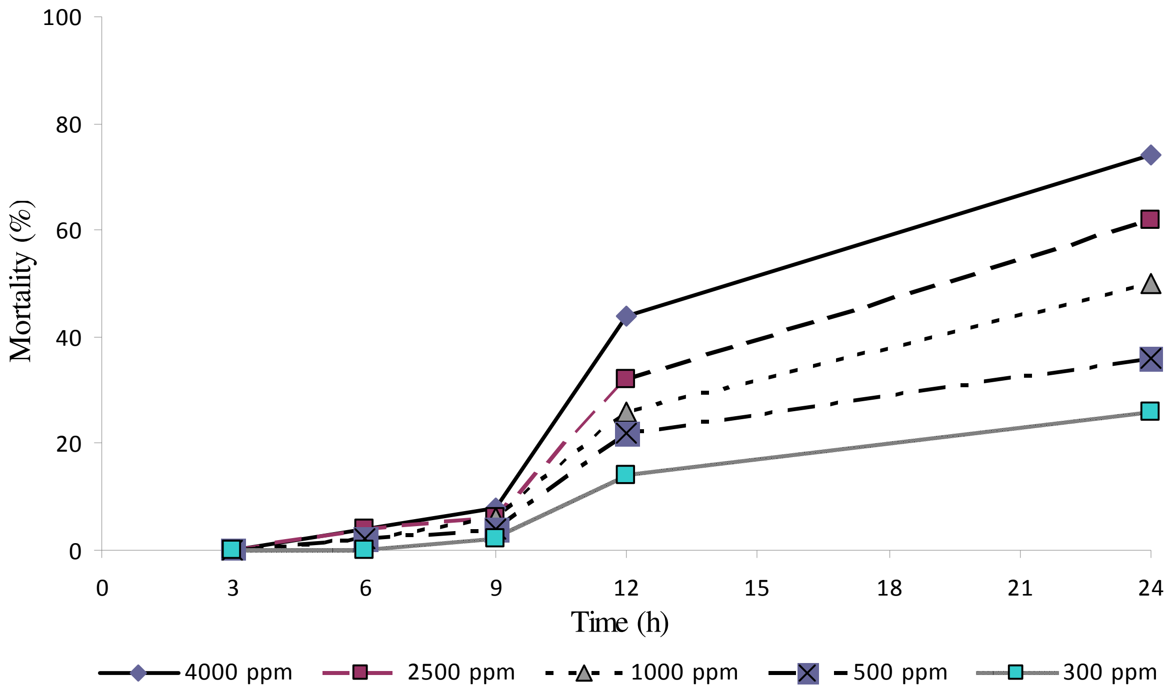

Figure 1. Mortality (%) of *C. maculatus* exposed to extract from *Datura stramonium* for various concentrations at different times.

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