Oviposition deterrent and insecticidal activities of some indigenous plant extracts against the rice moth, *Corcyra cephalonica* (Stainton)

S.R.C.N.K. Narangoda and M.M.S.C. Karunaratne

Department of Zoology
University of Sri Jayewardenepura
Nugegoda, Sri Lanka.

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Abstract

Methanol extracts of eighteen plants belonging to thirteen families were evaluated under laboratory conditions for their effects on the oviposition and larval mortality of the rice moth, *Corcyra cephalonica*. Each plant extract was tested at a concentration of 12g/l. All the extracts tested showed significant variations in toxic and oviposition deterrence against *C. cephalonica* when compared with the control. However, among the eighteen plants evaluated, leaf and seed extracts of *Azadiracta indica* and the seed extract of *Piper nigrum* were found to be the most effective causing 100% larval mortality. This was followed by leaf (81%) and seed (84%) extracts of *Annona squamosa*. Conversely, the seed extract of *Annona muricata* was the least toxic exhibiting only 2.83 % mortality. More over, maximum ovipostion deterrence was observed with *P. nigrum* followed by *A. indica* and *A. squamosa*. None of the plant extracts had any adverse effects on the viability of maize seeds. When percentage mortality and ovipositional deterrence were considered as indices of insecticidal activity, *P. nigrum* and *A. indica* together with *A. squamosa* proved to be the most effective plant materials that could be used as grain protectants in controlling infestations of *C. cephalonica.*

Key words: plant extracts, *Corcyra cephalonica,* rice moth, larval mortality, oviposition deterrence

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 25–40% in the tropical zone (Shaaya *et al.* 1997). The huge post-harvest losses and quality deterioration of grain crops caused by insect pests during storage threatens food security in developing countries like Sri Lanka. The use of chemical agents has been the main method of grain protection, since it is the simplest and the most cost-effective means of dealing with stored product pests (Hidalgo *et al.*, 1998). Control of these pests by synthetic insecticides, however, has given rise to many serious problems such as development of insect resistance, lethal effects on non-target organisms, toxic residues, and environmental pollution (Tapondjou *et al.*, 2002). The need to find materials that effectively protect stored produce, that are readily available, affordable, relatively less toxic and less detrimental to the non target organisms and environment had stimulated interest in the development of alternative control strategies and the re-evaluation of traditional botanical pest control agents (Niber, 1994; Talukder and Howse, 1995). The objective of the present study was therefore, to screen eighteen locally availablel plants, in order to evaluate their efficacies as possible stored grain protectants against the rice moth *Corcyra cephalonica.*

Materials and Methods

Methanol extracts of leaves and seeds of 18 plants (27 extracts) were screened against the rice moth, *C. cephalonica* under laboratory conditions at 29±2/°C & 84%RH.

Test Insects

A standard laboratory culture of the rice moth, *C. cephalonica* was maintained in plastic trays (30 x 30 x 5cm), containing previously cleaned partially milled maize seeds (*Zea mays*) at 29±2°C & 84%RH. Third instar larvae and newly emerged (24h old) adult moths were used in all the experiments. Width of the head capsule and the body length were used in selecting third instar larvae for the experiments. Moths which emerged within 24 h period prior to the experiments were considered as one day old adults.

Preparation of Plant Extracts

Reproductively mature plants were used in this study (Table 1). Plants which are known to possess some biological activity against stored product insects were collected from different localities of Sri Lanka and were identified at the National Herbarium, Royal Botanical Gardens, Peradeniya. These plant materials (leaves and seeds) were washed with running water to remove surface impurities and were then air dried. Leaves and seed kernels of plants were separately ground into a fine powder in an electric grinding machine (Multi national, 2101, India), to obtain seed kernel powder and leaf powder. Leaf and seed extracts of the eighteen botanicals were prepared in methanol at a concentration of 12g/l.

Table1. List of eighteen plant species used for screening tests

Plant	Family	Common name
Acrorus calamus	Acoraceae	Wada kaha
Aegle marmelos	Rutaeceae	Beli
Citrus aurantium	Rutaeceae	Bitter orange (Ambhul Dhodam)
Murraya koenigii	Rutaceae	Curry leaf (Karapincha)
Allium sativum	Alliaceae	Garlic (Sudu loonu)
Anacardium occidentale	Anacardiaceae	Cashew (Kaju)
Annona cherimola	Annonaceae	Cherimaya (MatiAnoda)
Annona muricata	Annonaceae	Sour sop (Katu Anoda)
Annona reticulata	Annonaceae	Bullock's heart (Weli Anoda)
Annona squamosa	Annonaceae	Sugar apple (Sini Anoda)
Azadiracta indica	Meliaceae	Neem (Khomba)
Chrysanthemum cinerariefolium	Ericaceae	Chrysanthemum (Kapuru)
Cinnmomum zelanicum	Lauraceae	Cinnamon (Kurudu)
Goryota urens	Palmaceae	Kithul
Ocimum sanctum	Labiaceae	Madhuruthala
Pancratium zelanicum	Amaryllidaceae	Wal loonu
Piper nigrum	Piperaceae	Pepper (Gammiris)
Zingiber officinale	Zingiberaceae	Ginger (Wal inguru)

Larval mortality

Five milliliters (5ml) of each extract (27 seed and leaf extracts) was thoroughly mixed with 50g of maize grains in a glass dish (6×8cm) and left open for one hour to allow the solvent to evaporate. Grains treated only with the solvent and without the solvent served as standard and untreated controls respectively. Six third instar larvae were then introduced into each medium and after 24hours the number of dead larvae was counted for 4 days to evaluate the mortality of larvae fed on treated and untreated diets. Each test was replicated six times.

Oviposition deterrence

50g of maize seeds in small jars were separately mixed with 5 ml of each extract. Grains treated with the solvent alone were used as standard control and grains without any solvent were used as an untreated control. Treated grain media were air dried for one hour, until the solvent evaporated. One newly emerged female and two males were introduced into each beaker and were left to lay eggs for 24 hours. Adults were then removed and egg counts were recorded. Six replicates were made for each treatment.

Seed viability

A germination test was carried out to evaluate the viability of maize seeds treated with crude extracts of plant leaves and seeds. Batches of fifty, previously cleaned maize seeds were mixed with crude extract (10ml) of plant materials. Each batch was then placed in a Petri dish (9cm diameter) containing moistened filter paper (Whatman No.01). Whenever necessary, water was added to the filter paper to provide sufficient moisture for the germinating seeds. The number of seeds germinated in each batch was recorded 7 days after the placement of seeds in the Petri dishes and compared with the control. Six replicates were made for each extract.

Statistical Analysis

Data obtained were subjected to one-way analysis of variance (ANOVA) and where significant differences ($p< 0.05$) existed, means were separated by Tukey's test in "Minitab 14".

Results and Discussion

Laboratory study with 27 seed and leaf extracts against *C. cephalonica* indicated that all the 18 plant species tested exhibited some degree of oviposition deterrence in the female moths (Table 2). However, the highest deterrence was found only with the leaf (130.20±7.1) and seed (110.60±7.1) extracts of *P. nigrum*. This was followed by *A. indica* and *A. squamosa*. When results were analyzed to compare the percentage larval mortality among the plants, all the selected plant extracts except *A. muricata* and *Z. officinale* were found to be significantly better in increasing the mortality compared with those of untreated and standard controls. (Table2). However, leaf and seed extracts of *A. indica* and seed extract of *P. nigrum* induced 100% mortality of the larvae followed by *A. squamosa* (80.7%). Generally the ability of the extracts to cause larval mortality can be attributed to contact or/and feeding toxicity effects of the plants. Furthermore, significantly very high mortality and reduced oviposition indicate the probable presence of insecticidal and oviposition deterrent compounds in the extracts.

Table 2:- Effects of plant extracts on the rice moth, *Corcyra cephalonica.*

Plant	% Larval Mortality		Oviposition (Mean ±SD)	
	Leaves	Seeds	Leaves	Seeds
A. calamus	36.16 c	25.00 bc	172.20±5.2 cd	183.63±4.2 d
A. marmelos	25.00 bc	_	186.65±3.2 d	_
C. aurantium	47.33 cd	_	163.28±4.6 c	_
M. koenigii	27.83 bc	_	177.23±2.3 cd	_
A. sativum	46.67 cd	25.00 bc	163.28±4.6 c	195.88±4.2 de
A. occidentale	36.17 c	52.83 d	184.80±4.2 d	153.27±4.8 bc
A. cherimola	25.00 bc	19.50 b	197.23±2.3 de	195.88±4.2 de
A. muricata	5.67 a	2.83 a	186.58±5.9 d	185.88±4.2 d
A. reticulata	24.50 bc	27.83 bc	189.32±7.9 d	182.13±2.3 d
A. squamosa	80.67de	84.50 de	150.20±7.1bc	141.60±7.1b
A. indica	100.00 e	100.00 e	141.75±1.3 b	130.60±7.1ab
C. cinerariefolium	27.83 bc	_	192.20±5.2 de	_
C. zelanicum	16.67 b	_	196.65±3.2 de	_
G. urens	14.00 b	_	195.80±4.2 de	_
O. sanctum	55.67 d	_	166.58±5.9 c	_
P. zelanicum	14.00 b	_	208.20±7.9 e	_
P. nigrum	80.67de	100.00 e	130.20±7.1ab	110.60±7.1a
Z. officinale	5.67 a	_	189.75±1.3 d	_
Untreated Control	0.00 a		211.25±2.3 e	
Standard Control	2.50 a		205.32±1.2 e	

*Mean values for 6 replicates; Means followed by the same letters in each column are not significantly different ($p<0.05$).

Similarity some interesting findings are reported where extracts of *A. squamosa* were highly effective in controlling some pests including the pulse beetles *Callosobruchus chinensis* (Ahmed et al, 1984). The high larval mortality exhibited by the extracts of *Annona* is attributed to the group of toxic compounds called acetogenins possessing insecticidal properties present in species of the family Annonaceae (Rupprechtt *et al.*, 1990;).

Table 3:- Viability of maize seeds treated with leaf and seed extracts of different plants.

Plant species	Viability (Mean ±SD)	
	Leaf Extract	**Seed Extract**
A. calamus	36.3±2.5	45.0±6.5
A. marmelos	45.5±6.2	–
C. aurantium	40.6±4.5	–
M. koenigii	40.0±3.4	–
A. sativum	36.6±4.1	38.2±6.5
A. occidentale	39.6±3.1	41.3±3.0
A. cherimola	43.5±2.2	38.0±2.6
A. muricata	42.5±6.2	41.3±3.0
A. reticulata	40.4±3.2	37.0±3.4
A. squamosa	36.0±4.5	40.0±3.4
A. indica	39.3±7.0	48.3±4.2
C. cinerariefolium	37.6±4.8	–
C .zelanicum	37.6±4.9	–
G. urens	38.6±8.5	–
O. sanctum	39.6±4.3	–
P. zelanicum	37.6±4.9	–
P. nigrum	37.0±3.4	42.9±3.4
Z. officinale	37.6±4.8	
Untreated Control	38.0±2.6	
Standard Control	37.6±4.8	
Probability	**NS**	

*Mean value for 6 replicates (Mean no: ±SD)

NS – Not Significant at p= 0.05 level

Their diverse bioactivities as pesticidal and insect antifeedant agents have attracted worldwide interest. Moreover, Neem extracts are reported to be very effective on many storage insect pests such as *C. chinensis, C. maculatus, Ephestia kuheniella* and *Sitophilus* sp. (Islam, 1983; Iloba & Ekrakene, 2006). Jacobson (1986) reported that Azadiractin, Meliantiol and Salanin are specific compounds found in neem seeds and leaves having insecticidal properties. Generally, the presence of azadiractin in the diet resulted in decreased intake and/or utilization of the food, and death could result from poisoning, or from starvation, or from a combination of the two, as described by Ma (1972). Asawalam (2006) noted strong ovipositional deterrent and insecticidal effects of *Piper guineense* against another stored product pest *Sitophilus zeamais*. Also, many studies have shown the effectiveness of *Piper* sp. against several stored products pests (Scott *et al*, 2007). However, no previously reported information is available on the mortality and oviposition deterrent effects of *C. cephalonica* for the above three plant species.
The results of the seed viability indicated there was no significant difference in the germination of maize seeds treated with different plant extracts when compared with that of the control (Table 3). This indicates that all the plant (leaf and seed) extracts do not have any adverse effects on the germination of maize seeds.
By considering percentage mortality and oviposition deterrence as indices among the plant extracts, *P. nigrum* and *A. indica* followed by *A. squamosa* proved to be the most effective plant materials that could be used as bio-rational management agents for controlling *C. cephalonica.*

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