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REPELLENT AND FEEDING DETERRENT EFFECTS OF SOME INDIGENOUS PLANTS AGAINST RED FLOUR BEETLE, *TRIBOLIUM CASTENEUM* (HERBST) (COLEOPTERA: TENEBRIONIDAE)

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Three plant species, bishkatali, *Polygonum hydropiper* Linn.; Nishinda, *Vitex negundo* Linn., and pithraj, *Aphanamixis polystachya* locally grown in Bangladesh were evaluated for their repellent and feeding deterrent activity against adult red flour beetle, *Tribolium casteneum* (Herbst). All the plant extracts were found to be effective repellents and having feeding deterrent action against the beetle. It was observed that bishkatali leaf extracts have strong repellent and feeding deterrent effect followed by nishinda and pithraj. The results also indicated that the water extract was more effective than acetone extract. The red flour beetle was more sensitive to the repellent than that of antifeedant action.

Key words: feeding deterrent, repellent, *Tribolium casteneum*

INTRODUCTION

In recent past the preservation of cereals and other durable agricultural products in storage has relied heavily upon chemical insecticides to control storage pests. These may have drawbacks, including toxicity to non-target organisms, human health hazards, development of pest resistance and environmental pollution. The present trend, however, is towards alternative non-toxic control methods that pose no threat, to the health of operator or consumer and are environmentally safe. The use of plant products (botanical pesticides) is one of the most promising alternatives. In the rural areas of Bangladesh, farmers traditionally mix leaves, barks, seeds, roots or oils of certain plants with stored grains to keep them free from insect attacks. Such techniques have been inherited as part of the traditional culture (Saxena et al., 1988). However, few studies have been conducted in Bangladesh on the traditional use of botanicals against stored product pests (Islam, 1984, 1987; Khanam et al., 1991). Experiments were carried out to determine the repellent and feeding deterrent action of bishkatali, *Polygonum hydropiper* Linn.; nishinda, *Vitex negundo* Linn., and pithraj, *Aphanamixis polystachya* Wall and Parker against the adult red flour beetle, *Tribolium casteneum,* a major stored product pest in Bangladesh.

MATERIALS AND METHODS

Insect: The red flour beetle, *Tribolium casteneum* (Herbst) (Coleoptera: Tenebrionidae) was used from the laboratory stock culture. The culture was maintained in a jelly jar (12 cm x 7.5 cm) on a diet of wheat flour. All the insects response assays were conducted in petri dishes (9 x 1.3 cm) placed in a growth chamber. The rearing and experimental work were conducted in the laboratory of the Pest Control and Management Division, Institute of Food and Radiation Biology, Atomic Energy Research Establishment, Savar, Dhaka, Bangladesh from April to October, 1998 at 28 ± 2°C temperature and 73 ± 2% relative humidity.

Extraction: Green and fresh leaves of bishkatali, nishinda and pithraj were washed, air dried and ground with electric grinder. Fifty grams of each type of ground leaves were taken in 500 ml beakers separately with water and acetone. Then 250 ml of distilled water and acetone were added to each beaker. The mixture was stirred for thirty minutes. It was filtered through fine cloth and condensed by evaporation in a water bath at 70-90°C temperature until the constant weight was gained. After the complete evaporation of solvent, the semi-solid extracts were cooled and preserved in the refrigerator for later use.

Preparation of Stock Solution

Repellent Test: Repellency was tested by the method of Talukder and Howse (1994). Substrates were prepared from 9 cm diameter filter paper disks (Whatman No. 40), cut in two halves and 1 ml of each category (WSE and ASE) solution of different plant extracts was applied to a half filter paper disk uniformly with a pipette. The treated half disks were then air dried to evaporate the solvent completely and attached with the untreated (control) half with

Table 1. Average repellency of different plant extracts (waterIWSE) to adult *T. casteneum* using the treated filter paper test

Plant extracts	Extract concentration (mg/ml)	Average hourly repellency rate (%) after treatment					Mean repellency rate (%)	Repellency class
		1	2	3	4	5		
Bishkatali	25	40.00 eg	33.33 ce	33.33 ce	33.33 eg	40.00 d	36.00 g	II
	50	53.33 cf	53.33 bd	53.33 ad	53.33 be	60.00 be	54.67 ef	III
	75	66.67 ad	66.67 ab	60.00 ac	66.67 ac	66.67 ab	65.33 cd	IV
	100	86.67 a	86.67 a	80.00 a	86.67 a	80.00 a	84.00 a	V
Nishinda	25	33.33 fg	26.67 de	26.67 de	26.67 fg	33.33 de	29.33 g	I
	50	46.67 df	46.67 bd	46.67 bd	46.67 cf	46.67 cd	46.67 f	II
	75	60.00 be	60.00 ac	53.33 bd	60.00 bd	60.00 be	58.67 d	III
	100	80.00 ab	73.33 ab	73.33 ab	73.33 ab	73.00 ab	74.67 b	IV
Pithraj	25	20.00 g	13.33 e	13.33 e	20.00 g	20.00 e	17.33 h	I
	50	40.00 eg	33.33 ce	33.33 ce	40.00 dg	40.00 d	37.33 g	II
	75	46.67 df	46.67 bd	53.33 ad	53.33 be	60.00 be	52.00 ef	III
	100	73.33 ac	66.67 ab	66.67 ab	66.67 ac	66.67 ab	68.00 be	IV

Within column values followed by the same letter(s) did not differ significantly at P< 0.01 by DMRT.

Table 2. Average repellency of different plant extracts (acetone/ASE) to adult *T. casteneum* using the treated filter paper test

Plant extracts	Extract concentration (mg/ml)	Average hourly repellency rate (%) after treatment					Mean repellency rate (%)	Repellency class
		1	2	3	4	5		
Bishkatali	25	33.33 ef	40.00 ce	40.00 cd	33.33 de	33.33 df	36.00 fg	II
	50	53.33 ce	53.33 bd	53.33 bd	53.33 ac	53.33 bd	53.33 ce	III
	75	66.67 ac	66.67 ab	66.67 ac	66.67 ac	60.00 ac	64.00 be	IV
	100	86.67 a	86.67 a	80.00 a	80.00 a	80.00 a	82.67 a	V
Nishinda	25	26.67 ef	33.33 de	33.33 de	26.67 ef	26.67 ef	29.33 g	I
	50	46.67 ce	40.00 cd	46.67 bd	40.00 cf	46.67 be	44.00 ef	II
	75	60.00 bd	53.33 bd	53.33 bd	60.00 ad	53.33 bd	56.00 cd	III
	100	80.00 ab	73.33 ab	66.67 ab	73.33 ab	66.67 ab	72.00 b	IV
Pithraj	25	13.33 f	20.00 e	13.33 e	13.33 f	20.00 f	16.00 h	I
	50	33.33 dg	40.00 e	33.33 de	33.33 df	40.00 cf	36.00fg	II
	75	46.67 ce	53.33 bd	53.33 bd	46.67 be	46.67 be	49.33 de	III
	100	66.67 ac	60.00 be	66.67 ab	66.67 ac	60.00 ac	64.00 be	IV

Within column values followed by the same letterts) did not differ significantly at P< 0.01 by DMRT.

Table 3. Feeding deterrent coefficient of different plant extracts (waterIWSE) to adult *T. oasteneum*

Plant extract	Extract concentration *(mg/ml)*	Coefficient of deterrency			Efficacy of extract
		Absolute	Relative	Total	
Bishkatali	25	52.05 g	58,49 h	110.54h	+++
	50	69.28 e	77.57 e	146.85 e	+++
	75	78,41 c	87.17 c	165.58 c	++++
	100	91,38 a	95.81 a	187.19 a	++++
Nishinda	25	43.18 h	55.05 i	98.23 i	++
	50	59.99 f	70.14 f	130.13 f	+++
	75	73,47 d	81,63 d	155.10 d	++++
	100	85.70 b	93.31 b	178.02 b	++++
Pithraj	25	39.28 h	48.61j	87.89j	++
	50	53.20 g	62.37 g	115.57 g	+++
	75	60.71 f	71.22 f	131,93 f	+++
	100	77.58 cd	86.78 c	164.36 c	++++

Within column values followed by the same letter(s) did not differ significantly at P< 0.01 by DMRT.

Table 4. Feeding deterrent coefficient of different plant extracts (acetone/ASE) to adult *T. oasteneum*

Plant extract	Extract concentration (mg/ml)	Coefficient of deterrency			Efficacy of extract
		Absolute	Relative	Total	
Bishkatali	25	52.05 e	58,49 h	110.54h	+++
	50	69.28 e	77.57 e	146.85 e	+++
	75	78,41 c	87.17 c	165.58 c	++++
	100	91,38 a	95.81 a	187.19 a	++++
Nishinda	25	43.18 h	55.05 i	98.23 i	++
	50	59.99 f	70.14f	130.13 f	+++
	75	73,47 d	81.63 d	155.10 d	++++
	100	85.70 b	93.31 b	178.02 b	++++
Pithraj	25	39.28 h	48.61.1	87.89.1	++
	50	53.20 g	62.37 g	115.57 g	+++
	75	60.71 f	71,22 f	131,93 f	+++
	100	77.58 cd	86.78 c	164.36 c	++++

Within column values followed by the same letter(s) did not differ significantly at P< 0.01 by DMRT.

cellotape and placed in a petri dish. The insects were released at the center of each filter paper disk and the cover was replaced on the petri dish. There were five replications for each concentration of different plant extracts. Insects present on each strip were counted at 1 hour intervals up to 5 hours. The average of counts was converted to express percentage repellency (PR) by the following formula:

$$PR\ (\%) = (N, - 50) \times 2$$

Where N, is the number of insects present in the control half.

Data were analyzed using analysis of variance after transforming them into arcsin percentage values. The repellency class was classified as: class I = 1.1 to 20.0; class Il = 20.1 to 40.0; class III = 40.1 to 60.0; class IV = 60.1 to 80.0 and class V = 80.1 to 100.0% repellency (McGovern et al., 1977).

Feeding Deterrence Test: The potency of the feeding deterrence of test plant extracts against *Tribolium casteneum* was determined by the method of Talukder and Ho~se (1995). Wheat flour was used to prepare disk (20 mm Diam.) as the test food. The disks were oven dried and the substrates by dipping into either solvents (control disks or 'C') or different concentration of stock solution of WSE and ASE (treated disk or 'T'). The disks were then air dried overnight and their individual weight was taken before being offered to 10 adults as the sole food for 5 days period. Some blank disks (treated with solvent only but not offered to insects) were also prepared. Feeding of insects was recorded under three conditions: (i) on pure food, composed of untreated disks 'CC' (control), (ii) on food with a possibility of choice between one treated 'T' and another untreated 'C' disk (choice test), (iii) on food with two treated 'TT' (no choice test). Each treatment was replicated 5 times. After the 5 days feeding period, the disks were reweighed and based on the amount of food consumed in control (CC), choice (CT) and no choice (TT) tests, three coefficients for feeding deterrent activity were calculated a's follows:

Absolute coefficient: $A = (CC---TI/CC+TT) \times 100$ (control and no choice test)

Relative coefficient of deterrency: $R = (C - T/C + T) \times 100$ (choice test)

Total coefficient of deterrency: $T = A + R$

The values of the total deterrence coefficient served as an index of feeding deterrence activity expressed on a scale between 0 to 200. The index zero (0) was an inactive compound and 200 a maximum deterrent compound. Feeding deterrent having an index of 151 to 200 was designated as ++++; 101 to 150, +++; 51 to 100, ++ and 0 to 50, +. All experimental data were analyzed by analysis of variance.

RESULTS

Repellent Effect: Data concerning hourly repellent activity of water and acetone extracts of three test plants against *Tribolium casteneum* have been presented in Tables 1 and 2. Among the four concentrations, the highest concentration (100 mg/ml) of all plant extracts had maximum repellency (84.00, 74.61 and 68.00% for WSE and 82.67, 72.00 and 64.00% for ASE of bishkatali, nishinda and pithraj respectively) activity from class IV to class V. In all cases, repellency decreased proportionately with decreasing concentration from class I to class Ill. The repellent effects of all the three plant extracts on *T. casteneum* in different hours were statistically significant ($P<O.Ol$). The best repellent activity was found in the leaf extract of bishkatali, WSE being more effective than ASE.

Feeding Deterrent Effect: All the plant extracts inhibited the feeding activity of *T. casteneum* (Tables 3 and 4). WSE appeared to have more deterrent effect than ASE. It was observed that maximum antifeedant activity was found in P. *hydropiper,* while *A. polystachya* was the least effective. The highest concentration of water and acetone extract of test plants, showed strong feeding deterrent activity (total coefficient of deterrency = 187.19, 178.02 and 164.36 for WSE and 176.93, 167.69 and 155.96 for ASE of bishkatali, nishinda and pithraj respectively) and ranked ++++. The antifeedant activity of different concentrations of the same plant were significantly different. The absolute and relative coefficient represent the no choice and choice test. When the insects had no opportunity to choose between treated and control disks (no choice test), adults consumed either a small amount of the treated disks or a large amount of the control disks, which gave low absolute coefficient values. But when they had the opportunity to choose between treated and control disks (choice test), the adults directed their feeding activity to control ones, which resulted into high relative coefficient values.

DISCUSSION

Following the filter repellency method, bishkatali, nishinda and pithraj leaf extracts were found to have strong repellency and feeding deterrent effect on *T. casteneum* ata dose of 100 mg/ml and showed class IV to V activity. The compounds having class IV activity are considered as repellents (McGovern, 1977).

Among the extracts, bishkatali exhibited more repellency and deterrency followed by nishinda and pithraj which were least effective. Talukder and Howse (1994) reported poor repellency effects of pithraj seed extracts on pulse beetle. Islam (1984) recorded weak feeding deterrent effects of *Aphanamixis polystachya* on *Dicladispa armigera* and repellent effect on *Sitophilus cerealella* and *Spilosoma obliqua.* In the present study the decrease of repellency and deterrency with time may be explained on the basis that the repellency and deterrency of compounds with low molecular weights and high volatility decrease rapidly over time. The present results also demonstrate the lower extraction capability of acetone than water from test plant leaves. The study also confirms the capability of bishkatali, nishinda and pithraj plant leaves to keep away insects by way of their repellent or feeding deterrent activity.

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