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Toxicity Effect of Commonly Used Indigenous Plant Extracts in Controlling Rice Moth, *Sitotroga cerealella* Oliv. In Stored Rice Grain

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Abstract: The experiment was conducted in the laboratory of the Department of Entomology, Sher-e-Bangla Agricultural University, Dhaka-1207 during the period from June 2009 to November 2009 to study the toxicity effect of commonly used indigenous plant (like neem, biskataly and karanja) extracts in controlling Angoumois grain rice moth in stored rice grain. Parboiled de-infested rice variety BR-11, collected from farm's store house of Sher-e-Bangla Agricultural University, was used for the experiments. The treatments of the experiment were T_1: 5% concentration of neem leaves extract @ 0.5 ml/50 g rice grain; T_2: 10% concentration of neem leaves extract @ 0.5 ml/50 g rice grain; T_3: 5% concentration of biskataly leaves extract @ 0.5 ml/ 50 g rice grain; T_4: 10% concentration of biskataly leaves extract @ 0.5 ml/50 gm rice grain; T_5: 5% concentration of karanja leaves extract @ 0.5 ml/50 g rice grain; T_6: 10% concentration of karanja leaves extract @ 0.5 ml/ 50 g rice grain and T_7: Control. The experiment was laid out in a Completely Randomized Design (CRD) with four replications. In all generation (1st, 2nd and 3rd generation), the results showed that extracts of all the plants had toxicity effect against rice grain moth. Among them neem plant extracts showed the highest toxic effect, whereas biskataly and karanja (5% concentration of leaves extracts) showed lowest. The effectiveness of all the plant extracts was found to increase proportionally with the increase of doses.

Key words: Indigenous plants · Rice moth (*Sitotroga cerealella*) · Extracts · Control

INTRODUCTION

Rice is the main food crop for more than half of the worlds' population. It is the most important cereal crop of Bangladesh. The demand for rice is constantly rising in Bangladesh with nearly 2.3 million people being added each year to her population of about 120 million [1]. Bangladesh produces a total of 26.530 million tons of rice from an area of 26.018 million hectares [2]. About 90% of the population of Bangladesh depends on rice for their major food intake [3]. The farmers store more than 65% of the total rice produces till the next season for their food, feed and seed purposes. Rice is stored as paddy (unhusked rice), brown and polished milled rice. It is being damaged by a number of agents, such as insects, rodents, fungi, mites, birds and moisture and among them, storage insects are the major agents causing considerable losses each year [4].

Insect infestation on stored grains and their products is a serious problem throughout the World. There are approximately 200 species of insects and mite species attacking stored grains and stored products [5]. According to Prakash *et al*. [6], nearly seventeen species of insects have been found to infest stored rice of which rice moth (*Sitotroga cerealella*), rice weevil (*Sitophilus oryzae* Linn.) and beetles (*Tribolium castaneum*) predominate in parboiled rice. On the other hand, moth and beetles predominate in raw rice and weevils predominate in milled rice [7]. According to Alam [8], 5-8% of the food grain seeds and different stored products are lost annually due to storage pests and if the losses incurred on farm were included, it would amount to 10%. Among the species angoumois grain moth, *Sitotroga cerealella* is common and most destructive pest. It is often placed at the top of the list of major insect pest of stored rice. It belongs to the family Gelechiidae under

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the order Lepidoptera and is one of the most dominant species in the stored paddy [9]. In many areas of the world locally available plant materials are widely used to protect stored products against damage by insect infestations [10]. Botanical plant products are less expensive, readily available, environmentally safe and less hazardous in comparison to chemical insecticides [11]. The main advantage of botanicals is that they are easily produced, locally available, broad spectrum and used by the farmers in small scale. There are about 2000 plant species reported to possess pest control properties [12] and the application of simple plant materials like neem, karanja, mahogany, nishinda, pithraj and datura in several cases proved to be very simple and highly effective against stored product insects. The plant products included oils, extracts, leaf powder, seed etc.

The insecticidal property of botanicals is not very quick (except natural pyrethrins) as compared to that of synthetic insecticides and fumigants. The plant products certainly possess certain advantages over synthetic chemicals. These are usually least toxic to mammals, possess surface persistence for a long period, have least or no adverse effect on germination of seed, have good cooking quality and milling, easily available and less expensive. Some of the products like natural pyrethrums have rapid killing action [13]. However, only a few products are generally adopted at the farmer's level. Information is restricted to only usage of plant products infesting stored rice in the text, though a number of products are reported for this purpose against insects attackting other cereals [14]. In Bangladesh, most of the farmers are poor and marginal. They store small quantities of seed for edible rice and cannot offer expensive control measures. Therefore, they essentially need some cheap, easy, readily available but effective methods for safe storing of rice.

MATERIALS AND METHODS

The investigation was undertaken in the laboratory of the Department of Entomology, Sher-e-Bangla Agricultural University, Dhaka-1207 during the period from June 2009 to November, 2009. Parboiled rice variety BR-11, collected from farm's store house of Sher-e-Bangla Agricultural University was used for the experiments. Male and female adult moths were collected from farm's store house of Sher-e-Bangla Agricultural University and sorted out under a simple microscope by observing their abdominal tergites and size of the body. One hundred pairs of *S. cerealella* were introduced into plastic container (26 cm ht ×110 cm dia) containing1kg of de-infested rice grains**.** The mouth of the containers were covered by fine mesh nylon nets and kept in the laboratory was maintained in the laboratory at prevailing temperature and relative humidity for rearing as stock culture. The insects were allowed to mate and lay eggs for seven days. After seven days, the adults were separated. The rice grains with eggs kept for 25 days to develop into adults and then the adult emergence was observed. One- day old adults were sorted from rice grains and were used for the study. Before artificial infestation of rice grains with moths, the parboiled rice grains of BR_{11} variety was dried in the sun for de-infestation. Nawab *et al*. [15] reported that solar heat treatments of rice grains destroy the initial insect infestation of the grains before storage. Petri-dishes (1.0cm ht × 6cm dia.) were used to set the experiment. In each Petri-dish 50 g rice seeds were taken. The leaves of neem, biskataly and karanja used for the experiments were collected from trees from in and around the university campus. After bringing leaves to the laboratory, they were washed in running water. Firstly, the plant materials were kept in the shade for air-drying and then dried in the oven at 60°C to gain constant weight. Dusts were prepared by pulverizing the dried leaves with the help of a grinder. Then dusts were passed through a 25-mesh diameter sieve to obtain fine and uniform materials. The dusts were preserved in airtight condition in polythene bags till their use for extract preparation according to Chitra *et al.* [16]. Previously prepared leaf dusts were used for preparation of plant leaves extract. Ten grams of each category of dust were taken into a 600ml beaker and separately mixed with 100ml of Ethanol solvent. Then the mixture was stirred for 30 minutes by a magnetic stirrer (at 6000 rpm) and left to stand for next 24 hours. The mixture was then filtered through a fine cloth and again through filter paper (Whatman No. 1). The filtered materials were taken into a round bottom flask and then condensed by evaporation of solvent in a water bath at 55°C temperature for ethanol extract. Evaporation was done to make the volume 10ml. After the evaporation of solvent from filtrate, the condensed extracts were preserved in tightly corked-labelled bottles and stored in a refrigerator until their use for the experiment. Stock solutions of plant extracts were prepared by diluting the condensed extracts with respective solvent ethanol. Two concentrations (5% and 10%) of each category of plant extracts were prepared by dissolving the stock solution in the respective solvent ethanol. Then each prepared solution was applied individually to the inside dorsal surface of each Petri dish containing rice grain using a micropipette. There were seven treatments including untreated control. The treatments of the experiment were T_1: 5% concentration of neem leaves extract @ 0.5 ml/50 g rice grain; T_2: 10% concentration of neem leaves extract @ 0.5 ml/50 g rice grain; T_3: 5% concentration of biskataly leaves extract @ 0.5 ml/50 g rice grain; T_4: 10% concentration of biskataly leaves extract @ 0.5 ml/50 g rice grain; T_5: 5% concentration of karanja leaves extract @ 0.5 ml/50 g rice grain; T_6: 10% concentration of karanja leaves extract @ 0.5 ml/50 gm rice grain and T_7: untreated control. Then 5 pairs of adult insects were released in each Petri dish. Insect mortalities (toxicity effect) were recorded at 24, 48 and 72 hours after treatment (HAT). Orginal data were corrected by Abbott's formula (Abbott, 1987) as follows: $P = (P' - C/100 - C) \times 100$. Where, P = Percentage of corrected mortality; P'=% Observed mortality; C =% Control mortality. The experiment was laid out in Completely Randomized Design (CRD) with four replications. The significance of the difference among the treatment means were estimated by the least significant difference (LSD) test at 5% level of probability [17]. The experiment was repeated for other two generations.

RESULTS

The experiment was conducted to find out the toxicity effect of commonly used indigenous plant (like neem, biskataly and karanja) extracts in controlling rice moth, *Sitotroga cerealella* Oliv. in stored rice grain. The results have been presented and discussed and possible interpretations were given below under the following headings:

Number of Dead insects: The cumulative number of dead insects after 24, 48 and 72 hours of treatment showed statistically significant variations due to some indigenous plant extracts for the management of rice moth in stored rice grain (Table :1).

After 24 hours of treatment application the highest number of dead insects (7.25) was found in T_2 treatment (10% concentration of neem leaves extract @ 0.5 ml/50 g rice grain) which was closely followed (6.00) by T_6 treatment (10% concentration of karanja leaves extract @ 0.5 ml/50 g rice grain). On the other hand, there were no dead insects were recorded in T_7 (untreated control) treatment which was statistically similar with treatment T_3 (2.25). The cumulative highest number of dead insects (12.00) was observed of treatment T_2 after 48 hours which was statistically similar with T_6 treatment (11.25) and closely followed T_1 treatment (9.50) whereas there were no dead insects was obtained in T_7 treatment which was closely followed T_3 treatment(4.75). Similar trend of result we found from after 72 hours.

Insect Mortality: Insect mortality showed statistically significant variation for some indigenous plant extracts in respect of the management of rice moth in stored rice grain (Table:1). The highest mortality (100.00%) was observed by T_2 treatment which was statistically similar with T_6 treatment (92.50%) and statistically similar with treatment T_1 (85.00) and treatment T_4, (80.50%) respectively, while there were no mortality was recorded by treatment T_7 (untreated control) which was followed (75.00%) by T_3 and T_5, respectively and these treatment were statistically identical. The highest percentage of corrected mortality was found from treatment T_2 (100.00)

Table 1: Effect of indigenous plant extracts for number of dead insects after different times

	No. of dead insects after				
*Treatment	24 hours	48 Hours	72 Hours	Insect mortality (%)	Corrected mortality
T_1	5.25 b	9.50 b	11.25 b	85.00 c	85.00 c
T_2	7.25 a	12.00 a	14.75 a	100.00 a	100.00 a
T_3	2.25 e	4.75 e	6.25 d	75.00 e	75.00 e
T_4	4.00 c	7.25 c	10.50 bc	80.50 d	80.50 d
T_5	3.50 d	6.50 d	8.25 c	75.00 e	75.00 e
T_6	6.00 b	11.25 a	12.25 b	92.50 b	92.50 b
T_7	0.00 f	0.00 f	0.00 e	0.00 f	0.00 f
$LSD_{(0.05)}$	1.045	1.198	1.452	3.981	3.981
Level of Significance	0.01	0.01	0.01	0.01	0.01
CV(%)	18.45	16.22	13.98	12.22	12.22

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability and numeric data represents the mean value of 4 replications

*The treatments of the experiment T_1: 5% concentration of neem leaves extract @ 0.5 ml^{750g} rice grain; T_2: 10% concentration of neem leaves extract @ 0.5 ml/50 g rice grain; T_3: 5% concentration of biskataly leaves extract @ 0.5 ml/50 g rice grain; T_4: 10% concentration of biskataly leaves extract @ 0.5 ml/50 g rice grain; T_5: 5% concentration of karanja leaves extract @ 0.5 ml/50 g rice grain; T_6: 10% concentration of karanja leaves extract @ 0.5 ml/50 g rice grain and T_7: Control

Table 2: Effect of indigenous plant extracts for adult emerged at 1st, 2nd, 3rd generation, total adult emerged, adult longevity and seed germination

	Adult emerged at					
*Treatment	1st generation	2nd generation	3rd generation	Total	Adult longevity (days)	Germination (%)
T_1	9.00 e	17.25 c	23.00 d	49.25 e	3.75 d	92.25 a
T_2	0.00 g	0.00 e	0.00	0.00 g	0.00 e	96.00 a
T_3	23.00 b	28.50 b	41.75 b	93.25 b	8.00 b	91.00 a
T_4	14.50 d	24.50 b	32.00 c	71.00 d	4.50 c	92.00 a
T_5	17.25 c	25.50 b	38.25 b	81.00 c	5.25 c	91.50 a
T_6	6.50 f	12.25 d	21.00 d	39.75 f	2.50 e	93.50 a
T_7	84.25 a	117.75 a	210.25 a	412.25 a	9.50 a	79.25 b
$LSD_{(0.05)}$	2.765	4.386	5.341	9.018	0.813	7.521
Level of Significance	0.01	0.01	0.01	0.01	0.01	0.01
CV(%)	9.22	11.84	9.33	10.94	7.44	9.33

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability and numeric data represents the mean value of 4 replications

The treatments of the experiment T_1: 5% concentration of neem leaves extract @ 0.5 ml$^{?50g}$ rice grain; T_2: 10% concentration of neem leaves extract @ 0.5 ml/50 g rice grain; T_3: 5% concentration of biskataly leaves extract @ 0.5 ml/50 g rice grain; T_4: 10% concentration of biskataly leaves extract @ 0.5 ml/50 g rice grain; T_5: 5% concentration of karanja leaves extract @ 0.5 ml/50 g rice grain; T_6: 10% concentration of karanja leaves extract @ 0.5 ml/50 g rice grain and T_7: Control

and the lowest (75.00) percentage of corrected mortality was obtained from treatment T_3 and treatment T_5, respectively (Table 3.1).

Adult Emerged: Adult emerged for 1st, 2nd and 3rd generation varied significantly due to the application of indigenous plant extracts for the management of rice moth in stored rice grain (Table:2).

At 1st generation no adults were emerged in T_2 treatment which was followed (6.50) by T_6, while the highest (84.25) adult was recorded in T_7 treatment which was followed (23.00) by T_3 treatment. At 2nd generation no emerged adults were recorded in T_2 treatment which was followed (12.25) by T_6 treatment, while the highest (117.75) adult was recorded in T_7 treatment which was followed (28.50, 25.50 and 24.50) by T_3, T_5 and T_4 treatment respectively and they were statistically identical. At 3rd generation no emerged adults were recorded in T_2 treatment which was followed (21.00 and 23.00) by T_6 and they were statistically identical, while the highest (210.25) adult was recorded in T_7 treatment which was followed (41.75 and 38.25) by T_3 and T_5 treatment respectively. In the 1st, 2nd and 3rd generation no adults were emerged in T_2 treatment which was followed (39.75) by T_6, while the highest (412.25) adult was recorded in T_7 treatment which was followed (93.25) by T_3 treatment.

Adult Longevity: Adult longevity showed statistically significant differences for the application of commonly plant extract for the management of rice moth in stored rice grain (Table 2). The highest longevity (9.50) was recorded in T_7 treatment which was closely followed (8.00) by T_3, while no longevity was attained in T_2 treatment which was followed (2.50) by T_6 treatment.

Germination of Seeds: Germination of treated seeds showed statistically significant differences due to the application plant extracts for the management of rice moth in stored rice grain (Table 2). The highest germination (96.00%) was found in T_2 treatment which was closely followed (93.50%, 92.25%, 92.00%, 91.50 and 91.00%) by T_6, T_1, T_4, T_5 and T_3 respectively and they were statistically identical, whereas the lowest germination (79.25%) was recorded in T_7 i.e. untreated control treatment.

Repellency Effect: Repellency effect showed statistically significant variation due to the application of plant extracts for the management of rice moth in stored rice grain (Table 3.).

In case repellency effect after 1 hour of treatment application the highest repellency rate (65.00%) was found from T_2 which was followed (50.00 and 45.00) by T_6 and T_1 respectively whereas the lowest repellency rate (15.00) was recorded in T_3 which was statistically identical (20.00 and 25.00) with T_5. After 2 hour of treatment application the highest repellency rate (60.00%) was found from T_2 which was followed (40.00) by T_6, whereas the lowest repellency rate (10.00) was recorded in T_3. After 3 hour of treatment application the highest repellency rate (50.00%) was found from T_2 which was followed (25.00) by T_6, whereas the lowest repellency rate (0.00) was recorded

Table 3: Repellency effect of indigenous plant extracts on rice moth in stored rice grain at different hours after treatment

	Percent of repelled after application of treatment				
*Treatment	1 hour	2 hour	3 hour	4 hour	5 hour
T_1	45.00 b	30.00 c	20.00 c	10.00 c	5.00 c
T_2	65.00 a	60.00 a	50.00 a	45.00 a	40.00 a
T_3	15.00 d	10.00 e	0.00 e	0.00 d	0.00 d
T_4	30.00 c	30.00 c	20.00 c	15.00 b	10.00 b
T_5	20.00 d	15.00 d	15.00 d	10.00 c	0.00 d
T_6	50.00 b	40.00 b	25.00 b	10.00 c	5.00 c
$LSD_{(0.05)}$	5.391	4.651	4.093	2.459	3.078
Level of Significance	0.01	0.01	0.01	0.01	0.01
CV(%)	8.33	17.22	7.29	9.56	10.44

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability and numeric data represents the mean value of 4 replications

The treatments of the experiment T_1: 5% concentration of neem leaves extract @ 0.5 ml$^{?50g}$ rice grain; T_2: 10% concentration of neem leaves extract @ 0.5 ml/50 g rice grain; T_3: 5% concentration of biskataly leaves extract @ 0.5 ml/50 g rice grain; T_4: 10% concentration of biskataly leaves extract @ 0.5 ml/50 g rice grain; T_5: 5% concentration of karanja leaves extract @ 0.5 ml/50 g rice grain; T_6: 10% concentration of karanja leaves extract @ 0.5 ml/50 g rice grain and T_7: Control

in T_3. After 4 hour of treatment application the highest repellency rate (45.00%) was found from T_2 which was followed (15%) by T_4, whereas the lowest repellency rate (0.00) was recorded in T_3. After 5 hour of treatment application the highest repellency rate (40.00%) was found from T_2 which was followed (10.00%) by T_4, whereas the lowest repellency rate (0.00) was recorded in T_3 and T_5 treatment respectively.

DISCUSSION

From the present study it was observed that T_2 (10% concentration of neem leaves extract) treatment was the most effective than all other treatments in controlling *S. cerealella*. But rests of the treatments of the present study were also effective in controlling S. *cerealella*.

The efficacy of neem leaves thus obtained in the present investigation is in agreement with the results obtained by Facknath and Sunita [18]; and Akter [19]. Facknath and Sunita [18] reported that neem (*Azadirachta indica* A. Juss.) has been demonstrated to reduce insect populations in stored products through its toxic and growth- disrupting and other effects on the pests. The efficacy of *Azadirachta indica* leaf extracts (70, 90 and 100%) to control weevil population on hosts increased with the increase of the extract concentration. Akter [19] reported that the antifeedent activities of the neem products might be responsible for lower damage of grains. These results were different from the findings observed by some others researchers [20, 21]. Siddika [20] reported that neem leaves powder reduced the loss of grain weight and percentage of infested grain of rice moth (*S. cerealella)* infestation in unhusked rice grain during storage. Akter [21] also reported that neem oil was most toxic and effective ranking next to Malathion for control of rice moth (*S. cerealella*).

Although, the result obtained in this study may be different from that of the other workers but it is logical because they used neem leaves dust, neem oil and Malathion against rice moth. The efficacy of indigenous plant (like neem, biskatali and karanja) leaves extract and neem leaves powder, neem oil and Malathion 57 EC may vary against rice moth (*S. cerealella)*. In the present study, the results obtained are very encouraging and there is a great potential for the use of neem, biskatali and karanja leaves extract as a toxic agent in storage pest, *Sitotroga cerealella* management systems in our country.

CONCLUSION

Considering the% of mortality,% of corrected mortality, adult emerged, adult longevity and repellency effect it was found that the treatment T_2 (10% concentration of leaves extract) @ 0.5 ml/50 g) was the most effective in comparison to all other treatments in this experiment against rice moth, *Sitotroga cerealella* in stored rice grains.

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