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Evaluation of six plant extracts for their possible repellent effects against lesser mealworm, *Alphitobius diaperinus* (Panzer)

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Abstract

Experiment was carried out to investigate the repellent effect of leaf and seed extracts of six indigenous plants namely dholkalmi, *Ipomoea fistulosa*; dutura, *Datura fastuosa*; eucalyptus, *Eucalyptus citriodora*; hatisur, *Helitropium indicum;* khetpapri, *Hedyotis corymbosa* and urmoi, *Sapium indicum* against lesser mealworm, *Alphitobius diaperinus* (Panzer). Leaf and seed extracts of the test plants had moderate repellent effect. Among the extracts, the highest repellency was observed in dholkalmi leaf extract (repellency 47.91%) and hatisur seed extract (repellency 47.47%). The ethanol extracts of leaf and water extracts of seed were more effective in repelling the pest than those of the other two solvent extracts. In most of the cases, repellency rate decreased with the progress of time and increased proportionally with doses. The results indicated the possibility of using dholkalmi leaf extract and hatisur seed extract as an alternative control measures for lesser mealworm as they were found to possess high repellency effect against the pest.

Keywords: Plant extracts, Solvent, Lesser mealworm, *A. diaperinus,* Repellent

Introduction

Wheat is the second most important cereal crop next to rice in Bangladesh and has gained much popularity among the farmers due to its higher nutritive value and lower cost of production than rice. Insect infestation in stored grains like wheat and their products is a serious problem throughout the world. The lesser mealworm is a cosmopolitan pest of stored products (Gautam, 1989). It is found in damp and dingy parts of stores, below mattings, feeding on the waste grain meal lying accumulated there, or any similar accumulations found in corners of stores, mills etc. Husked rice and wheat are generally attacked by this pest in Bangladesh. The pest attacks moist and badly preserved grains and reduces wheat seed viability by feeding on the embryo. Besides, the insect serves as a vector for common grain pathogens including bacteria (e.g., *Salmonella*), viruses (e.g., revovirus) and *Eimeria* (Goodwin and Waltman, 1996). Many investigators suggested to use chemical insecticides for its control. Chemical control of insects in storage has been used for a long time, but has serious drawbacks (Sharaby, 1988). The indiscriminate use of chemical insecticides has given rise to many serious problems, including genetic resistance of pest species, toxic residues, increasing costs of application, environmental pollution, hazards from handling and hazards in human being etc. (Ahmed *et al.,* 1981; Khanam *et al.,* 1990). There is an urgent need for safe but effective and biodegradable pesticides with no toxic effects on non-target organisms. This has created a world-wide interest in the development of alternative strategies, including the search for new types of insecticides, and the re-evaluation and use

of age-old traditional botanical pest control agents (Heyde *et al.,* 1983). Plants are a rich source of compounds that have insecticidal activity (Arnason *et al.*, 1989). Most of the botanical are non-hazardous and non-toxic to humans. They are less expensive and locally available. Botanical insecticides are broad-spectrum, safe to apply, unique in action and can be easily processed and used in pest control. Locally available plants and minerals have been widely used in the past to protect stored products against damage by insect infestation (Golob and Webley, 1980). Eucalyptus leaf extracts showed repellent action on *S. oryzae* (Sharaby, 1988). The earlier studies (Islam, 1987, Talukder *et al.,* 1990, Talukder and Howse, 1993, 1994 and 1995) established the successful actions of different plant parts and extracts against different major stored product insect pests of Bangladesh. However, a very few scientific and continuous research work has been done in Bangladesh to establish successful control action of our locally available plant materials against stored product pests. The present study was undertaken with some locally grown plants such as dholkalmi, dutura, eucalyptus, hatisur, khetpapri and urmoi to investigate their compatibility in Pest Management (PM) programme by determining their repellent effects against lesser mealworm under simple laboratory technique.

Materials and Methods

Experiments on the repellent effect of some plant leaf, seed and bark extracts against lesser mealworm, *Alphitobius diaperinus* (Panzer). were conducted in the laboratory of the Department of Entomology, Bangladesh Agricultural University, Mymensingh during 1999-2000. The lesser mealworm was collected from the stock culture of the Department of Entomology and reared in round plastic jars (12 x 23 x 6.5 cm in size) using sterilized wheat grains as rearing medium at 18.70-28.98^{0}C temperature and 73.34-87.90% relative humidity.

Preparation of plant extracts

The test plant materials (leaves, seeds, barks) of dholkalmi, dutura, eucalyptus, hatisur, khetpapri and urmoi were collected from different areas of Bangladesh. Fresh leaves, seeds and barks were washed in running water and then dried in shade. The air-dried plant materials were then oven-dried at 60^{0}C. Oven-dried plant materials were ground manually and passed through a 25-mesh diameter sieve to obtain fine dust and preserved them into air tight container, till their use in extract preparation. Thirty grams of fine dust of each category were taken in a 600 ml beaker after adding 300 ml of different solvents (acetone, ethanol and water) in it separately. 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 filtrates were condensed by evaporation of solvents in a water bath at 45^{0}C, 55^{0}C and 80^{0}C temperature for acetone, ethanol and water extracts, respectively. The condensed extracts were preserved in tightly corked-labeled bottles separately and stored in a refrigerator until their use for insect bioassays. Different concentrations of each category of plant extracts were prepared by dissolving them in the water prior to insect bioassay.

Insect bioassay

The repellency test was conducted according to the method of Talukder and Howse (1994) with minor modification. Nine-centimeter diameter Petri dish was divided into three parts, treated and untreated grain portion 3.5 cm each and neutral centre portion (without grain) 2 cm. Two grams of wheat grains were taken in each side portion of Petri dish. One ml of solution of different dose (0, 7.5, 10.0, 12.5 and 15.0%) of each plant extract was applied to the grains of the portion of the Petri dish as uniformly as possible with a pipette and the grains of other side remained untreated. Ten insects were released at the central portion of

each Petri dish and a cover was placed on the Petri dish. There were three replications for each dose of plant extracts. In the untreated portion of Petri dish the grains were treated with solvent only. Then the number of insects in each portion (treated and untreated) was counted at hourly intervals up to the fifth hour. The data were converted to express percent repulsion (PR) by the following formula as described by Talukder and Howse (1994): PR(%)=(Nc-50)x2 Where, Nc = The percentage of insect in the control portion. Positive (+) values expressed the degree of repellency and negative (-) values for the level of attractancy. Data (PR %) were analysed using analysis of variance (ANOVA) after arcsine transformation. The average values were then categorized into classes (McDonald *et al.*, 1970) viz., 0 >0.01-0.1%, I = 0.1-20%, II = 20.1-40%, III = 40.1-60%, IV = 60.1-80% and V = 80.1-100% repellent rate.

Results and Discussion

The repellent effect of dholkalmi, dutura, eucalyptus, hatisur, khetpapri and urmoi leaf, seed and bark extracts against lesser mealworm, *Alphitobius diaperinus* (Panzer) were investigated and the results are presented in Tables 1-6.

Plant leaf extracts

The results revealed that dholkalmi leaf extract and urmoi leaf extract caused the highest (47.91%) and the lowest (27.56%) mean repellency rate, respectively (Table 1). The dholkalmi leaf extracts showed medium repellent effect but other plant extracts have slight repellent effect on lesser mealworm. Though, their differences were statistically significant but the differences between dutura, eucalyptus, hatisur, khetpapri and urmoi were statistically identical. In most of the cases, repellency rate decreased with the progress of time. The rate of repellency differed with the extract type. Among three solvents, ethanol extract showed the highest repellency effect (34.62%) and significantly different from water extract (30.40%) (Table 2). It is evident from the result that all solvents are not equally effective for all plants and no solvent is found to perform well for all plants. So, it can be suggested that before making extract from plant, the type of solvent to be used should be determined first because it can not be generalized that a particular solvent will be useful for all plants. The rate of repellency increased proportionally with the increases of doses (Table 3).

Table 1. Effect of different plant leaf extracts on the repellency of lesser mealworm, *A. diaperinus* when applied in wheat grains

Name of the plant leaf extracts	Repellency rate (%) at different time intervals					Mean repellency rate (%)	Repellency class
	1 HAT	2 HAT	3 HAT	4 HAT	5 HAT		
Dholkalmi	44.00 a-d	48.89 ab	53.7 8a	53.78 a	39.11 a-f	47.91 a	III
Dutura	40.44 a-c	26.22 e-l	32.89 b-i	28.44 d-i	16.89 i	28.98 b	II
Eucalyptus	40.89 a-i	37.33 b-g	24.89 d-i	32.44 b-i	24.00 e-i	31.91 b	II
Hatisur	29.33 d-i	31.11 c-l	35.56 b-i	32.44 b-i	19.11 hi	29.91 b	II
Khetpapri	30.67 d-i	40.00 a-e	32.89 b-i	30.22 d-i	32.44 c-i	33.24 b	II
Urmoi	47.56 a-c	24.44 e-l	22.67 f-i	22.67 g-i	20.44 g-i	27.56 b	II
Sx	3.841					1.718	
Probability level	0.01					0.01	

Table 2. Effect of different solvents used in different plant leaf extracts on the repellency of lesser mealworm, *A. diaperinus* when applied in wheat grains

Name of the solvents used in leaf extracts	Repellency rate (%) at different time intervals					Mean repellency rate (%)	Repellency class
	1 HAT	2 HAT	3 HAT	4 HAT	5 HAT		
Acetone	42.22	33.78	35.33	30.67	30.67	34.35 a	II
Ethanol	39.11	37.11	37.56	34.89	24.44	34.62 a	II
Water	35.11	33.11	28.44	34.44	20.89	30.40 b	II
Sx	2.716					1.215	
Probability level	NS					0.05	

HAT= Hour after treatment
NS= Not significant
Within column values followed by different letter(s) are significantly different by DMRT

Table 3. Repellency effect of different plant leaf extracts at different doses on lesser mealworm, *A. diaperinus* in treated wheat grains

Doses (%) of plant leaf extracts	Repellency rate (%) at different time intervals					Mean repellency rate (%)	Repellency class
	1 HAT	2 HAT	3 HAT	4 HAT	5 HAT		
0	-0.37	0.74	0.37	-1.48	-8.14	-1.78 c	0
7.5	50.00	41.11	41.85	28.52	24.00	37.09 b	II
10.0	40.74	42.22	32.59	42.22	27.78	37.11 b	II
12.5	53.33	41.85	45.56	48.89	38.52	45.63 a	III
15.0	50.37	47.40	48.52	48.51	44.44	47.85 a	III
Sx	3.506					1.568	
Probability level	NS					0.01	

Plant seed/bark extracts

The repellency effects of six plant seed/bark extracts on lesser mealworm showed that hatisur extract has medium and other plant extracts have slight repellent effect (Table 4). Among six plant seed extracts, hatisur seed extract possessed the highest mean repellent effect (47.47%) and the lowest in eucalyptus seed extract (23.56%). Considering the solvents, water extract showed the highest mean repellency effect (31.87%) than that of acetone (31.16%) and ethanol (31.28%) extracts (Table 5). The results also indicated that repellency effect increased proportionally to the concentration (Table 6). No repellency effect was observed in the control treatment. In most of the cases, it was also observed that repellency rate decreased with the progress of time. Sharaby (1988) reported that the extract of eucalyptus showed more repellent effects on rice weevil. The present results on repellent effect of leaf and seed extracts supported findings of other authors (Ahmed and Eapea, 1986; Khan and Shahjahan, 1998 and Kamruzzaman *et al*, 2004). In the present experiment the decrease of repellency with time may be explained by the findings of Jilani and Saxena (1990), who found that the repellency of compounds with low molecular weights and high volatility decreased rapidly over time. The present study has shown that dholkalmi leaf extracts and hatisur seed extract have moderate repellent effects on adult lesser mealworm. This study also confirms the validity of traditional use of dholkalmi and hatisur against stored grain pests.

Table 4. Effect of different plant seed/bark extracts on the repellency of lesser mealworm, *A. diaperinus* when applied in wheat grains

Name of the plant seed/bark extracts	Repellency rate (%) at different time intervals					Mean repellency rate (%)	Repellency class
	1 HAT	2 HAT	3 HAT	4 HAT	5 HAT		
Dholkalmi	40.89	41.33	36.89	39.56	35.56	38.85 b	II
Dutura	24.89	29.78	32.44	27.11	27.11	28.27 c	II
Eucalyptus	23.56	20.44	29.33	24.89	19.56	23.56 c	II
Hatisur	48.89	45.33	48.89	46.67	47.56	47.47 a	III
Khetpapri	22.22	22.22	24.89	32.00	18.67	24.00 c	II
Urmoi	25.78	20.44	29.33	27.56	29.33	26.49 c	II
Sx	3.625					1.621	
Probability level	NS					0.01	

HAT= Hour after treatment
NS= Not significant
Within column values followed by different letter(s) are significantly different by DMRT

Table 5. Effect of different solvents used in different plant seed/bark extracts on the repellency of lesser mealworm, *A. diaperinus* when applied in wheat grains

Name of the solvents used in seed/bark extracts	Repellency rate (%) at different time intervals					Mean repellency rate (%)	Repellency class
	1 HAT	2 HAT	3 HAT	4 HAT	5 HAT		
Acetone	25.33	30.00	35.11	35.33	30.00	31.16	II
Ethanol	32.44	27.78	30.89	33.56	31.78	31.28	II
Water	35.33	32.00	34.89	30.00	27.11	31.87	II
Sx	2.563					1.146	
Probability level	NS					NS	

Table 6. Repellency effect of different plant seed/bark extracts at different doses on lesser mealworm, *A. diaperinus* in treated wheat grains

Doses (%) of plant seed/bark extracts	Repellency rate (%) at different time intervals					Mean repellency rate (%)	Repellency class
	1 HAT	2 HAT	3 HAT	4 HAT	5 HAT		
0	1.48	-1.11	-1.85	0.00	-1.85	-0.67 c	0
7.5	29.63	35.56	39.25	42.59	33.33	36.07 b	II
10.0	33.33	40.74	40.74	37.78	36.67	37.85 b	II
12.5	41.48	30.00	44.07	40.37	36.67	38.52 b	II
15.0	49.25	44.44	45.93	44.07	43.33	45.40 a	III
Sx	3.309					1.480	
Probability level	NS					0.01	

HAT= Hour after treatment
NS= Not significant
Within column values followed by different letter(s) are significantly different by DMRT

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References

Ahmed, S.M. and Eapea, M. 1986. Repellency of some essential plant extracts to insect pests. Indian Perfumer. 30(1): 273-278.

Ahmed, S.M., Chander, H. and Pereira, J. 1981. Insecticidal potential and biological activity of Indian indigenous plants against *Musca domestica*. Int. Pest Control. 23: 170-175.

Arnason, J. T. Philogene, B. J. R. and Morand, P. 1989. Insecticides of plant origin. ACS Symp. Ser. 387 P.

Gautam, R.D. 1989. Exploration of lesser mealworm, *Alphitobius diaperinus* (Panzer) for the control of storage insects together with its stages and effect on seed viability. Division of Entomology. Indian Agric. Res. Inst., New Delhi, Agricultural Situation in India. 64(6): 487-489.

Golob, P. and Webley, D.J. 1980. The use of plants and minerals as traditional protectants of stored products. Tropical Products Institute, London. 32 p.

Goodwin, M.A. and Waltman, W.D. 1996. Transmission of *Eimeria*, viruses and bacteria of chicks : darkling beetles, *Alphitobius diaperinus* as vectors of pathogens. J. Appl. Poult. Res. 5(1): 51-55.

Heyde, J.V.D., Saxena, R.C. and Schmutterer, H. 1983. Neem oil and neem extracts as potential insecticides for control of Hemipterous rice pests. Proc. 2nd Int. Neem Conf. Rauischholzhausen. pp. 377-390.

Islam, B.N. 1987. Use of some extracts from Meliaceae and Annonaceae for control of rice hispa, *Dicladispa armigera* and the pulse beetle, *Callosobruchus chinensis*. Proc. 3rd Int. Neem Conf., Nairobi, 1986. pp. 217-242.

Jilani, G. and Saxena, R.C. 1990. Repellent and feeding deterrent effects of turmeric oil, sweetflag oil, neem oil and a neem based insecticides against lesser grain borer (Coleoptera: Bostrychidae). J. Econ. Entomol. 83: 629-634.

Khan, M. and Shahjahan, R.M. 1998. Evaluation of eucalyptus leaf extracts as repellent for adult of *Sitophilus oryzae* (L.) (Coleoptera: Curculionidae) and attractant for *Callosobruchus chinensis* (L.) (Coleoptera: Bruchidae) Bangladesh J. Entomol. 8 (1 & 2): 81-88.

Kamruzzaman, M., Shahjahan, M.,Chowdhury, S. and Islam, M.F. 2004. Repellent effects of some indigenous plant extracts against rice weevil, *Sitophilus oryzae* (L.). Bangaldesh J. Environ. Sci.10:271-275.

Khanam, L.A.M., Talukder, D., Khan, A.R. and Rahman, S.M. 1990. Insecticidal properties at royna, *Aphanamixis polystachya* Wall and Parker (Meliaceae) against *Tribolium confusum* Duval. J. Asiat. Soc. Bangladesh, Sci. 16: 71-74.

McDonald, L.L., Guy, R.H. and Speirs, R.D. 1970. Preliminary evaluation of new candidate materials as toxicants, repellents and attractants against stored product insects. Marketing Res. Report No. 882. Agric. Res. Serv., U.S. Dept. Agric. Washington, D.C. 8 p.

Sharaby, A. 1988. Evaluation of some Myrtacae plant leaves as protectants against the infestation by *Sitophilus oryzae* L. and *Sitophilus granarius* L. Insect Sci. Appl. 9(4): 465-468.

Talukder, F.A. and Howse, P.E. 1993. Deterrent and insecticidal effects of extracts of pithraj, *Aphanamixis polystachya* (Meliaceae) against *Tribolium castaneum* in storage. J. Chem. Ecol. 19 (11): 2463-2471.

Talukder, F.A. and Howse, P.E. 1994. Laboratory evaluation of toxic and repellent properties of pithraj, *Aphanamixis polystachya* Wall and Parker, against *Sitophilus oryzae* L. Int. J. Pest Management. 41(3): 274-279.

Talukder, F.A. and Howse, P.E. 1995. Evaluation of *Aphanamixis polystachya* as a source of repellents, antifeedants, toxicants and protectants in storage against *Tribolium castaneum* (Herbst). J. Stored Prod. Res. 31(1): 55-61.

Talukder, F.A., Shahjahan, M. and Ahad, M.A. 1990. Screening of some local botanicals against rice weevil (*Sitophilus oryzae*). Bangladesh J. Agric. 15: 283-284.