

BIOACTIVITY STUDIES OF *SOLANUM FEROX* L. AGAINST *TRIBOLIUM CASTANEUM* (HERBST) ADULTS

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Abstract: Dose-mortality and repellent activity tests of the chloroform extracts of fruit, leaf, root and stem of *Solanum ferox* L. against the red flour beetle *Tribolium castaneum* (Herbst) adults have been done. The fruit, leaf and stem extracts offered promising toxicity to the beetles within 30 min. of exposure. The LD₅₀ values for 30 min., 12, 24, 36 and 48h of exposures were 0.440, 0.247, 0.211, 0.207 and 0.164mg cm⁻² respectively for the fruit extract; 2.394, 1.712, 1.540, 1.239 and 0.993mg cm⁻² respectively for the leaf extract; and 4.918, 0.871, 0.546, 0.472 and 0.522mg cm⁻² respectively for the stem extract. However, the root extract did not offer any mortality for 30 min. and 12h of exposure; and thus the LD₅₀ values for 24, 36 and 48h of exposure were 6.667, 5.086 and 3.357mg cm⁻² respectively. While the dose-mortality activity can be arranged in the order of fruit> leaf> stem> root extracts. The fruit and stem extracts showed repellent activity against *T. castaneum* adults at P<0.01 and the leaf extract at P<0.05 level of significance, while the root extract did not show any repellency.

Keywords: Mortality, repellency, *Solanum ferox*, *Tribolium castaneum*.

সারাংশ: পূর্ণাঙ্গ *Tribolium castaneum* (Herbst) এর উপর *Solanum ferox* L. এর ফল, পাতা, মূল ও কাণ্ডের ক্লোরোফর্ম নির্যাস প্রয়োগে মাত্রা-মৃত্যুহার ও বিতাড়ন কার্যকারিতা পরীক্ষা করা হয়। ফল, পাতা ও কাণ্ডের নির্যাস প্রয়োগের ৩০ মিনিটের মধ্যেই উল্লেখযোগ্য বিষক্রিয়া দেখায়। ফলের নির্যাসের জন্য ৩০মি: এবং ১২, ২৪, ৩৬ ও ৪৮ ঘণ্টা প্রয়োগকৃত সময়কালের জন্য LD_{৫০} ছিল প্রতি বর্গসেন্টিমিটারে যথাক্রমে ০.৪৪০, ০.২৪৭, ০.২১১, ০.২০৭ এবং ০.১৬৪ মি.গ্রা.; পাতার নির্যাসের জন্য LD_{৫০} ছিল প্রতি বর্গসেন্টিমিটারে যথাক্রমে ২.৩৯৪, ১.৭১২, ১.৫৪০, ১.২৩৯ এবং ০.৯৯৩; আর কাণ্ডের নির্যাসের জন্য LD_{৫০} ছিল প্রতি বর্গসেন্টিমিটারে যথাক্রমে ৪.৯১৮, ০.৮৭১, ০.৫৪৬, ০.৪৭২ এবং ০.৫২২ মি.গ্রা।। মূলের নির্যাস ১২ ঘণ্টা অবধি কোন কার্যকারিতা না দেখালেও ২৪, ৩৬ ও ৪৮ ঘণ্টা প্রয়োগকৃত সময়কালের জন্য LD_{৫০} ছিল প্রতি বর্গসেন্টিমিটারে যথাক্রমে ৬.৬৬৭, ৫.০৮৬ এবং ৩.৩৫৭ মি.গ্রা.; এবং উপরোক্ত কার্যকারিতার ধারা উচ্চ থেকে নিম্নতর পর্যায়ে ফল> পাতা> কাণ্ড> মূল এভাবে সাজান যায়। পূর্ণাঙ্গ *Tribolium castaneum* (Herbst) এর উপর ফল ও কাণ্ডের নির্যাস বিতাড়ন কার্যকারিতা প্রদর্শন করেছে P<০.০১ ও পাতার ক্ষেত্রে P<০.০৫ তাৎপর্যতায়, অবশ্য মূলের নির্যাস কোনরূপ কার্যকারিতা দেখায়নি।

Introduction

Solanum ferox L. of the family Solanaceae is a large valuable annual and perennial plant, small in size, suberect, prickly and hairy herb and gets 0.5 to 1.5 meters in height. They often have attractive fruits and flowers. Most are poisonous but many bear edible fruits, leaves, or tubers, and the genus including three major food crops. A decoction of this root is used against syphilis, for body pains and discomfort after meals, to the cases of different varieties of fevers, as poultice for itches, cuts, wounds and bruises, and as an antipyretic, but for the later it is not supported by the trial conducted to find out the effect of the herb (Kirtikar and Basu, 1935). In Bangladesh, this herb is used for coughs, asthma, fever, vomiting, sore throat and gonorrhoea; and in India it is used for female sex disorders. Its roots and berries are bechic, antiasthmatic, antirheumatic, antiviral, anticancer and spermicidal (Joy et al. 2001). However, information on its biological activities against the insect pests is still scanty, and thus it was attempted for screening through insecticidal assay and repellent activity tests against *T. castaneum*, which is a major stored product insect pest.

Materials and Methods

Collection and preparation of test materials: Fresh plants were collected from the Rajshahi University Campus, Bangladesh followed by identification by

Prof. A.T.M. Naderuzzaman, and a voucher specimen (No. 41, 02-04-2008) was also kept in the herbarium of the Department of Botany, University of Rajshahi. After collection leaves, roots and stem were separated, and were chopped into small pieces to dry in a well-ventilated room under shade. Fruits were also collected and allowed to dry. Dried materials were then powdered using a grinder, weighed and placed in separate conical flasks to add chloroform (100g × 300ml × 3 times) for 48 hours. Filtrations were done by Whatman filter paper at 24h interval in the same flask followed by evaporation until the extracts were left. Those were then removed to glass vials and preserved in a refrigerator at 4°C with proper labeling.

Culture of the test insect: Five days old adult beetles of *Tribolium castaneum* used in the present experiment were reared in glass beakers (500 ml) in a standard mixture of whole-wheat flour with powdered dry yeast (19:1) in an incubator at 30°C±0.5°C without light and humidity control.

Dose-mortality test against *T. castaneum*: For dose-mortality responses in the experiments of surface film method the doses for the CHCl₃ extracts of fruits, leaves, roots and stem were confirmed through *ad hoc* experiments by putting 50mg of each of the extracts diluted separately in 1ml of solvent to apply in 50mm Petri dishes and by increasing or decreasing the amount of

extracts in repeated manners until a suitable mortality range was obtained. The doses selected for the fruit extract were 0.509, 0.254, 0.127, 0.063, 0.0318 and 0.0159mg cm⁻², for the leaf extract 2.547, 1.911, 1.273, 0.955, 0.636 and 0.477mg cm⁻², for root extract 7.643, 5.095, 2.547, 1.273 and 0.636mg cm⁻² and for the stem extract 4.076, 2.038, 1.019, 0.509, 0.254 and 0.127mg cm⁻². Each of the five doses were diluted in 1ml of solvent, poured into a Petri dish and allowed to dry. Ten adult beetles were released in each of the Petri dishes, and the experiments of all the doses for each of the extracts were set in 3 replicates. The mortality of the beetles was assessed at 30min., 12, 24, 36 and 48h of exposure.

Statistical analysis of the dose-mortality data: The mortality of the beetles was recorded, while an instant observation was made just after 30 min. of application for the detection of acute toxicity, if any. The mortality (%) was corrected by Abbott's formula (1925). The statistical analyses were done according to Finney (1947) and Busvine (1971) to calculate the LD₅₀ values.

Repellent activity against *T. castaneum* adults: The methodology for repellency test used in this experiment was adopted from the method (No. 3) of McDonald et al. (1970) with some modifications by Talukder and Howse (1993, 1994). Half filter paper discs (Whatman No. 40, diameter 9 cm) were treated with the selected doses of 0.079, 0.039, 0.020, 0.010 and 0.005mg cm⁻² of fruit extract and were then attached lengthwise, edge-to-edge,

to a control half-disc with adhesive tape and placed in the Petri dishes. The orientation was changed in the two remaining replicates to avoid the effects of any external directional stimulus affecting the distribution of the test insects. Ten adult insects were released in the middle of each of the filter paper circles. The same was then done for the leaf, root and stem extracts.

Observation and analysis of repellency data: Each concentration was tested for five times. Insects that settled on each of the non-treated half of the filter paper discs were counted after 1h and then observed repeatedly at hourly intervals for five hours. The average of the counts was converted to percent repellency (*PR*) using the formula of Talukder and Howse (1993, 1995): $PR = (N_c - 5) \times 20$, where, N_c is the percentage of insects on the untreated half of the disc.

Results and Discussion

Dose mortality effects: The results of the dose-mortality assay revealed the fruit extract the highest in activity against the test beetles, presented in Table 1. However, the root extract, weakest among the four extracts didn't offer any mortality for 30 min. and 12h of exposure; but the LD₅₀ values for 24, 36 and 48h of exposure were 6.667, 5.086 and 3.357mg cm⁻² respectively; and the dose-mortality activity can be arranged in the order of fruit > leaf > stem > root extracts.

Table 1. LD₅₀ values of fruit, leaf, root and stem extracts (CHCl₃) of *S. ferox* against *T. castaneum* adults.

Plant parts	Duration of exposure				
	30 min.	12h	24h	36h	48h
Fruit	0.440	0.247	0.211	0.207	0.164
Leaf	2.394	1.712	1.540	1.239	0.993
Root	-	-	6.667	5.086	3.357
Stem	4.918	0.871	0.546	0.472	0.522

Repellent effects: The repellency results are presented in Tables 2 and 3. The CHCl₃ extracts of the fruit, leaf and stem of *S. ferox* offered a promising repellent effect against *T. castaneum* adults ($P < 0.01$, $P < 0.05$ and $P < 0.01$ respectively) while the root extracts did not show any repellency.

These findings receive supports from the previous researchers who carried out different biological assays including insecticidal activity tests. An alcoholic extract of the root of *S. ferox* was found active against *Staphylococcus aureus* and *Escherichia coli* (Khare, 2007). The fume produced on burning of its seed was plant inhaled to relief from toothache (Pal Singh, 2007). In Sri Lanka root of this was used as remedy in cutaneous diseases (Ahmed et al. 2009). In Philippines, leaves of the test plant are used as cataplasma for indolent swellings (Pal Singh, 2007). Because of the medicinal activity this plant has been enlisted in the ethnobotanical inventory of medicinal plants (Barbosa

Filho et al. 1991). It also has nearly the same history like other species of the same genera in context of online information. Cheryl Lans (2007) reported that these plants are used for Man's waist pain and also used for reproductive purposes. No report was found on its repellent activity among the previous findings. Being enlisted among weeds no cultivation of this plant is available even though it is a very good and promising medicinal plant and growing naturally covering a vast area of the world mostly in the tropics, and being used in the traditional and folk medicines this plant should be investigated thoroughly until furnishing the active ingredients for different health disorders.

Table 2 Percent repulsion values and the arcsin transformed data of the fruit, leaf, root and stem extracts (CHCl₃) of *S. ferox* against *T. castaneum* adults.

Plant part	Dose mg cm ⁻²	Observation at regular intervals				
		1h	2h	3h	4h	5h
Percent repulsion PR = (Nc – 5) × 20 (Arcsin transformed values for ANOVA)						
Fruit	10	60 (50.77)	100 (84.84)	93.32 (75.00)	93.32 (75.00)	100 (84.84)
	5	26.66 (31.05)	26.66 (31.05)	33.32 (35.24)	26.66 (31.05)	33.32 (35.24)
	2.5	0 (0.00)	33.32 (35.24)	0 (0.00)	0 (0.00)	6.66 (14.89)
	1.25	26.66 (31.05)	80 (63.43)	86.66 (68.53)	6.66 (14.70)	60 (50.77)
	0.625	-20 (26.57)	80 (63.43)	26.66 (31.05)	86.66 (68.53)	86.66 (68.53)
	Leaf	10	-66.66 (54.70)	-73.34 (58.89)	-66.66 (54.70)	-86.66 (68.53)
	5	-6.66 (14.89)	-26.66 (31.05)	-20 (26.57)	-13.34 (21.39)	13.34 (21.39)
	2.5	0 (0.00)	0 (0.00)	-20 (26.57)	-46.66 (43.05)	-40 (39.23)
	1.25	-40 (39.23)	6.66 (14.89)	-26.66 (31.05)	-26.66 (31.05)	-20 (26.57)
	0.625	-20 (26.57)	-26.66 (31.05)	-66.66 (54.70)	-53.34 (46.89)	-33.34 (35.24)
Root	10	-40 (39.23)	-26.68 (31.05)	-33.34 (35.24)	-33.34 (35.24)	-33.34 (35.24)
	5	-40 (39.23)	-26.68 (31.05)	-20 (26.57)	-13.34 (21.39)	-20 (26.57)
	2.5	-13.34 (21.39)	0 (0.00)	-40 (39.22)	33.34 (35.24)	33.34 (35.24)
	1.25	0 (0.00)	13.32 (21.39)	-6.68 (14.89)	-6.68 (14.89)	0 (0.00)
	0.625	20 (26.57)	40 (39.23)	20 (26.57)	33.32 (35.24)	26.66 (31.05)
	Stem	10	40 (39.23)	-33.34 (35.24)	-33.34 (35.24)	-40 (39.23)
	5	66.66 (54.70)	-53.34 (46.89)	-86.66 (68.53)	-100 (84.84)	-86.66 (68.53)
	2.5	40 (39.23)	-33.34 (35.24)	-53.34 (46.89)	-86.66 (68.53)	-80 (63.43)
	1.25	6.66 (14.89)	-26.66 (31.05)	-20 (26.57)	-26.66 (31.05)	-33.34 (35.24)
	0.625	-6.66 (14.89)	6.66 (14.89)	6.66 (14.89)	-6.66 (14.89)	6.66 (14.89)

Table 3. Repellency effect of fruit, leaf, root and stem extracts (CHCl₃) of *S. ferox* against *T. castaneum* adults.

Extract	Between time interval (df=4)	Between doses (df=4)
	F-value	F-value
Fruit	4.226	22.065**
Leaf	2.014	10.457*
Root	0.162	4.435
Stem	2.699	22.1993**

*= significant at 5% level; **= significant at 1% level

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