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Biocidal activities of *Abrus precatorius* (L.) against tobacco leaf caterpillar *Spodoptera litura* Fab. (Noctuidae: Lepidoptera)

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Abstract

Antifeedant and insecticidal properties of *A. precatorius* suggested by the locals of karaikal district, Puducherry was studied by conducting laboratory bioassay against third instar of *Spodoptera litura* (F.) (Lepidoptera). The higher antifeedant activity was noticed in methanol extract (84.11%), petroleum ether extract (71.29%) and hexane extract (42.02%). The insecticidal activity was more pronounced in methanol (100%), petroleum ether (83.33%) and hexane activity (66.67%). The results revealed the active toxic compound of *A. precatorius* to be used in the biorational pest management strategies.

Keywords: *A. precatorius*, antifeedant, insecticidal activity, *Spodoptera litura*

Introduction

A. precatorius is a high-climbing, twining creeper of the family Fabaceae that grows in many tropical areas and is propagated through seeds [1]. It is native to India and also called jequirity bean, crab's eye and love bean. The whole plant is poisonous and toxalbumin in seeds. The plant flowers in winter or early spring and the fruits ripen in late summer. The flowers appear in clusters, shaped like peas and can be white or tinged with pink. The fruit is a flat oblong pod and has 3-8 shiny hard seeds which are 6-7 mm in diameter.

The various toxic constituents isolated from various parts of the plant are reported as N-methyltryptophan, glycyrrhizin (lipolytic enzyme that is the active principle of liquorice), abrin (toxalbumin), abrine as alkaloid (amino acid), abralin (glucoside), and abric acid. It has a wide-range of numerous bioactive and insecticidal properties that have been investigated for over a hundred years [2]. The present investigation was carried out to find out its antifeedant and insecticidal potentials against tobacco leaf caterpillar, *S. litura* (Host). The tobacco leaf caterpillar is a ubiquitous, polyphagous, multivoltine and lepidopterous pest that feeds on nearly 112 cultivated crops all over the world and on about 60 species from India [3]. Since, it feeds on a wide range of host plants, which ensures the survival of *S. litura* individual over a broad range of environmental conditions and used as a test agent in the toxicological laboratory.

Materials and methods

Culturing of *S. litura*

Egg mass of the tobacco leaf caterpillar, *S. litura* collected from cotton and rice fields established as the initial source for the continuous, disease free culture. It was maintained in laboratory conditions on castor (*Ricinus communis*) leaves under standard conditions of temperature (27 ± 2^0 C) and relative humidity (70± 5^0 C) to get the homogenous population of larvae throughout the bioassay experiments [4].

Collection and preparation of test materials

The Seeds of *A. precatorius* were collected in the month of April to June 2018 from nearby villages of PAJANCOA and RI, Karaikal, Pondicherry, India. The collected seeds were washed with running tap water and dried under the sunlight for one week. Then shade dried samples were ground with the help of electric blender into powder. About 10 g of samples were weighed and packed in whatman filter paper no.40 as thimbles. In the conical flasks, thimbles were kept inside and add 200 ml of solvent (Methanol, Petroleum ether and Hexane). Then the mouths of conical flasks were closed with non– absorbent cotton and wrapped with aluminium foil using a rubber band. These conical flasks were kept overnight for soaking. Thimbles were taken from the conical flasks and placed in the soxhlet extractor unit and the respective soaked solvent was transferred from conical flask to bottom flask. Further, the required quantity of solvent was added. The boiling point of methanol (64 – 65.5 °C), petroleum ether (50 -70°C) and hexane (68 -70°C) was fixed in a heating mantle [5]. When the solvent reduced to 20 ml in the glass bowl, silica gel was added to make it into paste form (miscella) then it is purified by the column chromatography [6].

Antifeedant activity

The extracts were tested for antifeedant activity using leaf disc no choice method [7]. Fresh castor leaf discs of 4 cm were punched using cork borer and dipped in 0.5%, 1%, 1.5%, 2%, 2.5% and 3 % of the solvent extract (methanol, petroleum ether and hexane) and azadirachtin (20%) used as positive control. After air drying, each leaf disc was placed in petridish (1.5 X 9 cm) and introduced 2 h prestarved third instar into petri dishes containing respective leaf discs. For each concentration three replicates were maintained. Progressive consumption of leaf area by the larva after 24 h feeding was recorded in control and treatment using graphical leaf area method. Leaf area consumed in plant extract was corrected from the control. The percent antifeedant index was calculated using the formula of [8].

$$\text{Antifeedant index} = \frac{C - T}{C + T} \times 100$$

Where, C and T represent the amount of leaf eaten by the larva on control and treated discs, respectively.

Larvicidal activity

The larvae were fed with leaf disc of different concentration of the solvent extract for 24 hrs were continuously maintained on untreated fresh leaves. Every 24 h, the diet was changed. After 96 h of treatment larval mortality was recorded. Four replicates were maintained for each treatment with two larvae per replicate. Percent mortality was calculated using the formula of [9].

$$\text{Percent larval mortality} = \frac{\text{Number of dead larvae}}{\text{Total number of treated larvae}} \times 100$$

Statistical analysis

The data obtained from laboratory experiment were analyzed in a Completely Randomized Block Design by "F" test for significance. Standard Error of difference (S.E (d)) and Critical difference values were calculated at 5 per cent probability level and the treatment means values of the experiments were compared using Duncan's Multiple Range Test (DMRT) [10].

Results and discussion

Antifeedant activity

The antifeedant activities of methanol, petroleum ether and hexane extracts of *A. precatorius* seed at different concentration were studied using the castor leaf disc no-choice test method. The methanol extract at 3 per cent concentration showed the highest antifeedant activity against *S.litura* (Table 1); activity was recorded as 84.11 per cent which was statistically significant ($P<0.05$) compare to other extracts and azadirachtin as control. Among the six concentration of methanol extract, minimum activity was noticed in 0.5 per cent concentration (2.03%). The highest antifeedant activity in *A. precatorius* may be due to the presence of plant secondary metabolites such as triterpenes, sesquiterpene, lactones and alkaloids [11]. Antifeedant act as first line of crop protection against notorious pests. It also referred as allomone substances which inhibit feeding and do not kill the pests and performed as a phagodeterrent and phagorepellent [12].

In the effect of petroleum ether extract of *A. precatorius* seed recorded the antifeedant activity ranged from 71.29 per cent to 2.03 per cent (Table 1). Among the six concentrations, petroleum ether extract at 3 per cent recorded more pronounced antifeedant activities (71.29%) compared to control (45.33%). Our findings coincide with the finding of [9] who indicated the ethyl extract of *Strychnos nuxvomica* (88.98%) and petroleum ether extract of *Abrus precatorius* (78.61%) showed the maximum antifeedant activity. Higher antifeedant index normally indicate decreased rate of feeding. Antifeedant is a phytochemical that inhibits the feeding without direct killing of pest and dies through starvation [13, 14].

The antifeedant activity of hexane extract of *A. precatorius* seed exhibited moderate activity compared to methanol and petroleum ether extract. Among the six concentrations, hexane extract at 3 per cent recorded 42.02% (Table 1). Our findings contradicted with the finding of [15] reported that hexane extract of *Acorus calamus* leaf showed maximum and significant antifeedant activity (77.8%) followed by *Lobelia leschenaultiana* on *S.litura.*

Insecticidal activity

The insecticidal activity of methanol, petroleum ether and hexane extract of *A. precatorius* seed at different concentration and azadirachtin as control against 3rd instar larvae of *S. litura* (30-40 mg) was assessed via leaf disc no-choice test method. Very high mortality was observed in methanol extract at 3 per cent concentration recorded 100 per cent mortality which was significantly compared to that of the control larvae (Table 2). Among the different concentration of methanol extract, the lowest larval mortality was observed in 0.5 per cent concentration (16.67%). The larval mortality was directly proportional to treatment concentration in all conditions. As per [16], azadirachtin is a predominant IGR compound. It interacts with the neuroendocrine control of metamorphosis. The effect of azadirachtin ranged from mortality, notable at moult into morphogenic defects such as production of malformed wings in adults. The present findings are in consonance with the above studies.

In the effect of petroleum ether extract of *A. precatorius* seed, high number of larval mortality was noticed in 3 per cent concentration (83.33%) compare to azadirachtin (66.67%) followed by 2.5 per cent concentration of petroleum ether extract (66.67%) (Table 2). It was understood that the treated food after reaching the digestive system of exposed larvae was not digested and kept as such. Therefore, the treated larvae consumed very less quantity fresh food which was not sufficient for normal growth and development. So, it is resulted in the malformed larvae and mortality. This is coinciding with the findings of [17], that the active compounds present in the petroleum ether fractions were able to inhibit the enzymes in the gut system of the treated larvae.

The hexane extract of *A. precatorius* seed showed that 3 per cent concentration had caused the larval mortality (66.67%) which is on par with the control (66.67%) (Table 2). The mortality rate was not significant compared to that of the control larvae.

Tables

Table 1: Percent antifeedant activity of Methanol, Petroleum ether and Hexane extract of *A. precatorius* seed against *S.litura*

SI. No.	Tested Compounds (Concentration)	Methanol Extract	Petroleum ether Extract	Hexane Extract
1	T1 (0.5%)	- (2.03)	- (2.03)	- (2.03)
2	T2 (1.0%)	+ (23.52)	+ (25.01)	- (2.03)
3	T3 (1.5%)	++ (43.23)	+ (23.87)	+ (22.41)
4	T4 (2.0%)	++ (42.82)	++ (41.77)	+ (23.11)
5	T5 (2.5%)	+++ (73.86)	+++ (72.10)	++ (41.67)

6	T6 (3.0%)	++++ (84.11)	+++ (71.29)	++ (42.02)
7	T7 Azadirachtin (20%)	++ (44.56)	++ (45.53)	++ (44.01)

The result obtained from the above table was calculated by one way ANOVA, F value is less than tabulated value at 81 and 34 degrees of freedom at 5% level of significance and the null hypothesis is accepted.

- No antifeedant activity
+ Antifeedant activity below 25%
++ Antifeedant activity between 25- 50%
+++ Antifeedant activity between 50- 75%
++++ Antifeedant activity above 75%

Table 2: Effect of promising solvent extract of *A. precatorius* seed on the mortality of *S. litura* larvae (Poison food bioassay)

SI. No.	Tested Compounds (Concentration)	Methanol Extract	Petroleum ether Extract	Hexane Extract
1	T1 (0.5%)	16.67 (23.94)^{f}	16.67 (23.94)^{e}	0.00 (2.03)^{e}
2	T2 (1.0%)	33.33 (35.22)^{e}	16.67 (23.94)^{e}	16.67 (23.94)^{d}
3	T3 (1.5%)	50.00 (45.00)^{d}	33.33 (35.22)^{d}	16.67 (23.94)^{d}
4	T4 (2.0%)	66.67 (54.78)^{c}	50.00 (45.00)^{c}	33.33 (35.22)^{c}
5	T5 (2.5%)	83.33 (66.06)^{b}	66.67 (54.78)^{b}	50.00 (45.00)^{b}
6	T6 (3.0%)	100.00 (87.97)^{a}	83.33 (66.06)^{a}	66.67 (54.78)^{a}
7	T7 Azadirachtin (20%)	66.67 (54.78)^{c}	66.67 (54.78)^{b}	66.67 (54.78)^{a}
S.E(d)		2.13	2.41	1.87
F – test		*	*	*
CD (P = 0.05)		4.39	4.97	3.99

In a column mean followed by the common letter are significantly different by DMRT (P<0.05) by one way ANOVA Values in the parentheses are arc sin transformed values # Mean of 3 replications *Significantly at 5 per cent level

Conclusion

Antifeedant and larval mortality could either be due to the presence of deadly ingredients in the extracts or the imbalances between growth stimulating and growth inhibiting hormones. The results obtained from the present study investigation clearly indicate that further studies on identification of the active compounds present in the promising extract will emerge as an alternative method for the management of notorious pest.

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