Insecticidal and antifeedant effect of *Pedalium murex* Linn. root and on *Spodoptera litura* (Fab.) (Lepidoptera: Noctuidae)

K. Sahayaraj*, M. Venkateshwari and R. Balasubramanian

Crop Protection Research Centre, Dept. of Zoology, St. Xavier’s College (autonomous), Palayamkottai -627 002, Tamil Nadu, India.


Impact of ethanol extract of *Pedalium murex* (Linn) (Family: Pedaliaceae) root (0.1, 0.2, 0.4, and 0.8%) were screened for its antifeedant and insecticidal activities against third, fourth and fifth instar larvae of *Spodoptera litura* (Fab.) by leaf-dip method. The larval mortality more than 50 percent at higher concentration (0.8%) was observed in the ethanol root extract. Stage dependant LC₅₀ value was observed for *S. litura* (0.100, 0.118 and 0.258% for third, fourth and fifth nymphal instars). *P. murex* reduced the food consumption index, growth rate, approximate digestability, efficiency of conversion of ingested food, efficiency of conversion of digested food of *S. litura* indicating the antifeedant activity of this plant. Qualitative analysis of *P. murex* root extract revealed that it contains phytochemical such as, steroids, terpenoids, phenolics, saponines, tannins and flavanoids. Phenol, 2-(5,6-dimethyl pyrazinyl) methyl (molecular weight 214); O-Terphenyl-13C (molecular weight 230) and 3,3A, 4,9B-Tetrahydro-2H-Furo(3,2-C)(1) Benzopyran (molecular weight 206) were identified from the ethanol root extract of *P. murex* by using GC-MS. *P. murex* impact was more than the neem-based biopesticide neemgold. Hence this plant can be explored as biopesticidal plant in the near future.

**Key words:** *Pedalium murex*, *Spodoptera litura*, insecticidal, antifeedant, phytochemical analysis

**Introduction**

*Spodoptera litura* (Fab.) (Lepidoptera: Noctuidae) is a polyphagous insect pest widely distributed throughout Asia (Hadapad *et al*., 2001). It has a wide range of host, feeding on 112 species world wide, of which 40 species are known from India (Singh *et al*., 1998 and Paulraj, 2001). Traditional farmers have been practicing synthetic pesticides to eliminate *S. litura* and hence it has developed resistance against almost all the commonly using pesticides in this aerea. Human health problem and environmental hazards caused by the
indiscriminate use of chemical pesticides during past three decades have leads to the scientists to look for less persistent and biodegradable alternatives (Muraleedharan and sheeladevi, 1992; Mehrotra, 1992 and Sahayaraj et al., 2003). For this purpose, medicinal as well as weed plants that have been occasionally attacked by the pests were screened and are being reported to contain bio-pesticidal property (Selvaraj and Sahayaraj, 2005). These novel bioactive compounds isolated from the insectidial plants have been integrated in the Biointensive Integrated Pest Management (BIPM) programme for many crops. Biological, physiological and biochemical impact of many insecticidal plants on different insect pests has been reported by many authors. Pedaliaceae such as *Seasamum orientale* Linn. and *S. indicum* Linn. have been used as insecticidal plant against green gram pulse beetle *Callosobruchus chinensis* Linn. and *Sitophilus oryzae* Linn. (Sujatha and Punniaiah, 1985; Choudhary, 1990). This study was aimed to found out the insecticidal activity of *P. murex* root ethanol extract on *S. litura* third, fourth and fifth instar larvae.

**Materials and methods**

**Collection and rearing of pest**

Egg masses and larva of *S. litura* were collected from groundnut and castor fields in and around Tirunelveli district, Tamil Nadu, India. Collected leaves with egg masses were transferred on to the filter paper and kept in petridishes under laboratory conditions (27°C ± 1°C temperature; 65 - 70% RH, 11 L : 13 D). Newly hatched first instar larva were reared in plastic trough (28 x 21 x 9 cm) on castor leaves. Laboratory emerged third, fourth, and fifth instar larvae (<3 hours old) of *S. litura* were used for this experiment.

**Collection and extraction of plants**

*Pedalium murex* (L.) (Family: Pedaliaceae) was chosen for the present study. It was collected from St. Xavier’s College campus, Palayamkottai, Tamil Nadu, India. Collected plants were washed thrice in tap water and once in 0.5% of sodium hypochloride and distilled water subsequently. Roots were removed from the plant and were shade dried for two weeks. The plants were powdered in a domestic grinder and stored in refrigerator for further use. From the stock, 250 grams of powder was extracted with 500 ml of ethanol using soxhelet apparatus for about 24 hrs. Ethanol extracts were concentrated using a distillation unit, air dried and stored at – 4°C for further experimental purpose.
Preparation and treatment

One gram of the crude ethanol extract of *P. murex* was dissolved in 5 ml of water. After thorough mixing the extract was again mixed with 95 ml of water. This extract was treated as 5% plant extract and used for the preliminary range finding tests and also to detect the concentrations of extracts which causing 100% larval mortality. Based on this preliminary concentration, we have prepared different concentrations such as 0.1, 0.2, 0.4 and 0.8% and used for this studies. 10g castor leaves were soaked in 0.1% of *P. murex* extract for five minutes. Control leaves were soaked in water. After five minutes, leaves were air dried for another 5 minutes and were supplied to the pests. Five weighed third, (less than 3 hours old) instar larvae of *S. litura* were released into the plastic vials (500 ml capacity). *P. murex* ethanol extract and water treated castor leaves were provided to experimental and control category of *S. litura* respectively. Then the vials were covered with muslin cloth for aeration. Similar procedure was also followed for other concentrations such as 0.2, 0.4 and 0.8% and also for fourth and fifth instars. Six replications were made for each concentration, standard and control. For standard a neem based herbal pest repellent/antifeedant insecticide Neemgolad (SPIC, Thoothukudi, Tamil Nadu, India) was used at field concentration (3%). The larvae were allowed to feed the treated leaves for a period of 96 hours continuously. After 72 and 96 hours of treatment, number of larvae died was recorded. By using this data, LC$_{50}$, chi-square value, regression equation, lower and upper fiducial limits were calculated using (Finney, 1971) formula. Furthermore, any change in the morphology of the larvae was also noticed.

Antifeedant study

Energetics was considering as a tool for antifeedant activity 96 hours LC$_{50}$ concentration was diluted 10 times with water. 10 g castor leaves were treated with the same; shade dried and provided to the 3 hours old third instar leaves for four days continuously. After every 24 hrs of treatment, unconsumed leaves, faecal pellets and larval weight were taken with the help of monopan balance (Dhona). Similar parameters were recorded after 48, 72 and 96 hrs of the experiment. Similar procedure was followed for fourth and fifth instars of *S. litura* with control (water), standard (neemgold) and experimental plant. In order to find out the dry weight of the castor leaves, fresh leaves were weighed and they were placed in an oven at 50°C. After 12 hrs, the dry weight of the leaf was noted. Similar procedure was also followed for the faecal pellets and
S. litura larva. Procedures and formula were used to study energetics (WALDBAURI, 1968).

**Phytochemical analyses of Petalium murex root extract**

Steroids, alkaloids, reducing sugar, phenolic compounds, saponins, xanthoproteins, tannins and flavonoids were tested using Brindha et al., (1981). The ethanol extracts of P. murex was subjected to the compound identification using HPLC, one mg of ethanol extract was dissolved in 1 ml HPLC grade imported methanol and the required quantity of sample was injected into the HPLC unit. The spectrum and their mass peak were compared and identified with the Tutor and Wiley library records. Student ‘t’ test was performed to found out the significance between control to standard and P. murex treatments. The significance was expressed at 5% level.

**Result and discussion**

**Phytochemistry**

Preliminary phytochemical analysis of P. murex ethanol extract showed the presence of reducing sugars, phenolic compounds, saponins, xanthoprotein, alkaloids, triterpenoids, tannins and flavonoids. (Srinivasa et al., 1999, Suganthy, 2000, Sundararajan and Ananthakrishnan, 2002) were used ethanol as a solvent for the extraction of different secondary metabolites of plants. Since the polarity of ethanol is higher, most of the secondary metabolits of P. murex dissolved in ethanol. Saponins and their derivatives inhibit the larval growth and development (Suresh et al., 2002). Furthermore tannine combine with protein inhibite the enzyme activity and reduce the availability of protein in haemolymph insect (Chan et al., 1982). Insecticidal activity of P. murex might be due to the presence of saponins and tannins present in this extract. HPLC analyses revealed that P. murex ethanol extract consists of three major compounds such as phenol, 2-(5,6-dimethyl pyrazinyl) methyl (Molecular weight 214); O-Terphenyl-13C (Molecular weight 230) and 3,3A,4,9B-Tetrahydro-2H-Furo(3,2-C)(1)Benzopyran (Molecular weight 206). More studies are essential to test these compounds either individually or in combination and recommend them for industrial usage.

Median lethal concentration

LC₅₀ values of S. litura with P. murex treated castor leaves are presented in Table 1. It showed that S. litura with higher concentration of P. murex (above 0.4%) died at the early period of the treatment. But those animals,
Table 1. Impact of *Pedaliun murex* root ethanol extract on the LC$_{50}$ regression equation, variance, chi-square, lower (LFL) and upper fiducial limit (UFL) on *S. litura* third, fourth and fifth instar larvae of *Spodoptera litura*.

<table>
<thead>
<tr>
<th>Duration (in Hrs.)</th>
<th>Life stages</th>
<th>Regression equation</th>
<th>LC$_{50}$ Variance</th>
<th>Chi-square</th>
<th>LFL</th>
<th>UFL</th>
</tr>
</thead>
<tbody>
<tr>
<td>72</td>
<td>Third instar</td>
<td>$Y = 1.339x + 5.51$</td>
<td>0.042</td>
<td>0.0975</td>
<td>1.14</td>
<td>0.032</td>
</tr>
<tr>
<td></td>
<td>Fourth instar</td>
<td>$Y = 1.216x + 4.13$</td>
<td>0.052</td>
<td>0.1145</td>
<td>0.62</td>
<td>0.041</td>
</tr>
<tr>
<td></td>
<td>Fifth instar</td>
<td>$Y = 0.877x + 4.69$</td>
<td>0.244</td>
<td>0.0336</td>
<td>1.32</td>
<td>0.103</td>
</tr>
<tr>
<td>96</td>
<td>Third instar</td>
<td>$Y = 1.578x + 5.0$</td>
<td>0.100</td>
<td>0.031</td>
<td>0.61</td>
<td>0.021</td>
</tr>
<tr>
<td></td>
<td>Fourth instar</td>
<td>$Y = 2.336x + 4.83$</td>
<td>0.118</td>
<td>0.019</td>
<td>2.08</td>
<td>0.003</td>
</tr>
<tr>
<td></td>
<td>Fifth instar</td>
<td>$Y = 0.937x + 4.61$</td>
<td>0.258</td>
<td>0.027</td>
<td>0.75</td>
<td>0.011</td>
</tr>
</tbody>
</table>

which fed with lesser concentration (below 0.2%), failed to complete the moulting and died either in the larvae or in pupae. Those fed with least concentration (0.1%) were transformed into normal adults. But some of the larvae were failed to normal growth and development. Because, haemolymph was expelled out from the *S. litura* larvae and they died after two to four hours of haemolymph expulsion. From the result it was very clear that LC$_{50}$ value was life stage dependent factor. For instance LC$_{50}$ value for third instar *S. litura* was 0.100% and it gradually increased when the pest grew older (0.118 and 0.258% for fourth and fifth instars respectively).

*Antifeedant activity by energetics*

Food consumption was higher in control and lower in *P. murex* treated castor leaves fed *S. litura* larvae. As observed for the food consumption, the growth rate was also higher in control as well as in third instars. It was gradually decrease when *S. litura* grew older. Among all the categories the growth rate was very minimum at 0.8% *P. murex* root ethanol extract. From the result it is very clear that the nutritional requirements of *S. litura* differs when it was provided with either neemgold treated castor leaves or *P. murex* treated leaves. Irrespective of the life stages, food consumption index was higher in control followed by neemgold and *P. murex* (Table 2). It was higher in third instar and gradually decreased when the pest grew older. As observed for third instar the approximate digestability was also higher in third instar.
followed by fourth and fifth instar. This parameter is an indirect indication of the amount of food converted into body biomass. Food on which insect’s greater body weight is always classified as better source of energy (Ananthakrishnan, 1992). According to this hypothesis our study also revealed that \textit{S. litura} fed \textit{P. murex} was highly reduce the body weight. The comparison between ECI of control and \textit{P. murex} were statistically significant at 5% level in all the life stages of \textit{S. litura}. Earlier (Waldbaur, 1968) reported ECI values rise and fall with AD. It could be conducted that \textit{P. murex} treated food was quickly converted to body substance in response to the various bioactive components of \textit{P. murex} to \textit{S. litura}. In insects that develop eggs following adult ec dysone, vitellogenesis is often triggered in response to food intake. In response dietary cues, vitellogenesis is synthesized by fat body, transported in haemolymph, endocytosed by the ovarian follicle and incorporated as yolk protein (vitellin) in to developing oocytes. We have hypothesized not initial magnitude of synthetic response to diet is determined by dietary quality. Control treatment reaches higher ECD values as comparatively to neem biopesticide and \textit{P. murex} ethanol extract. This study clearly revealed that \textit{P. murex} highly reduces the food consumption index, approximate digestability, growth rate, efficiency of conversion of ingested food and efficiency of conversion of digested food. Hence \textit{P. murex} root extract can be explored in \textit{S. litura} management.

\textbf{Table 2.} Impact of \textit{Pedalium murex} root ethanol extract on food consumption index (FCI), growth rate (GR) and approximate digestability (AD) (mg dry weight/day), efficiency of conversion of ingested food (ECI) and efficiency of conversion of digested food (ECD) (%) on third, fourth and fourth instar larvae of \textit{Spodoptera litura}.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>FCI</th>
<th>GR</th>
<th>AD</th>
<th>EC</th>
<th>ECD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Third Instar</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>\textit{P. murex}</td>
<td>23.18 ± 6.85</td>
<td>19.36 ± 2.85</td>
<td>1.05 ± 0.02</td>
<td>3.56 ± 0.62</td>
<td>3.35 ± 0.94</td>
</tr>
<tr>
<td>Neemgolad</td>
<td>31.10 ± 10.85</td>
<td>25.12 ± 3.83</td>
<td>1.2 ± 0.26</td>
<td>4.49 ± 0.34</td>
<td>6.46 ± 1.19</td>
</tr>
<tr>
<td>Control</td>
<td>47.08 ± 12.86</td>
<td>31.2 ± 6.22</td>
<td>15.5 ± 0.60</td>
<td>6.41 ± 0.39</td>
<td>7.33 ± 0.94</td>
</tr>
<tr>
<td></td>
<td>Fourth Instar</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>\textit{P. murex}</td>
<td>19.68 ± 7.58</td>
<td>18.20 ± 1.90</td>
<td>29.95 ± 2.09</td>
<td>11.30 ± 4.01</td>
<td>10.55 ± 4.04</td>
</tr>
<tr>
<td>Neemgolad</td>
<td>31.82 ± 8.15</td>
<td>14.3 ± 0.76</td>
<td>38.2 ± 4.23</td>
<td>10.86 ± 4.58</td>
<td>15.68 ± 5.48</td>
</tr>
<tr>
<td>Control</td>
<td>37.50 ± 10.82</td>
<td>17.05 ± 1.91</td>
<td>41.0 ± 3.74</td>
<td>19.43 ± 6.05</td>
<td>22.77 ± 6.32</td>
</tr>
<tr>
<td></td>
<td>Fifth Instar</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>\textit{P. murex}</td>
<td>8.69 ± 0.76</td>
<td>9.79 ± 1.21</td>
<td>6.02 ± 10.34</td>
<td>9.17 ± 2.97</td>
<td>8.74 ± 4.89</td>
</tr>
<tr>
<td>Neemgolad</td>
<td>10.39 ± 0.37</td>
<td>11.16 ± 27.27</td>
<td>10.5 ± 7.82</td>
<td>7.72 ± 1.93</td>
<td>15.68 ± 4.69</td>
</tr>
<tr>
<td>Control</td>
<td>11.21 ± 0.67</td>
<td>12.46 ± 16.45</td>
<td>11.82 ± 8.42</td>
<td>19.28 ± 3.75</td>
<td>22.79 ± 6.82</td>
</tr>
</tbody>
</table>
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References


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