Feeding inhibitory activity of different medicinal plant oils against *Papilio demoleus* L

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Abstract

The study was carried out to evaluate feeding inhibitory activity of plant oils viz., Lemon grass-Chirharit, Lemon grass-Krishana, Jatropha, Citronella grass, Eucalyptus, Nilgiri, Lippia, Lemon tulsi, Levender, Fennel, Mint, Palmrosa, *Geranium* sp. (at 1% and 2% conc.) against 5d and 10d old larvae of *Papilio demoleus*. The data showed varying degree of antifeedant activities of plant oils against *P. demoleus*. At 1% conc. Maximum antifeedant activity was exhibited by Lemon grass-Chirharit (94.34%) followed by Lemon grass-Krishana (78.11%). At 2% conc. similar trend was examined and Lemon grass-Chirharit revealed maximum antifeedant activity. Out of the twelve medicinal plant oils tested at 1 and 2% conc. against 10d old larvae of *P. demoleus*, all the plant oils significantly lowered the feeding. However a non-significant reduction in feeding was observed with *Geranium* (6.7 and 4.25 cm²) at 1 and 2% conc., respectively.

Keywords: Feeding inhibitory activity, Plant oils, *Papilio demoleus*

1. Introduction

The lemon butterfly, *Papilio demoleus* is an economically imperative pest where larval forms cause severe injure to citrus family in the field by consuming huge quantity of foliage during later stages of their growth. This insect is regarded as the most vital leaf feeding insect in India [1]. The caterpillars defoliate citrus trees and are very damaging to plants in the seed beds and nurseries. The larvae have preference young plants of 1-2 feet high and are proficient of completely defoliating nursery groves [2-5]. Dispersal capability and ability for rapid population growth make *P. demoleus* a potentially severe pest.

So, suitable management of this pest could play considerable economic impact on production and profitability of the citrus crop. Besides the use of new insecticides, there is a need of holistic approach towards insect pest management which includes the use of botanicals such as plant products and plant essential oils to combat residue and resistance problem. In recent years, great importance has been given on the use of natural products, which are non-toxic, safe, low cost and biodegradable alternative to the conventional control of insects by synthetic pesticides. Earlier studies have indicated that antifeedant compounds derived from seeds, flowers, fruits, leaves and roots of the plants could be used as effective bio-compounds against the growth and metamorphosis of the noxious insects. There is a vital need for the development of safer substitute crop protectants such as botanical insecticides and antifeedants. Plants are rich source of natural essences that can be employed in the enlargement of environmentally safe methods for insect control [6]. Nowadays the application of synthetic pesticides due to their high effectiveness and speedy action has become popular. Besides, these pesticides have some harmful effects and source of ecological damage and health hazards. For that reason, a study was performed with the aim of managing *P. demoleus* population at Pantnagar, through eco-friendly approaches.

Materials and Methods

Studies on the feeding inhibitory activity of different medicinal plant oils against *P. demoleus* L. was carried out in the department of Entomology, G.B. Pant University, Pantnagar during the year 2015-16. A citrus nursery consisting of cultivar Pant lemon-1 was maintained at Horticulture Research Centre, Patharchatta for collecting the culture of *P. demoleus*.
**Culture of lemon butterfly, *Papilio spp.***  
Eggs and larvae were collected from the citrus and bell nurseries. Eggs were kept in petri plates (diameter 9 cm) for hatching and larvae were transferred separately to petri plates (dia. 9 cm) and fed on fresh citrus leaves. The pupa from these petri plates were collected placed in separate jars and covered with muslin cloth to get the adults of lemon butterfly. The male and female butterfly collected from jars were separated and transferred to other glass jars and covered with muslin cloth. The adults of lemon butterfly were supplied with cotton soaked in glucose solution in petri plates. Tender twigs of citrus in a small beaker having water was placed inside the glass jar to get the eggs from these adults. The eggs were kept in petri dishes. In order to provide proper humidity, a lining of wet filter paper was kept at the bottom. The neonate larvae were transferred to big petri dishes containing fresh and soft lemon leaves with the help of fine brush. The nursery was maintained under irrigated conditions in order to obtain faster and luxuriant growth of foliage. Fresh food was supplied daily and proper hygienic conditions were maintained. Second instar larvae of desired age groups were supplied daily and proper hygienic conditions were maintained. The male and female butterfly collected from jars were sorted out and divided into two groups; experimental/test and control. The larvae were used for conducting the various experiments.

Feeding inhibitory activity of some plant oils was studied against 5d and 10d old larvae of *P. demoleus*, under laboratory conditions using no-choice feeding bioassay method. Two concentrations (1% and 2%) of each of the plant oils were prepared in acetone. Fresh leaf discs of (size: 3 x 3 cm²) were cut from the leaves of citrus, dipped in the oils were prepared in acetone. Fresh food was supplied daily and proper hygienic conditions were maintained. Second instar larvae of desired age groups were sorted out and divided into two groups; experimental/test and control larvae. The larvae were used for conducting the various experiments.

Control leaf discs were treated with acetone only [7]. The experimental plant oils were assigned categories as under [13].

### Antifeedant activity (A.A.)

\[
A. A. = \text{Leaf protection in treated disc (\%)} - \text{leaf protection in control disc (\%)} \times 100
\]

100- Leaf protection in control disc (\%)

**Results**

**Antifeedant activity of different medicinal plant oils against 5d old larvae of *P. demoleus***

**Mean leaf area consumed (MLAC)**

The analyzed data was presented in table 1. It is evident from the table 1 that all the treatments caused significant reduction in feeding over control. Minimum feeding was observed in *C. flexuosus* (Lemon grass-Chirharit) (0.50 cm²) at 1% followed by *C. flexuosus*-Krishna (1.95 cm²), *O. tenuiflorum* (2.00), *J. curcus* (2.30), *C. martini* (2.50 cm²), *M. arvensis* (2.53 cm²), *C. nardus* (2.90), *L. angustifolia* (3.00 cm²), *L. alba* (3.50 cm²), *E. citriodora* (3.75 cm²), *F. vulgare* (4.50 cm²). At 1% maximum feeding was observed in *Geranium* (6.10 cm²). At 2% all the plant oils significantly reduced the feeding in the following order *C. flexuosus*-Chirharit (0.10 cm²) < *C. flexuosus*-Krishna (0.30 cm²) < *J. curcus* (0.40 cm²) < *M. arvensis* (0.50 cm²) < *O. tenuiflorum* (0.70 cm²) < *L. angustifolia* (0.80 cm²) < *C. nardus* (1.00 cm²) < *L. alba* (1.25 cm²) = *C. martini* (1.25 cm²) = *E. citriodora* (1.50 cm²) = *F. vulgare* (1.50 cm²) < *Geranium* (4.75 cm²).

**Antifeedant activity**

The data showed varying degree of antifeedant activities of plant oils against 5d old larvae of *P. demoleus*. At 1% conc. maximum antifeedant activity was exhibited by *C. flexuosus*-Chirharit (94.34 %) followed by *C. flexuosus*-Krishna (78.11 %) > *O. tenuiflorum* (77.55 %) > *J. curcus* (74.18 %) > *C.
Preference index
At 1 and 2% concentrations C. flexuosus- Chirharit proved to be extremely antifeedant with C-value of 0.17 and 0.12 (range: 0.1 – 0.25). C. flexuosus- Krishna and J. curcus proved to be strongly antifeedant and extremely antifeedant with C-value of 0.39 and 0.44 at 1%; 0.14 and 0.16 at 2% respectively. Geranium at 1% fall under slightly antifeedant category with C-value of 0.86 (range: 0.76-0.99) and at 2% fall under slightly antifeedant category with C-value of 0.74 (range: 0.51-0.75). Whereas C. nardus, L. angustifolia, L. alba, E. citriodora, F. vulgare at 1% showed moderately antifeedant activity with C-value of 0.53, 0.54, 0.60, 0.63 and 0.72 respectively (range: 0.51-0.75). At 2% conc. C. nardus, L. alba, E. citriodora and F. vulgare proved to be strongly antifeedant with C-value of 0.24, 0.30, 0.35 and 0.31 respectively (range: 0.25-0.50). The data exposed that among the tested plant oils C. flexuosus- Chirharit, C. flexuosus- Krishna and J. curcus showed preference index of less than 0.25 and were considered acquiring antifeedant activity.

Antifeedant activity of different medicinal plant oils against 10d old larvae of P. demoleus
Mean leaf area consumed (MLAC)
From the analyzed data presented in table 2 indicated that out of the twelve medicinal plant oils tested at 1 and 2% concentrations against 10d old larvae of P. demoleus. All the plant oils significantly lowered the feeding. However minimum reduction in feeding was observed with Geranium (6.7 and 4.25 cm²) at 1% and 2% concentrations respectively. All the plants tested were effective in causing significant reduction in feeding over control (MLAC=8.25cm²) at p<0.05. However at 1% minimum feeding was observed in M. arvensis (2.0 cm²) followed by C. flexuosus- Chirharit (2.09 cm²), L. alba (2.50 cm²), J. curcus (2.80 cm²), O. tenuiflorum (2.80 cm²), C. martini (3.0 cm²), C. flexuosus- Krishna (3.10 cm²), C. nardus (3.80 cm²), E. citriodora (4.00 cm²), L. angustifolia (4.20 cm²), F. vulgare (5.25 cm²) and Geranium (6.7 cm²). While at 2% conc. minimum feeding was observed with C. flexuosus- Chirharit (0.50 cm²) and J. curcus (0.50 cm²).

Anti-feedant activity
The data showed varying degree of antifeedant activities of plant oils against 10d old larvae of P. demoleus. At 1% concentration Maximum antifeedant activity was exhibited by M. arvensis (77.60%) followed by C. flexuosus- Chirharit (76.59%) and least antifeedant activity was found in Geranium (16.59%). At 2% concentration maximum antifeedant activity was showed by C. flexuosus- Chirharit and J. curcus (94.40%) followed by C. flexuosus- Krishna (91.60%), O. tenuiflorum (89.36%), C. nardus (85.44%), L. alba (83.20), M. arvensis (80.40%), E. citriodora (79.84%), L. angustifolia (77.60 %), F. vulgare (67.55 %) and least was observed in Geranium (52.41%).

Feeding inhibition
In the present investigation all the plant oils exhibited feeding inhibitory activity and their activity increased with increase in conc. Geranium at 1% and 2% caused minimum feeding inhibition with 13.47 and 25.49 %. C. flexuosus-Chirharit showed maximum feeding inhibitory activity with 67.96 and 97.53 at 1% and 2% conc. followed by C. flexuosus-Krishna (60.80 and 92.77%) at 1% and 2% respectively. These plant oils with significant antifeedant and feeding inhibition activity can be integrated in management programme of this pest at higher conc.
Table 1: Effect of plant oils on feeding behaviour of 5d old larvae of *P. demoleus*

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Plant species Scientific name (Common name)</th>
<th>MLAC (cm²)</th>
<th>Antifeedant activity (%)</th>
<th>Feeding inhibition (%)</th>
<th>Preference index (C- value)</th>
<th>Antifeedant category</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cymbopogon flexuosus Stapf. (Lemon grass-Chirharit)</td>
<td>0.50±0.05&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.10±0.26&lt;sup&gt;b&lt;/sup&gt;</td>
<td>94.34±0.02&lt;sup&gt;c&lt;/sup&gt;</td>
<td>98.78±0.01&lt;sup&gt;c&lt;/sup&gt;</td>
<td>67.96±0.01&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>2</td>
<td>Cymbopogon flexuosus Stapf. (Lemon grass-Krishana)</td>
<td>1.95±0.01&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.30±0.50&lt;sup&gt;c&lt;/sup&gt;</td>
<td>78.11±0.05&lt;sup&gt;d&lt;/sup&gt;</td>
<td>93.26±0.01&lt;sup&gt;e&lt;/sup&gt;</td>
<td>60.80±0.01&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td>3</td>
<td>Jatropha curcas L. (Jatropha)</td>
<td>2.30±0.05&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.40±0.50&lt;sup&gt;c&lt;/sup&gt;</td>
<td>74.18±0.01&lt;sup&gt;e&lt;/sup&gt;</td>
<td>92.14±0.02&lt;sup&gt;d&lt;/sup&gt;</td>
<td>55.33±0.17&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td>4</td>
<td>Cymbopogon nardus L.(Citronella grass, Ganjiri)</td>
<td>2.90±0.05&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1.10±0.50&lt;sup&gt;c&lt;/sup&gt;</td>
<td>67.44±0.02&lt;sup&gt;e&lt;/sup&gt;</td>
<td>87.65±0.01&lt;sup&gt;c&lt;/sup&gt;</td>
<td>46.78±0.01&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>5</td>
<td>Eucalyptus citriodora Hook. (Eucalyptus,Nilgiri)</td>
<td>3.75±0.02&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1.50±0.50&lt;sup&gt;c&lt;/sup&gt;</td>
<td>57.90±0.02&lt;sup&gt;c&lt;/sup&gt;</td>
<td>83.16±0.00&lt;sup&gt;c&lt;/sup&gt;</td>
<td>44.68±0.11&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>6</td>
<td>Lippia alba L.(Lippia)</td>
<td>3.50±0.28&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1.25±0.74&lt;sup&gt;c&lt;/sup&gt;</td>
<td>60.71±0.00&lt;sup&gt;c&lt;/sup&gt;</td>
<td>73.89±0.05&lt;sup&gt;c&lt;/sup&gt;</td>
<td>39.13±0.05&lt;sup&gt;c&lt;/sup&gt;</td>
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<tr>
<td>7</td>
<td>Ocimum tenuiflorum L. (Lemon tuli, Tului)</td>
<td>2.00±0.28&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.70±0.28&lt;sup&gt;c&lt;/sup&gt;</td>
<td>77.55±0.05&lt;sup&gt;c&lt;/sup&gt;</td>
<td>92.14±0.01&lt;sup&gt;e&lt;/sup&gt;</td>
<td>60.2±0.08&lt;sup&gt;c&lt;/sup&gt;</td>
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<tr>
<td>8</td>
<td>Lavandula angustifolia L. (Levender)</td>
<td>3.00±0.28&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.80±0.14&lt;sup&gt;c&lt;/sup&gt;</td>
<td>66.32±0.02&lt;sup&gt;c&lt;/sup&gt;</td>
<td>91.02±0.01&lt;sup&gt;c&lt;/sup&gt;</td>
<td>36.3±0.05&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>9</td>
<td>Foeniculum vulgare Mill. (Fenekel)</td>
<td>4.50±0.28&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1.50±0.14&lt;sup&gt;c&lt;/sup&gt;</td>
<td>49.49±0.00&lt;sup&gt;c&lt;/sup&gt;</td>
<td>83.16±0.00&lt;sup&gt;c&lt;/sup&gt;</td>
<td>28.00±0.57&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>10</td>
<td>Mentha arvensis L. (Mint)</td>
<td>2.53±0.01&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.50±0.28&lt;sup&gt;c&lt;/sup&gt;</td>
<td>71.60±0.05&lt;sup&gt;c&lt;/sup&gt;</td>
<td>94.34±0.05&lt;sup&gt;c&lt;/sup&gt;</td>
<td>51.94±0.05&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>11</td>
<td>C. martinii (Roxb.) Wats. (Palmosra)</td>
<td>2.50±0.28&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1.25±0.05&lt;sup&gt;c&lt;/sup&gt;</td>
<td>71.94±0.02&lt;sup&gt;c&lt;/sup&gt;</td>
<td>73.39±0.02&lt;sup&gt;c&lt;/sup&gt;</td>
<td>52.38±0.05&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>12</td>
<td>Geranium sp. L.(Crannesbills)</td>
<td>6.10±0.05&lt;sup&gt;c&lt;/sup&gt;</td>
<td>4.75±0.11&lt;sup&gt;c&lt;/sup&gt;</td>
<td>31.53±0.00&lt;sup&gt;c&lt;/sup&gt;</td>
<td>46.68±0.05&lt;sup&gt;c&lt;/sup&gt;</td>
<td>13.47±0.01&lt;sup&gt;c&lt;/sup&gt;</td>
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</tbody>
</table>

Means followed by common letters do not differ significantly by DMRT (p=0.05%), Mean±SE (Standard Error) MLAC = Mean leaf area consumed, EA – Extremely antifeedant, SA = Strongly antifeedant, MA = Moderately antifeedant, P = Preferred, following [12]

Table 2: Effect of plant oils on feeding behaviour of 10d old larvae of *P. demoleus*
Discussion
Not as much of work is done on management of *P. demoleus* by using essential oils, therefore more plant oils should be screened to measure the efficiency against *P. demoleus*. The antifeedant and growth inhibitory effects of the essential oil of *Lippia alba* were evaluated against *S. obliqua*, *S. litura* and *Heliotrois armigera* (*Helicoverpa armigera*). The essential oil, which was found to be rich in linalool, exhibited feeding deterrence (FD%) of 6.9, 10.3 and 11.0 mg/g diet and growth inhibition (GI%) of 4.2, 7.8 and 9.0 mg/g diet against *S. obliqua*, *S. litura* and *H. armigera*, respectively [19]. The study exposed by Basera, 2009 [16] to find out antifeedant activity of nine plant oils (1 and 2% concentration in acetone) viz., Azadirachta indica, Eucalyptus citridora, Cinnamomum camphora, Ricinus communis, Cymbopogon winterianus, Pongamia pinnata, Cymbopogon flexuosus and Curcuma longa. *Jatropa curcas* against 9d old larvae of *S. litura* using ‘no-choice’ bioassay method showed similar findings with our study that all the plant oils taken in the investigation significantly deterred feeding at both of the concentrations (1.0% and 2.0%).

Similar results were obtained by [19] who conducted an experiment to find out antifeedant activity of seven plant oils (1% and 2% concentration in acetone) viz., Cymbopogon winterianus Bio 13; *C. flexuosus*-Krishna; *C. flexuosus*-Chirharit, Ocimum tenuiflora, Vetiveria zizanioides, Eucalyptus citridora and Pogostemon patchouli - Indonesia against 9d old larvae of *S. litura* revealed that, all plant oils except, *P. patchouli* - Indonesia and *E. citridora* at 1 and 2% concentration showed promising results in terms of lowering the larval feeding.

The antifeeding effects of *Melia azedarach*, Colocynthis citrullis, Nicotiana tabacum and Eucalyptus camaldulensis, Azadirachta indica against Tribolium castaneum, Ryzopertha dominica, and Trogoderma granarium under laboratory conditions was studied by [20]. All treatments illustrated the major feeding anticipation activities. The most efficient essential oil not in favour of all insect pests was found in *A. indica*, with utmost reduction in weight loss (0.56, 1.02, 1.69%) and feeding deterrent index (75.44, 54.57 and 39.21%) against *T. castaneum*, *T. granarium* and *R. dominica*, respectively followed by *M. azedarach* (0.63, 1.05 and 1.76%) (67.59, 50.85 and 34.92%), *C. citrullis* (0.65, 1.17 and 1.76%) (65.35, 43.57 and 33.94%), *N. tabacum* (0.7, 1.22 and 1.84) (58.43, 38.87 and 30.28%) and *E. camaldulensis* (0.84, 1.32 and 1.97%) (45.11, 38.98 and 23.18), respectively.

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References