Investigated Repellency Effect of Some Essential Oils of 17 Native Medicinal Plants on Adults *Plodia interpunctella*

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**ABSTRACT**

Volatile oils are some secondary metabolites of plants for defending against insects and other herbivores. Some of them are very repellent for insects. Behavioral responses of adults *Plodia interpunctella* was investigated to 17 native medicinal plants of Iran with a Y tube olfactometer (RZR model). Plants were collected from Markazi province of Iran. Volatile oils extracted by hydrodistillation from 17 plant species growing in Iran, included as: *Achillea wilhelmsii*, *Achillea millefolium*, *Artemisia dracunculus*, *Salvia multisacalis*, *Thymus vulgaris*, *Ziziphorah cinopodioides*, *Rosmarinus officinalis*, *Lavandula angustifolia*, *Mentha piperata*, *Hyoscyamus officinalis*, *Salvia officinalis*, *Anethum graveolens*, *Foeniculum vulgare*, *Carum carvi*, *Petroselinum sativum*, *Artemisia absinthum* and *Melissa officinalis*. Adults of *P. interpunctella* were less than one-day old. In each experiment 50 adults individually were placed in olfactometer. In one arm was placed two grams food without essential oil and in another arm food plus 2 micro liters essential oil and week air flowed from end of each arm that was filtered with active charcoal. If insect entered 5 centimeters to tube it was selected choice for insect. For determining significance of data, we used $\chi^2$ test. The results showed all essential oils had significance repellency effect and moths had different responses for each essential oil. The strongest repellency showed in *Anethum graveolens* (100%), *Thymus vulgaris* (100%) and *Rosmarinus officinalis* (93.33%) and the weakest repellency in *Hyoscyamus officinalis* (7.69%) and *Petroselinum sativum* (9.48%). These results showed that medicinal plants could use as a repellent against *P. interpunctella*.

**Key words:**

**Introduction**

The Indian meal moth, *Plodia interpunctella* (Hu¨bner), is a major economic insect pest of stored products (Rees, 2004). The moth prefers to feed on broken grains and more especially on milled cereal products such as flour, breakfast foods, stored cereal products, dried vegetables, dried fruits and almonds, pistachios and walnuts, groundnuts, raisins and prunes, processed foods and meals. It is cosmopolitan and is found in warehouses and storage bins throughout the world (Veena et al. 2005). The continuing loss of chemical insecticides through regulatory action, new laws and interpretations of those laws, economic costs of pesticide regulations, and consumer preferences and expectations, have important consequences for the management of *P. interpunctella* and other stored-product insects (Arthur, 1996). The impending loss of the fumigant methyl bromide through compliance with the Montreal Protocol (Anonymous, 2004) will undoubtedly further affect management programs for *P. interpunctella*, accelerating the demand for new control strategies (Phillips et al., 2000). Many of the commonly used synthetic chemical fumigants are associated with health and environmental risks, and many insects have developed resistance to them (Zettler, 1982). There is therefore the need to develop safer alternatives to conventional fumigants.

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Several natural products, including principals from many species of spices, herbs and medicinal plants, are known to have a range of useful biological properties against insects (Tripathi et al., 1999). Their essential oils appear to be the most toxic (Shaaya et al., 1991). The essential oils are considered a powerful source of natural derivatives useful as an insecticide and repellent against stored product pests (Lee et al., 2001).

Few reports describe the contact and fumigant toxicity of essential oils or their major components against eggs of stored product insects (Obeng-Ofori and Reichmuth, 1997 and Huang et al., 1997; Tripathi et al., 2000). Essential oils have a low toxicity to warm-blooded animals, high volatility, and toxicity to stored-grain insect pests (Keita, et al., 2000, 2001; Tripathi et al., 2002). Plant essential oils are obtained through steam distillation of herbs and medicinal plants. These oils have been used traditionally as medicines in many countries, and ancient peoples were also aware of their pesticidal properties; however, only in recent years have these oils been commercialized as pest control products (Isman 2000).

In recent years, essential oils have received much attention as potentially useful bioactive compounds against insects. Essential oils from plants like Myrtus communis, Origanum syriacum, Laventula stoechos and pure compounds like thymol, carvacrol and α-pinene have been documented for larvicidal activities towards Culex pipens molestus (Traboulsi et al., 2002).

Most of these oils are environmentally non-persistent and non-toxic to humans (with some exceptions), while being effective against several pest species. In the present study, we investigated repellency effect of essential oils of 17 medicinal plants against adults of P. interpunctella.

Material and methods

Plant material and extraction of essential oils

Plant materials were collected from Markazi province of Iran, from Agricultural Research Center. The collected plants were included of: Achillea wilhelmsii (leaf), Achillea millefolium (leaf), Artemisia dracunculus (leaf), Salvia multiaculis (leaf), Thymus vulgaris (leaf), Ziziphus clinopodioides (leaf), Rosmarinus officinalis (leaf), Lavandula angustifolia (leaf), Mentha piperata (leaf), Hyossopus officinalis (leaf), Salvia officinalis (leaf), Anethum graveolens (seed), Foeniculum vulgare (seed), Carum carvi (seed), Petroselinum sativum (seed), Artemisia absinthium and Melissa officinalis (leaf). Plant materials were dried in dark and then cut in pieces and hydrodistilled. This extraction of essential oils was carried out by a Cleveenger type apparatus for 4 h hydrodistillation.

Insect rearing

Plodia interpunctella was reared at 28±1 °C with photoperiod 13h dark and 11h light and 60±5% relative humidity. Larvae were reared in an artificial diet containing of: wheat bran (800 g), brewers yeast (160 g), pure honey (200 ml), glycerin (200 ml), methyl paraben (1 g) and chloramphenicol 1 g. Adults entered to plastic funnel that covered with a net cloth for gathering eggs.

Repellency assay

In this study, a Y tube glass olfactometer model RZR (Rafiee et al, 2008) was used to test repellency of medicinal plant essential oils (figure 1). For studying repellency effect, we introduced one new emergence female of P. interpunctella to main branch of olfactometer. In one arm was settled 2 µl essential oil plus 2 g of food, in another arm only 2 g of food. The repellency was assessed 30 min after introduction of adult insect to olfactometer. For each essential oil have been tested 50 individual of moth. For preventing pseudoreplication insects were settled in olfactometer individually. All data analyzed as nonparametric data via X² test. Before that all data has been weight cases. Data analyzed by SPSS 15. Percentage of repellency achieved from this formula (%R) = 2 (X - 50), X is percentage of insects in control tube.

Results and discussion

The results showed all essential oils had significance repellency effect and moths had different responses for each essential oil. The Strongest repellency was exhibited in Anethum graveolens (100%), Rosmarinus officinalis (100%) and Thymus vulgaris (93.33%) and the weakest repellency effect has been shown in Hyossopus officinalis (7.69%) and Petroselinum sativum (9.48%) repellency, respectively (Table 1). The others had repellency effect between 32% to 88%.
Fig. 1: olfactometer RZR for studying

Table 1: \( \chi^2 \) test of repellency effect of essential oils on adults of *P. interpunctella*

<table>
<thead>
<tr>
<th>plant</th>
<th>control</th>
<th>treatment</th>
<th>% Repellency</th>
<th>( \chi^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Achillea millefolium</td>
<td>33</td>
<td>17</td>
<td>32</td>
<td>5.12*</td>
</tr>
<tr>
<td>Artemisia dracunculus</td>
<td>35</td>
<td>15</td>
<td>40</td>
<td>8**</td>
</tr>
<tr>
<td>Thymus vulgaris</td>
<td>48</td>
<td>2</td>
<td>93.33</td>
<td>42.33**</td>
</tr>
<tr>
<td>Lavandula angustifolia</td>
<td>40</td>
<td>10</td>
<td>62</td>
<td>38**</td>
</tr>
<tr>
<td>Hyoscyamus officinalis</td>
<td>27</td>
<td>23</td>
<td>7.69</td>
<td>32&quot;</td>
</tr>
<tr>
<td>Salvia officinalis</td>
<td>33</td>
<td>17</td>
<td>32</td>
<td>5.12*</td>
</tr>
<tr>
<td>Achillea wilhelmsii</td>
<td>40</td>
<td>10</td>
<td>60</td>
<td>18**</td>
</tr>
<tr>
<td>Ziziphora clinopodioides</td>
<td>42</td>
<td>8</td>
<td>68</td>
<td>23.12**</td>
</tr>
<tr>
<td>Salvia multicaulis</td>
<td>45</td>
<td>5</td>
<td>80</td>
<td>32**</td>
</tr>
<tr>
<td>Mentha piperata</td>
<td>39</td>
<td>11</td>
<td>36</td>
<td>15.68**</td>
</tr>
<tr>
<td>Melissa officinalis</td>
<td>35</td>
<td>15</td>
<td>40</td>
<td>8**</td>
</tr>
<tr>
<td>Petroselinum sativum</td>
<td>27</td>
<td>23</td>
<td>9.48</td>
<td>0.32&quot;</td>
</tr>
<tr>
<td>Foeniculum vulgare</td>
<td>33</td>
<td>17</td>
<td>32</td>
<td>5.12&quot;</td>
</tr>
<tr>
<td>Carum carvi</td>
<td>47</td>
<td>3</td>
<td>88</td>
<td>38.72**</td>
</tr>
<tr>
<td>Artemisia absinthum</td>
<td>41</td>
<td>9</td>
<td>64</td>
<td>20.48&quot;</td>
</tr>
<tr>
<td>Anethum graveolens</td>
<td>100</td>
<td>0</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Rosmarinus officinalis</td>
<td>100</td>
<td>0</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

** There is significant difference at 1%
* There is significant difference at 5%
ns there is no significant difference at 1%

The results of goodness of fit test \( \chi^2 \) showed that there is significant differences at 1% level between essential oils of Achillea wilhelmsii, Ziziphora clinopodioides, Artemisia dracunculus, Thymus vulgaris, Salvia multicaulis, Mentha piperata, Lavandula angustifolia, Melissa officinalis, Artemisia absinthum and Carum carvi with control. For Achillea millefolium, Salvia officinalis and Foeniculum vulgare significant difference observed at 5%. There is no significant repellency for Hyoscyamus officinalis, Petroselinum sativum had no significant difference. We could not calculate \( \chi^2 \) for Rosmarinus officinalis and Anethum graveolens because of 100% repellency.

These results showed that medicinal plants could use as repellent of *P. interpunctella*, especially Anethum graveolens, Thymus vulgaris and Rosmarinus officinalis. These essential oils can use for protecting stored products from injury of Indian meal moth. They have good potential to replace with chemical repellents for this pest and they are safe for human and had no residue on stored products.

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References


