RESEARCH ARTICLE

BIO-EFFICACY OF CERTAIN INDIGENOUS PLANTS EXTRACTS AGAINST A STORAGE PEST TRIBOLIUM CASTANEUM HERBST (COLEOPTERA; TENEBRIONIDAE)

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ARTICLE INFO

ABSTRACT

In continuation of our work on indigenous plants we have taken in to consideration the search for plants with potential insect pest management. Ethanol extracts of five species of certain indigenous plants screened for their insecticidal activity against the storage pest Tribolium castaneum which are known to cause maximum damage in pulses and wheat flour in storage. The tests were carried out using filter paper impregnation method at concentration levels range between 25µg-200µg/ml crude ethanol extracts. Among the plants tested Ocimum sanctum plant was showed more insecticidal activity than other plants.

Key words:
Insecticidal activity, ethanol, Ocimum sanctum, Tribolium castaneum.

INTRODUCTION

The red flour beetle, Tribolium castaneum (Herbst) (Coleoptera: Tenebrionidae) the most important insect pest of stored-products such as cereals, cereal products, cocoa beans, dried cassava tubers, flour mills, grocery shops, and warehouses (Rees, 2004; Garcia et al., 2005). T. castaneum is regarded as a secondary coloniser because it develops more easily on broken grain kernels, flour grain already infested by primary colonisers (Vayias et al., 2010). Adults and larvae of both species are serious economic pests that cause quantitative and qualitative losses in tropical and sub tropical regions (Rees, 2004). Cereals constitute the most important component in the diet of the majority of the people in the tropics and are usually stored to provide food and feed reserves as well ased for planting (Obeng-Ofori and Reichmuth, 1997). Early attempts to control stored-product pests relied on methods such as: (i) mixing dry soil and wood ash with the grains to cause lethal dehydration of insects, and (ii) fumigating with plant-derived fumigants (Levinson and Levinson, 1998). Over the past few decades, synthetic, broad-spectrum pesticides and fumigants such as methyl bromide and phosphine have been frequently used to control stored-product pest species. However, because of the increasing problems associated with the use of toxic synthetic pesticides, such as loss of efficacy, development of pest resistance, regulatory restrictions as a result of adverse effects on non-target organisms, human and eco-toxicity (Daglish, 2004; Lorini et al., 2007; Sousa et al., 2009), financial and technical limitations at the time of need (Umoetok et al., 2009), there has been a pressing need for the development of safer, alternative crop protect ants such as botanical insecticides, repellents and antifeedants (Isman, 2006; Rajendran and Srinanjini, 2008; Ukeh et al., 2010). Plant secondary compounds have been the subject of investigation for the past 20 years in an effort to discover new sources of botanical insecticides, repellents and antifeedants (Akhtar and Isman, 2004). Generally, botanical insecticides are less toxic to humans and the environment than conventional insecticides. Many botanical insecticides degrade rapidly and do not accumulate in the environment while some are very pest specific and do little or no harm to non-target organisms (Isman, 2006; Rozman et al., 2007). Essential oils of botanical origin and their major components, often various monoterpenoids have attracted attention in recent years as potential pest control agents due to their insecticidal, repellentand/or antifeedant properties (Stamopoulos, 1991; Shaaya et al., 1997). Essential oils are composed of complex mixtures of monoterpenes (10 carbon atoms often arranged in a ring or cyclic form), biogenetically related phenols, and sesquiterpenes (comprising 15carbons) obtained from various parts of plants. As by-products of plant metabolism, essential oils are sometimes referred to as volatile plant secondary...
metabolites. Bioactivity of essential oils is related to their chemical composition, part of the plant extracted, phonomological state of the plant, environmental conditions and the method of extraction (Isman, 2000; Angioni et al., 2006; Zapata and Smagghe, 2010; Nerio et al., 2010). The present study was undertaken to investigate the insecticidal activity of five indigenous plants against the selected pest species under laboratory condition.

MATERIALS AND METHODS

Collection and extraction of plant material

Fresh leaves of the selected plants (Table 1) were collected in and around Bommidy Village, Dharmapuri District, Tamil Nadu and India. Then the plant materials were thoroughly washed to remove particles and shade dried at room temperature (27±2°C; R.H. 75±5%). After shade drying, the leaves were powdered by using mechanical grinder. 100 grams of the dry powder were extracted in 100 ml of hexane, ethyl acetate and ethanol. After 48 hrs the crude extracts were individually filtered using Whatmann No.1 filter paper in 500 ml pre-sterilized amber bottle using a rotary vacuum evaporator and then they were condensed to powder form by placing them in desiccators crude extract has stored in refrigerator for further studies. The extracts obtained were dissolved in the corresponding pure solvent for further experimentations.

Table 1. Indigenous plant materials

<table>
<thead>
<tr>
<th>Plant</th>
<th>Family</th>
<th>Part used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiospermum halicacabum</td>
<td>Sapindaceae</td>
<td>Leaves</td>
</tr>
<tr>
<td>Coriandrum sativum</td>
<td>Apiaceae</td>
<td>Leaves</td>
</tr>
<tr>
<td>Menthe longifolia</td>
<td>Lamiaceae</td>
<td>Leaves</td>
</tr>
<tr>
<td>Ocimum sanctum</td>
<td>Lamiaceae</td>
<td>Leaves</td>
</tr>
<tr>
<td>Ponagmia glabra</td>
<td>Lamiaceae</td>
<td>Leaves</td>
</tr>
</tbody>
</table>

Collection of test organism

Stored product pests, T. castaneum was procured from the local market and godowns from the infested black gram and have been continuously cultured on the same food source. The stock culture was maintained in the laboratory in the dark at 20±2°C and around Bommidi Village, Dharmapuri District, Tamil Nadu, India. A second experiment was designed to assess 50% and 95% lethal doses. A series of dilutions was prepared to evaluate mortality of insects after an initial dose-setting experiment. Ten adult insects were put into 44 ml Plexiglas bottles with screw lids. Different plant extract amounts tested on T. castaneum were 25, 50, 100 and 200µg/ml respectively. Control insects were kept under the same conditions without any extract and each dose was replicated five times. The number of dead and alive insects in each bottle was counted 24 h after initial exposure. The mortality was evaluated by direct observation of the insects every hour till total mortality. Probit analysis (Finney, 1971) was used to estimate LC50 and LC90 values.

RESULTS AND DISCUSSION

Insecticidal activity of C. halicacabum Ethanol extract against the adult insect of T. castaneum is represented in (Table 2). It is noteworthy to note that as the concentration increased the insect mortality is also increased. The maximum insecticidal activity was recorded from the highest concentration i.e., 100 µg/ml and the lowest insecticidal activity were recorded from the 25 concentration of C. halicacabum ethanol extract tested against T. castaneum. Furthermore, the insect mortality of 25, 50, 75 and 100 µg/ml respectively. In nut shell, the experimental insect subjected to 100 µg/ml concentrations were found more susceptible to the extracts tested since the lethality of the insect were found to be maximum among the test concentrations. Insecticidal activity of C. sativum against the adult insect of T. castaneum is represented in Table 3.

It is noteworthy to note that as the concentration increased the insect mortality is also increased. The maximum insecticidal activity was recorded from the highest concentration i.e., 100 µg/ml and the lowest insecticidal activity were recorded from the 25 concentration of C. sativum ethanol extract tested against T. castaneum. Furthermore, the insect mortality of 25, 50, 75 and 100 µg/ml respectively. These results obtained from the experimental have been proved significant statistically and they are all on par with the control groups. The LC50 of C. halicacabum was derived to be 64.90µg/ml with LCL of 43.49 and UCL of 73.33 µg/ml. Similarly the LC90 was found to be 125.73 µg/ml with LCL of 93.84 and UCL of 146.32µg/ml against T. castaneum. In nut shell, the experimental insect subjected to 100 µg/ml concentrations were found more susceptible to the extracts tested since the lethality of the insect were found to be maximum among the test concentrations. Insecticidal activity of C. sativum against the adult insect of T. castaneum is represented in Table 4. It is noteworthy to note that as the concentration increased the insect mortality is also increased. The maximum insecticidal activity was recorded from the highest concentration i.e., 100µg/ml and the lowest insecticidal activity were recorded from the 25 µg/ml concentration of M. longifolia ethanol extract tested against T. castaneum.
Furthermore, the insect mortality of 29.44±6.89, 55.64±5.44, 82.64±9.77 and 98.12±5.40 were observed from the 25, 50, 75 and 100 µg/ml respectively. These results obtained from the experimental have been proved significant statistically and they are all on par with the control groups. The LC₅₀ of M. longifolia was derived to be 49.87 µg/ml with LCL of 34.26 and UCL of 75.53 µg/ml. Similarly the LC₉₀ was found to be 111.94 µg/ml with LCL of 88.84 and UCL of 158.93 µg/ml against T. castaneum. In nut shell, the experimental insect subjected to 100 µg/ml concentrations were found more susceptible to the extracts tested since the lethality of the insect were found to be maximum among the test concentrations. Insecticidal activity of O. sanctum against the adult insect of T. castaneum is represented in table 5. It is noteworthy to note that as the concentration increased the insect mortality is also increased. The maximum insecticidal activity was recorded from the highest concentration i.e., 100 µg/ml and the lowest insecticidal activity were recorded from the 25 concentration O. sanctum ethanol extract tested against T. castaneum. Furthermore, the insect mortality of 26.22±4.22, 53.47±6.44, 79.36±7.40 and 96.90±6.15 were observed from the 25, 50, 75 and 100 µg/ml respectively.

Furthermore, the mortality of the insect observed after 24h of exposure period (Abbott, 1925). LC₅₀=Lethal Concentration brings out 50% mortality and LC₉₀ = Lethal Concentration brings out 90% mortality. LCL = Lower Confidence Limit; UCL = Upper Confidence Limit; Values in a column with a different superscript alphabet are significantly different at 95% Fiducial Limit (MANOVA; LSD Tukey's Test).

These results obtained from the experimental have been proved significant statistically and they are all on par with the control groups. The LC₅₀ of O. sanctum was derived to be 49.73 µg/ml with LCL of 43.88 and UCL of 72.37 µg/ml. Similarly the LC₉₀ was found to be 134.75 µg/ml with LCL of 107.41 and UCL of 174.14 µg/ml against T. castaneum. In nut shell, the experimental insect subjected to 100 µg/ml concentrations were found more susceptible to the extracts tested since the lethality of the insect were found to be maximum among the test concentrations. Insecticidal activity of P. glabra against the adult insect of T. castaneum is represented in table 6. It is noteworthy to note that as the concentration increased the insect mortality is also increased. The maximum insecticidal activity was recorded from the highest concentration i.e., 100 µg/ml and the lowest insecticidal activity were recorded from the 25 concentration P. glabra ethanol extract tested against T. castaneum. Furthermore, the insect mortality of 27.63±2.21, 57.47±3.32, 85.23±4.21 and 96.32±3.22 were observed from the 25, 50, 75 and 100 µg/ml respectively. These results obtained from the experimental have been proved significant statistically and they are all on par with the control groups. The LC₅₀ of P. glabra was derived

### Table 2. Insecticidal activity of Cardiospernum halicacabum against the adult Tribolium castaneum

<table>
<thead>
<tr>
<th>Concentration (µg/ml)</th>
<th>%Mortality</th>
<th>LC₅₀ µg/ml</th>
<th>95% Fiducial Limit</th>
<th>LC₉₀ µg/ml</th>
<th>95% Fiducial Limit</th>
<th>Slope</th>
<th>Regression</th>
<th>χ²</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>25.70±2.92</td>
<td>64.90</td>
<td>43.49</td>
<td>73.33</td>
<td>125.73</td>
<td>3.</td>
<td>y = 3.490x + 0.712</td>
<td>15.972</td>
</tr>
<tr>
<td>50</td>
<td>45.30±4.13</td>
<td>98.12</td>
<td>82.64</td>
<td>107.41</td>
<td>174.14</td>
<td>3.52710</td>
<td>y = 3.148x + 0.217</td>
<td>13.201</td>
</tr>
<tr>
<td>75</td>
<td>78.10±5.56</td>
<td>98.12</td>
<td>82.64</td>
<td>107.41</td>
<td>174.14</td>
<td>3.52710</td>
<td>y = 3.148x + 0.217</td>
<td>13.201</td>
</tr>
<tr>
<td>100</td>
<td>93.09±5.14</td>
<td>93.09</td>
<td>82.64</td>
<td>107.41</td>
<td>174.14</td>
<td>3.52710</td>
<td>y = 3.148x + 0.217</td>
<td>13.201</td>
</tr>
</tbody>
</table>

### Table 3. Insecticidal activity of ethanol extracts of Coriandrum sativum against the adult Tribolium castaneum

<table>
<thead>
<tr>
<th>Concentration (µg/ml)</th>
<th>%Mortality</th>
<th>LC₅₀ µg/ml</th>
<th>95% Fiducial Limit</th>
<th>LC₉₀ µg/ml</th>
<th>95% Fiducial Limit</th>
<th>Slope</th>
<th>Regression</th>
<th>χ²</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>25.47±2.64</td>
<td>52.76</td>
<td>43.24</td>
<td>69.18</td>
<td>122.27</td>
<td>3.25710</td>
<td>y = 4.101x + 1.494</td>
<td>14.427</td>
</tr>
<tr>
<td>50</td>
<td>42.64±10.8</td>
<td>98.12</td>
<td>82.64</td>
<td>107.41</td>
<td>174.14</td>
<td>3.52710</td>
<td>y = 3.148x + 0.217</td>
<td>13.201</td>
</tr>
<tr>
<td>75</td>
<td>55.64±5.44</td>
<td>98.12</td>
<td>82.64</td>
<td>107.41</td>
<td>174.14</td>
<td>3.52710</td>
<td>y = 3.148x + 0.217</td>
<td>13.201</td>
</tr>
<tr>
<td>100</td>
<td>89.00±0.34</td>
<td>93.09</td>
<td>82.64</td>
<td>107.41</td>
<td>174.14</td>
<td>3.52710</td>
<td>y = 3.148x + 0.217</td>
<td>13.201</td>
</tr>
</tbody>
</table>

### Table 4. Insecticidal activity of ethanol extracts of Mentha longifolia against the adult Tribolium castaneum

<table>
<thead>
<tr>
<th>Concentration (µg/ml)</th>
<th>%Mortality</th>
<th>LC₅₀ µg/ml</th>
<th>95% Fiducial Limit</th>
<th>LC₉₀ µg/ml</th>
<th>95% Fiducial Limit</th>
<th>Slope</th>
<th>Regression</th>
<th>χ²</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>29.44±6.89</td>
<td>49.87</td>
<td>34.26</td>
<td>75.53</td>
<td>111.94</td>
<td>3.75497</td>
<td>y = 4.101x + 1.494</td>
<td>14.427</td>
</tr>
<tr>
<td>50</td>
<td>55.64±5.44</td>
<td>98.12</td>
<td>82.64</td>
<td>107.41</td>
<td>174.14</td>
<td>3.52710</td>
<td>y = 3.148x + 0.217</td>
<td>13.201</td>
</tr>
<tr>
<td>75</td>
<td>82.64±9.77</td>
<td>93.09</td>
<td>82.64</td>
<td>107.41</td>
<td>174.14</td>
<td>3.52710</td>
<td>y = 3.148x + 0.217</td>
<td>13.201</td>
</tr>
<tr>
<td>100</td>
<td>98.12±5.40</td>
<td>93.09</td>
<td>82.64</td>
<td>107.41</td>
<td>174.14</td>
<td>3.52710</td>
<td>y = 3.148x + 0.217</td>
<td>13.201</td>
</tr>
</tbody>
</table>

### Table 5. Insecticidal activity of ethanol extracts of Ocimum sanctum against the adult Tribolium castaneum

<table>
<thead>
<tr>
<th>Concentration (µg/ml)</th>
<th>%Mortality</th>
<th>LC₅₀ µg/ml</th>
<th>95% Fiducial Limit</th>
<th>LC₉₀ µg/ml</th>
<th>95% Fiducial Limit</th>
<th>Slope</th>
<th>Regression</th>
<th>χ²</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>26.22±4.22</td>
<td>49.73</td>
<td>34.88</td>
<td>72.37</td>
<td>134.75</td>
<td>3.11494</td>
<td>y = 0.297x + 5.196</td>
<td>12.225</td>
</tr>
<tr>
<td>50</td>
<td>53.47±6.44</td>
<td>98.12</td>
<td>82.64</td>
<td>107.41</td>
<td>174.14</td>
<td>3.11494</td>
<td>y = 0.297x + 5.196</td>
<td>12.225</td>
</tr>
<tr>
<td>75</td>
<td>79.36±7.40</td>
<td>98.12</td>
<td>82.64</td>
<td>107.41</td>
<td>174.14</td>
<td>3.11494</td>
<td>y = 0.297x + 5.196</td>
<td>12.225</td>
</tr>
<tr>
<td>100</td>
<td>96.90±6.15</td>
<td>98.12</td>
<td>82.64</td>
<td>107.41</td>
<td>174.14</td>
<td>3.11494</td>
<td>y = 0.297x + 5.196</td>
<td>12.225</td>
</tr>
</tbody>
</table>

Value represents mean ± S.D.of five replications. *Mortality of the insect observed after 24h of exposure period (Abbott, 1925). LC₅₀=Lethal Concentration brings out 50% mortality and LC₉₀ = Lethal Concentration brings out 90% mortality. LCL = Lower Confidence Limit; UCL = Upper Confidence Limit; Values in a column with a different superscript alphabet are significantly different at P<0.05 (MANOVA; LSD Tukey’s Test).
to be 49.23 µg/ml with LCL of 34.49 and UCL of 67.16 µg/ml. Similarly the LC$_{90}$ was found to be 117.36 µg/ml with LCL of 126.01 and UCL of 123.55 µg/ml against T. castaneum. In nut shell, the experimental insect subjected to 100 µg/ml concentrations were found more susceptible to the extracts tested since the lethality of the insect were found to be maximum among the test concentrations. The increasing number of investigations on plant-insect chemical interactions (Prakash and Rao 2000) in the last decades unveiled the potential of utilize secondary plant metabolites or allelochemicals, as pest control agents. In our results insecticidal activity of plant essential oils extracts were tested against T. castaneum. The percentage mortality was maximum in ocimum sanctum. Generally, plant compounds that act as insecticidal agent could also act as semi chemicals that alter the behaviour of the insect via the factory sensilla of the antennae. This is because, at the time of experimentation, we found that the live insect species are avoided to contact with the treated food sources. Insect repellents work by providing a vapour barrier deterring the arthropod from coming in to contact with the stimulus or surface (Nerio et al., 2010). Our results indicate that the major component of the promising plant crude extract conferring insecticidal activity against T. castaneum.

**REFERENCE**


of the Standard Reference Data Base, National Institute of Standards and Technology, Gaithersburg, Maryland.


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