A comparative study of repellent effects of dichloromethane extracts of *Lantana camara* L. and *Calotropis procera* Ait. on *Tribolium castaneum* (Herbst) (Coleoptera : Tenebrionidae)

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Abstract

Dichloromethane extract from *Lantana camara* L. and *Calotropis procera* Ait. were evaluated for their repellent effect on a stored grain pest, *Tribolium castaneum* (Herbst). Both plant extracts exhibited a significant repellency. The results indicated that *Lantana camara* showed 60% repellency against *Tribolium castaneum* as compared to *Calotropis procera* which showed 72% repellency during an exposure time of 24 hours at 8mg/ml concentration.

Keywords: Repellency, botanical pesticides, *Lantana camara*, *Calotropis procera*, *Tribolium castaneum*.

1. Introduction

The red flour beetle, *Tribolium castaneum* (Herbst) (Coleoptera : Tenebrionidae) is one of the common pests found in indoor food storage facilities (Liu and Ho, 1999). Infestations cause significant losses due to the consumption of grains and they also result in elevated temperature and moisture conditions which lead to an accelerated growth of molds, including toxigenic species (Magan et al., 2003). They infest stored products with their larva layers and excrements and consequently lower the quality of stored products greatly. Adult insects and larva also feed on broken up grains (Bagheri and Zenouz, 1995). Control of *T. castaneum* populations is primarily dependent on repeated applications of conventional insecticides or fumigants (Zettler and Arthur, 2000; Rajendran and Sriranjini, 2008). Although effective, their repeated use fosters serious environmental and human health concerns (Isman, 2006, 2008). These problems have highlighted the need for development of selective stored product beetle-control alternatives. Thus, products based on plant extracts, phyto-oils and purified substances of plant origin can be an alternative to the conventional pesticides (Isman, 1999). Botanical pesticides being compounds of natural origin, no problems with persistence in the environment are anticipated (Gebbinck et al., 2002). Finding safer alternatives to synthetic insecticides to protect stored grains and grain products from insect infestations is highly desirable.

Recently, attention has been given to the possible use of plant products or plant derived compounds as promising alternatives to synthetic insecticides in controlling insect pests of stored products (Jahan et al., 1989; Mondal et al., 1989; Khalequzzaman & Islam, 1992; Senguttuvan et al., 1995; Liu & Ho, 1999; Ohazurike et al., 2003; Umoetok & Gerard, 2003). Joseph et al., (1994) and Haque et al., (2000) had studied the growth inhibitory effects of some commercially available plant extracts on the red flour beetle, *Tribolium castaneum*. Plant extracts have been explored to study their insecticidal properties against stored grain pests (Malik and Naqvi, 1984; Su, 1990; Dunkel and Sears, 1998; Wongo, 1998). Essential oils of many common spices have been evaluated for their repellent and insecticidal effects on several insects (Tripathi et al., 2000; Isman et al., 2000) with promising results.

In the present study, dichloromethane extracts of *Lantana camara* and *Calotropis procera* were
evaluated for their repellent effect on a stored grain pest, *Tribolium castaneum*. *Lantana camara* is an evergreen hairy shrub growing up as an ornamental hedge, widely found in tropics and sub-tropics and coastal locations of Asia. *Calotropis procera* is a wild shrub found throughout the tropics of Asia and Africa and is used in many traditional systems of medicine.

2. Methodology

2.1 Insect rearing

Red rust flour beetle, *Tribolium castaneum* were used to examine the repellent effects of the plant extracts. Adults were taken from insect culture maintained at 28±2º C, 75% RH and a photoperiod of 12:12 (L : D) conditions. These were reared on wheat flour.

2.2 Plant materials

Leaves were collected, washed and dried in shade for 3-5 days depending on the weather conditions and dried in an oven at 40ºC for 24 hours. Dried leaves were powdered in a mixer-grinder and extraction was carried out with Dichloromethane in a Soxhlet apparatus. The extract was collected and the solvent was air-dried. Then it was sealed with Aluminium foil and stored at 4ºC for use in the experiment.

2.3 Method

Test solutions were prepared by dissolving different concentrations (1, 2, 4 and 8mg) of extract in 1ml acetone. The repellency test was performed as described by Mc Donald *et al.*, 1970. Test areas consisted of 9cm. Whatman no.1 filter papers that were cut in two parts. In first part, 1ml of four different concentrations viz. 1, 2, 4 and 8mg/ml of extracts were applied as uniformly as possible with a micropipette. The other part was taken as control and was treated with 1ml acetone only. Both the treated and control parts were air-dried to evaporate the solvent completely. A full disc (filter paper) was carefully remade by attaching the treated part to the control part with cello tape. Each filter paper was placed in a petridish and 10 adult insects were released in the centre of each filter paper disc and covered in such a way that the insects could not escape. Each treatment was replicated 5 times. The numbers of insects present on control (NC) and treated (NT) strips were recorded after 1, 2, 3, 4, 12 and 24 hours. Percent repellency (PR) values for test was calculated as, 

\[
PR = \frac{NC-NT}{NC+NT} \times 100
\]

(Obeng-Ofori and Reichmuth, 1997).

Statistical difference and significance was calculated.

3. Results and discussion

In the present study, it was observed that plant extracts of *Lantana camara* and *Calotropis procera* repelled adults of *Tribolium castaneum*. Repellency activities were observed to be dependent on the concentration of extracts and duration of exposure. Significant repellent effect was observed for *Lantana camara* during the first hour of exposure when 1mg/ml was applied (Table 1, Graph 1). However, no significant repellency was recorded for *Calotropis procera* during the first two hours of application at concentrations of 1 and 2 mg/ml on adults of *Tribolium castaneum*. (Table 2, Graph 2).

### Table -1 : Repellency of *Lantana camara* against *Tribolium castaneum*.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>NC</th>
<th>NT</th>
<th>NC</th>
<th>NT</th>
<th>NC</th>
<th>NT</th>
<th>NC</th>
<th>NT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hour</td>
<td>1mg/ml</td>
<td>2mg/ml</td>
<td>4mg.ml</td>
<td>8mg/ml</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>6.0±0.71</td>
<td>4.0±0.71*</td>
<td>6.6±0.55</td>
<td>3.4±0.55*</td>
<td>6.6±0.55</td>
<td>3.4±0.55*</td>
<td>6.8±0.45</td>
<td>3.2±0.45**</td>
</tr>
<tr>
<td>2</td>
<td>6.4±0.55</td>
<td>3.6±0.55*</td>
<td>6.6±0.55</td>
<td>3.4±0.55*</td>
<td>6.8±0.84</td>
<td>3.2±0.84*</td>
<td>7.2±0.84</td>
<td>2.8±0.84*</td>
</tr>
<tr>
<td>3</td>
<td>6.6±0.55</td>
<td>3.4±0.55*</td>
<td>6.8±0.45</td>
<td>3.2±0.45**</td>
<td>6.8±0.45</td>
<td>3.2±0.45**</td>
<td>7.2±0.84</td>
<td>2.8±0.84*</td>
</tr>
<tr>
<td>4</td>
<td>6.6±0.55</td>
<td>3.4±0.55*</td>
<td>6.8±0.45</td>
<td>3.2±0.45**</td>
<td>7.0±0.71</td>
<td>3.0±0.71*</td>
<td>7.4±0.55</td>
<td>2.6±0.55**</td>
</tr>
<tr>
<td>12</td>
<td>6.8±0.45</td>
<td>3.2±0.45**</td>
<td>7.2±0.45</td>
<td>2.8±0.45**</td>
<td>7.4±0.55</td>
<td>2.6±0.55**</td>
<td>7.6±0.55</td>
<td>2.4±0.55**</td>
</tr>
<tr>
<td>24</td>
<td>7.0±1.0</td>
<td>3.0±1.0*</td>
<td>7.6±0.55</td>
<td>2.4±0.55**</td>
<td>7.8±0.84</td>
<td>2.2±0.84**</td>
<td>8.0±0.71</td>
<td>2.0±0.71**</td>
</tr>
</tbody>
</table>

(Figures represent the mean of individual 5 sets ± S.D. *, significant; **, highly significant at p<0.05 level)
A high significant repellency at 5% level was recorded for *Lantana camara* after exposure time of 12 hours for a concentration of 1mg/ml while similar result for *Calotropis procera* was observed at a higher concentration of 4mg/ml after a longer exposure time of 24 hours. However, when 8mg/ml concentration was used for the exposure time of 1-24 hours, *Calotropis procera* was found to be more effective, exhibiting higher repellency compared to *Lantana camara* for the same concentration and exposure time. 72% repellency was observed when adults of *Tribolium castaneum* were exposed to 8mg/ml of *Calotropis procera* extract for an exposure duration of 24 hours while only 60% repellency was observed when adults of *Tribolium castaneum* were exposed to *L. camara* extract for same concentration and exposure duration. *L. camara* was found to exhibit repellent effect from the first hour of application at the lowest dose but the overall repellency was found to be more in case of *C. procera* for exposure duration of 24 hours, when applied at a concentration of 8mg/ml.

Table 2: Repellency of *Calotropis procera* against *Tribolium castaneum*.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>NC 1mg/ml</th>
<th>NT 1mg/ml</th>
<th>NC 2mg/ml</th>
<th>NT 2mg/ml</th>
<th>NC 4mg/ml</th>
<th>NT 4mg/ml</th>
<th>NC 8mg/ml</th>
<th>NT 8mg/ml</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hour</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>12</td>
<td>24</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>5.2±0.84</td>
<td>5.2±0.84</td>
<td>5.4±0.89</td>
<td>5.4±0.89</td>
<td>5.6±0.55</td>
<td>6.0±0.71</td>
<td>6.6±0.55</td>
<td>3.4±0.55</td>
</tr>
<tr>
<td></td>
<td>4.8±0.84α</td>
<td>4.8±0.84α</td>
<td>4.6±0.89α</td>
<td>4.6±0.89α</td>
<td>4.4±0.55*</td>
<td>4.0±0.71*</td>
<td>3.4±0.55*</td>
<td>3.4±0.55*</td>
</tr>
<tr>
<td></td>
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<td>4.2±0.84*</td>
<td>3.6±0.55*</td>
<td>3.6±0.55*</td>
<td>4.4±0.55*</td>
<td>3.8±0.45*</td>
<td>2.6±0.55*</td>
<td>2.6±0.55*</td>
</tr>
<tr>
<td></td>
<td>7.0±0.71</td>
<td>7.3±0.71*</td>
<td>3.0±0.55</td>
<td>3.8±0.45*</td>
<td>7.4±0.55</td>
<td>7.4±0.55</td>
<td>8.6±0.55</td>
<td>8.6±0.55</td>
</tr>
<tr>
<td></td>
<td>3.0±0.71*</td>
<td>2.8±0.84*</td>
<td>1.8±0.45**</td>
<td>1.8±0.45**</td>
<td>1.6±0.55**</td>
<td>1.4±0.55**</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Figures represent the mean of individual 5 sets ± S.D. α, non significant; *, significant; **, highly significant at p<0.05 level)
4. Conclusion

Earlier studies have shown that plants like Annona squamosa, Lantana camara, Clerodendrum inerme, Cassia fistula, Azadirachta indica and Calotropis procera were found to be lethal to various stored grain pests and delayed their developmental stages by interfering with their apolytic and molting processes (Tewari & Singh, 1978; Dwivedi & Garg, 2003; Deka & Singh, 2005). Oil of L. camara revealed insecticidal activity against 3rd instar larvae of Musca domestica (Abdel-Hady et al., 2005) and the adults of Sitophilus zeamais (Bouda et al., 2001). Leaf powders of Annona squamosa and Balanites aegyptica caused high mortality in T. castaneum and provided protection against seed damage (Sule & Ahmed, 2009). Essential oils from mentha, carvacryl, citronella and eucalyptus have shown good repellent effects against A. albopictus (Yang and Ma, 2005), while Artemisia princeps and Cinnamomum camphora oils have shown repellent and insecticidal activity against S. oryzae and Bruchus rufimanus Bohemann (Liu et al., 2006). Volatile oils isolated from leaves and flowers of Lantana camara, Callistemon lanceolatus, Cymbopogon winterianus, Eucalyptus sp., Nerium oleander, Ocimum basilicum, Ocimum sanctum and Vitex negundo (Sharma et al., 2001), S. hortensis, Thymus serphyllum and Origanum sp. (Isman et al., 2000) have shown insecticidal, antifeedant and growth inhibitory activities against insect pests. This study also shows similar results. Thus, botanical extracts may be used for treatment of food commodities as these have the least chance of residual toxicity thereby ushering in an era of health and environment friendly pesticides.

References


Yang, P., Ma, Y., 2005 : Repellent effect of plant essential oils against *Aedes albopictus*. Journal of Vector Ecology, 30 (2) : 231-234