DEVELOPMENT OF ESSENTIAL OIL BASED FUMIGANT SYSTEM TO CONTROL COWPEA BRUCHID *Callosobruchus maculatus* (F.) IN STORED COWPEA

by

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Thesis submitted to the Faculty of Graduate Studies, University of Kelaniya,
Kelaniya, Sri Lanka for the degree of Master of Philosophy in Chemistry

December 2003

ABSTRACT

Contact and fumigant toxicity of the essential oils of *Cymbopogon citratus, Murraya koenigii, Cinnamomum zeylanicum* and leaf volatiles of *Azadirachta indica* were evaluated against adult *Callosobruchus maculatus* (F.). Among these plant, *A. indica* leaf volatiles did not show any appreciable levels of toxicity on adult *C. maculatus.* Investigations were carried out on the effect of the (1:1 v/v) mixtures of the essential oils of *C. citratus*: *C. zeylanicum*, *C. citratus*: *M. koenigii* and *C. zeylanicum*: *M. koenigii* on eggs, larvae and adult *C. maculatus*. The olfactory responses of adult *C. maculatus* against the test volatiles were evaluated using Electroantennogram (EAG) and GC-EAG responses. Behavioral bioassays were conducted to confirm the repellent effects of test compounds. The non-volatile fractions of the leaves of *C. citratus*, *M. koenigii* and *C. zeylanicum* were extracted into methanol and dichloromethane separately and the toxicity effects of these extracts against adult *C. maculatus* were tested using residual film and treated seeds bioassays. Kaolin pellets treated with volatile oils were used to test the effect of test oils on *C. maculatus* in storage condition.

Kaolin pellets treated with test oils were also used to test the effect of these compounds on cowpea storage conditions. The essential oil of *C. citratus*, showed the highest effect when used as contact toxicant as well as fumigant toxicant on adult *C. maculatus* indicating lowest LC_{50} values of 0.066 g/m^2 and 0.202 g/l respectively. *Cinnamomum zeylanicum* and *M. koenigii* essential oils were moderately toxic whereas leaf volatiles of *A. indica* showed the lowest toxicity on adult insects (LC_{50} values for contact

3.119 g/m^2 and fumigant 8.401 g/l toxicity). The toxicity effects of the essential oils of *C. citratus, M. koenigii, C. zeylanicum* on eggs and larvae were parallel to the effect of these volatiles on adult *C. maculatus*. However, the results revealed that the effects on eggs were higher than the effect on larvae.

According to the EAG studies, the highest olfactory responses of adult male and female *C. maculatus* were observed for 0.30 mg of *C. zeylanicum* leaf volatiles (1.233 ± 0.095 & 1.733 ± 0.170 mV respectively). The lowest olfactory responses were indicated against *M. koenigii* and *A. indica* volatiles, whereas the essential oils of *C. citratus* exhibited moderate olfactory response. *Cymbopogon citratus* and *C. zeylanicum* indicated significantly higher ($p < 0.05$) repellent activity in both olfactometer and choice chamber bioassays than *M. koenigii* and *A. indica*. These observations confirm the olfactory activity observed in EAG studies. Although the GC-EAD was carried out to identify the bioactive constituents of the compound, no EAD responses were observed for individual compounds separated from the GC columns.

The essential oil mixtures of *C. citratus* and *C. zeylanicum* (1: 1 v/v) gave the highest contact and fumigant effect on adult *C. maculatus* with the LC_{50} values of 0.132 g/m^2 and 1.016 g/l respectively. *Callosobruchus maculatus* eggs were more susceptible to all 3 oils combinations than larvae when used as fumigant or contact toxicant. With increasing concentrations of oil combinations, fumigant and contact effects also increased in all combinations. However, the contact effect of the oil on both eggs and larvae were higher than that of the fumigant effects.

Non-volatile fractions of dichloromethane (CH_2Cl_2) and methanol (MeOH) extracted from *C. zeylanicum* and *C. citratus* leaf indicated the highest toxicity on adult *C. maculatus* in residual film bioassay. Dichloromethane extracts of *C. zeylanicum* (LC_{50} 0.568 % w/w) and the MeOH extract of *C. citratus* (LC_{50} 1.350 % w/w) gave the lowest LC_{50} values in treated seeds bioassay.

Based on the LC_{50} values obtained, essential oils of *C. citratus* and *C. zeylanicum* and 1:1 v/v mixture of *C. citratus* and *C. zeylanicum* were selected for the field trials. Percentage seed damage and 100-seed weight loss were higher in *C. zeylanicum* oil treatment than the other two oil treatments after 168 days of storage period in woven polypropylene bags. Stored seeds were highly protected from *C. maculatus* infestation throughout the test period when treated with *C. citratus* essential oils and the activity of the oil mixture was moderate. The results indicated that the oil treatments did not influence the seed viability. According to the data obtained by the taste panel, the consumer acceptability of *C. citratus* treated cowpea seeds was higher than that of the other two treatments.

Further studies should be conducted to investigate the toxicological effect of these compounds on mammals and to develop techniques to identify bioactive constituents of the leaf extracts.