EFFECT OF SELECTED ESSENTIAL OILS ON PHYSICOCHEMICAL CHANGES OF STORED COWPEA, *VIGNA UNGUICULATA*, TREATED TO CONTROL COWPEA BRUCHID, *CALLOSOBRUCHUS MACULATUS* (F.)

Gayan R. S. Rubasinghege [1], Krishanthi Abeywickrama [2] and Priyani Paranagama [1*]

[1]Department of Chemistry, University of Kelaniya, Kelaniya, Sri Lanka,

[2]Department of Botany, University of Kelaniya, Kelaniya, Sri Lanka. e-mail: priyani@kln.ac.lk[1*], kris@kln.ac.lk[2] & gayan@kln.ac.lk[1]

INTRODUCTION

Cowpea has been one of the most ancient and important food legumes in Africa, Asia and Mediterranean countries for more than 3500 years. It is a rich source of carbohydrate, protein, dietary fiber, calories and minerals (Bliss, 1972). It is a heat-loving, drought-tolerant crop with lower soil fertility requirements. In Sri Lanka, the annual production of cowpea in the year 2004 was 12,000 metric tons cultivated in 3813 hectares. Constant consumption of this seasonal crop increases the importance of a proper storage system. Clay pots, poly sacks, jute bags, "Goni Bissa" etc. are used to store cowpea in Sri Lanka (Karunasena, 2001). Nearly 15% of the total production in Sri Lanka is lost annually due to post harvest handling and infestation during storage. *Callosobruchus maculatus* is the most common storage pest encountered in the cowpea storage (Hill, 1992). The current pest control recommendation method in Sri Lanka is the use of pirimiphos methyl, which has given rise to many well-known and serious problems, including genetic resistance of pest species, toxic residue in stored products, increasing costs of application, hazards from handling etc. Volatile substances of essential oils from cinnamon leaf (*Cinnamomum zeylanicum*), citronella (*Cymbopogon nardus*), lemongrass (*Cymbopogon citratus*) and wild sprang (*Micromelum minutum*) have indicated high fumigant toxic effect on *C. maculates* (Adhikari, 2002 & Gunasekera, 2003). The physicochemical changes that occur during storage of cowpea, after treating with essential oils as a bioinsecticide against *C. maculatus*, have not been investigated. The overall objective of the current study was to perform a comparative study on physicochemical changes of cowpea stored in aluminium lined bags, after treating with essential oils of *C. citratus, C. nardus, C. zeylanicum* and *M. minutum* as fumigant toxicants against *Callosobruchus maculatus* (F.).

METHODS AND MATERIALS

Materials: *C. citratus, C. nardus* and *C. zeylanicum* leaf oils were purchased from EOAS Organic (Pvt.) Ltd., Rathmalana, and Industrial Technology Institute, Colombo, Sri Lanka. *M. minutum* leaf oil was extracted using steam distillation at the Department of Chemistry, University of Kelaniya. All chemicals used in the analysis were of analytical grade purchased from BDH and Fluka Chemicals Co. Ltd.

Treatment of essential oil as a fumigant toxicant: The required doses of essential oils and pirimiphos methyl (Table 1) were separately impregnated into cylindrical "kaolin" pellets (0.5 cm diameter, 1 cm height) and introduced into aluminium-lined bags (0.05 mm thickness) containing 500 g of recently harvested cowpea seeds.

Table 1. Doses of essential oils and pirimiphos methyl for storage systems

Treatment system	Required oil weight for 100% mortality of *C. maculatus* [a] (g / Kg of seeds)
C. citratus	2.04
C. nardus	2.02
M. minutum	2.02
C. zeylanicum	2.50
Pirimiphos methyl	6.50×10^{-9}
Control	0.0

a - According to values reported by Adhikari *et al.*, 2002; Gunasekara, 2003; Karunasena, 2001)

Analysis of stored cowpea

Appearance, seed density, moisture & Ash content, crude protein & total fat, total dietary fiber and mineral contents were determined according to the methods described in AOAC, 2000, Narayan *et al.*, 1987 & Pearson, 1996.

Statistical Analysis: Data obtained for three replicates from five storage systems and fresh sample were statistically analyzed by one-way ANOVA using Minitab Statistical Package (Minitab Inc., State College, PA, USA). Mean separation was by Tukey's multiple range comparison tests.

RESULTS AND DISCUSSION

Effects of storage on Physical properties: The colour of the stored cowpea seeds remained unchanged in all treated systems. The characteristic odor of the essential oil was found in the treated sample, due to absorption of essential oil. The order was insignificant to alter the taste or the acceptability of cowpea seeds. In the control, the seeds were damaged, with characteristic emergence holes of *C. maculatus* larvae. The percentage of the damaged seeds was 8±1%.

There was no significant difference in seed density and swelling capacity in essential oil and pirimiphos methyl-treated cowpea samples. When the density of stored cowpea seeds was compared with that of fresh sample, there was a loss in the density of stored seeds. During storage period, the volume of the seed remained unchanged while the weight decreased. This may be due to the hydrolyse effect on the contents of the seed. The maximum loss in seed density was recorded from the control (1.15 g cm^{-3}). The reason may be the attack of *C. maculatus* larvae on the nutrient components of the seed.

The observed swelling capacity for the variety used in the investigation was lower than reported for other cowpea varieties (50–104%). This may be due to having comparatively thick, smooth coat in the seed. The swelling capacity of the samples treated with essential oils showed a higher value than that of fresh cowpea sample. This may be due to having lower moisture content in samples treated with essential oils.

Effects of storage on Chemical properties: The loss of moisture content in essential oil-treated samples was significant ($p<0.05$) with a minimum recorded for *M. minutum*. This result could be due to removal of water, with absorption of essential oils into the seeds. Control showed higher moisture content (14.55%) than that of the fresh sample (12.67%).

This may be due to absorption of moisture from atmosphere by increased insect population and increased insect metabolism·

There was no significant difference ($p>0.05$) in ash and dietary fiber in treated samples. Both ash and dietary fiber contents of the control showed a significant difference, with a minimum of 2.8% and 5.09 % respectively. These components are rich in the husk portion of the seed; therefore, decrease in above properties may be due to formation of emergence holes in the husk by the *C. maculatus* larvae.

Crude protein and total fat in treated storage systems showed no noticeable difference. Crude protein gave a maximum for C. *nardus* (23.32%) and a minimum for the control (20.26%). The crude protein content in stored cowpea samples was slightly low when compared with that of fresh sample (25.69%). This can be attributed to the activity of proteolytic enzymes. Compared to pirimiphos methyl-treated system protein preservation was higher in essential oil-treated systems.

The maximum total fat percentage was reported from the cowpea seeds treated with citronella oil (3.05%) and the minimum from the control (2.34%). The cowpea seeds treated with essential oils, showed an increase in the total fat percentage during storage period. This may be due to absorption of treated essential oils into the seeds in minute quantities, which is evident by the characteristic odor present in those samples.

The crude protein and total fat in control was significantly lower than those of fresh seeds flour. These components are rich in endosperm and germ portions of the seed. Therefore, the loss may be due to consumption of these nutrients by *C. maculatus* larvae.

Na, K, Mg and Ca were the major metal elements in cowpea seeds, which is similar to other legumes and most plant materials. There was no significant difference in magnesium content in all the cowpea samples. A similar variation in Na, K, Ca and Zn contents was found in the analysis. In those metals, no noticeable difference was observed in five treated systems but a significant loss in the control. These minerals were rich in the husk portion of the seed; therefore, decrease in above properties may be due to formation of emergence holes in the husk by the *C. maculatus* larvae.

CONCLUSION

Physicochemical properties of stored cowpea had no noticeable difference in essential oil- and pirimiphos methyl-treated systems except moisture content and total fat. The major nutrient components in cowpea seeds, protein and dietary fiber, have been preserved in higher amounts in essential oil-treated samples. With lower toxicity to humans and other mammals, selected essential oils have shown better qualities as fumigant toxicants for controlling *C. maculatus* (F.).

ACKNOWLEDGEMENT

The authors wish to thank National Science Foundation, Sri Lanka and International Foundation of Science, Sweden, for the financial support.

REFERENCES

Adhikari, A.A.C.K., Paranagama, P.A., Abeywickrama, K.P. and Bandara K.A. N. P. 2002. Behavioral studies of cowpea bruchid, *Callosobruchus maculatus* (F.) against volatile extracts from leaves of Lemongrass (*Cymbopogon citratus*), Neem (*Azadirachta indica*) and curry leaf (Murraya *koenigii*). Tropical Agricultural Research. **14:** 138 – 147.

AOAC 2000. Official Methods of Analysis of AOAC International, 17th ed. Arlington, AOAC International, Gaitherburg, MD, USA.

Bliss, F.A. 1972. Cowpea in Nigeria. In: Milner, M. (ed.) Nutritional Improvement of Food Legumes by Breeding. PGA/FAO. Rome. pp 151 –153.

Gunasekara, J. 2003. Investigation of toxic and repellent activity of essential oils of *Micromelum minutum* against cowpea weevil. *B.sc. thesis*. University of Kelaniya, SL.

Hill, D.S. 1992. Agricultural insect pests of the tropics and their control. 1st ed. CBS, New Delhi. 559 – 560.

Karunasena, P.G.C.S. 2001. Investigation of toxic and repellent activity of essential oils of *Alpinia calcarata* ross and *Cymbopogan nardus* against cowpea weevil. *B.sc. thesis*. University of Kelaniya, SL.

Narayan, R., Chauhan, G.S. and Verna, N.S. 1987. Changes in the quality of soybean during. Storage. Effect of storage on some physico-chemical properties of soybean. Food Chem. **27b:** 13 – 23.

Pearson, D. 1976, The Chemical Analysis of Foods. 7th ed. Churchill, London.