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Insecticidal effect of some spices on *Callosobruchus maculatus* (Fabricius) in black gram seeds

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Abstract: The experiment was conducted to investigate the insecticidal potency of some spices eg. clove (*Syzygium aromaticum*), black pepper (*Piper nigrum*), ceylon cinnamon (*Cinnamomum zeylanicum*), black cardamom (*Amomum subulatum*), nutmeg (*Myristica fragnans*), black cumin (*Nigella sativa*), turmeric (*Curcuma longa*), red pepper (*Capsicum frutescens*), cumin (*Cuminum cyminum*), green cardamom (*Elettaria cardamomum*) and bay leaf (*Cinnamomum tamala*), against the pulse beetle, *Callosobruchus maculatus* (F.) on stored black gram (*Phaseolus bengalensis* L.). Data were recorded on days to 100% mortality; number of adults emerged and weight loss (%) of black gram. All the spices were effective as protectants of black gram seeds. However, clove and black pepper were most effective.

Key words: *Callosobruchus maculatus*, stored black gram, mortality, adult emerge, extent of damage.

Introduction

Spices are dried seed, fruit, root, bark or vegetative substance used in nutritionally insignificant quantities as a food additive for the purpose of flavouring. Many of these substances have other uses, e.g. food preservation, as medicine, in religious rituals, as cosmetics, in perfumery or as vegetables. Pulses have a prominent place in daily diet as a rich source of vegetable protein, minerals and vitamin-B. They are of special significance to the people in developing countries, who can hardly afford animal protein in adequate quantities. Among the pulses black gram, *Phaseolus bengalensis* L. belonging to the family Leguminosae is the most important legume crop in the world.

Pulse seeds suffer a great damage during storage due to insect attack (Sherma, 1989). Among the insect pests attacking stored pulses, the pulse beetle, *Callosobruchus chinensis* L. is a serious one (Alam, 1971). This insect has been reported from the Phllippines, Japan, Indonesia, Srilanka, Burma, India and Bangladesh. It is a notorious pest of chickpea, mung, cowpea, garden pea, black gram, lentil and arhar. The extent of damage to pulse seeds is very high both qualitatively and quantitatively (Atwal, 1976). There was a 55-69% loss in seed weight and 45.6-66.3% loss in protein content by the pulse beetle on chickpea (Gugar & Yadav, 1978). About 100% loss of pulse seeds was found due to infestation by the pulse beetle (Borikar & Puri, 1985).

The use of plants and minerals as traditional protectants of stored products is an old practice used all over the world (Golob & Webley, 1980). These traditions have been largely neglected by farmers, after the Second World War, with the advent of synthetic or petroleum based insecticides. However, the potential hazards for mammals from synthetic insecticides, the ecological consequences and the increase of insect resistance to pesticides has led to a search for new classes of insecticides with lower mammalian toxicity and a lower persistence in the environment (Roger & Hamraoui, 1993).

Sighamony *et al.* (1984) tested oils of clove, cedarwood *(Juniperus virginiana),* karanja (*Pongamia glabra)* and an acetone extract of black pepper *(Piper nigrum)* in India by a choice method to determine their repellent effects on adults of *Tribolium castaneum.* Cedarwood, karanja and pepper products were found to be more potent than the standard repellent, dimethylphthalate. Karanja oil and pepper extract were rated as the most repellent at the highest concentration tested (10.38mg/cm^3) but were less repellent at the lowest concentration tested (2.59mg/cm^3). Karanja oil appeared to retain its repellent effect strongly over the 8 weeks of the experimental period.

Miah *et al.* (1993) reported the effects of several Bangladeshi plant materials against *C. chinensis* on chickpea seeds. Nishinda (*Vitex engundo*) leaf powder was the most effective in reducing numbers of eggs laid, adult emergence and seed weight loss. Iqbal & Poswal (1995) tested powdered spices (flowers of clove. rhizome of ginger and turmeric, fruits of black and chilli pepper and bulb of garlic), malathion (1.5%) and powdered stem of the tree *Combrerum imberbe* mixed against *C. maculatus*. Reduction in oviposition and seed weight loss were recorded 10 and 70 days post-treatment respectively. Cloves and black pepper gave results, which were not significantly different from those produced by malathion.

Aslam *et al.* (2002) tested six spice powders against *C. chinensis*. Clove and black pepper were good protectants of stored chickpea against the beetle. Kim *et al.* (2003) showed the potent insecticidal activity of extract from cinnamon (*Cinnamomum cassia*) bark and oil, horseradish (*Cocholeria aroracia*) oil, and mustard (*Brassica juncea*) oil against *C. chinensis*. Bortolin *et al.* (2006) tested four spices produced in Mexico,

namely black pepper, two kinds of chilli and oregano, by electron paramagnetic resonance technique for detection purposes. Asif (2007) tested plant powders and extracts of black pepper, red chilies, cloves, neem, datura (*Datura stramonium*), garlic and turmeric against pulse beetles and found the neem extract to be most insecticidal.

The pulse beetle being an internal feeder is hard to control with insecticides. It is also not advisable to mix insecticides with food grains. Fumigation being the most effective method cannot be practiced in our villages because the storage structures are not airtight and are mostly built inside the residential areas. Plant materials which arc being traditionally used by some farmers are quite safe and appear to be the most promising as grain protectants. The use of spices is cheaper, they are easily available and safe. Keeping these views in mind, the present experiment was designed to investigate the insecticidal potency of some spices against the pulse beetle on black gram seeds.

Materials and Methods

Eleven spices, *viz.* clove (*Syzygium aromaticum*), black pepper (*Piper nigrum*), ceylon cinnamon (*Cinnamomum zeylanicum*), black cardamom (*Amomun subulatum*), nutmeg (*Myristica fragnans*), black cumin (*Nigella sativa*), turmeric (*Curcuma longa*), red pepper *(Capsicum frutescens*), cumin (*Cuminum cyminum*), green cardamom (*Elettaria cardamomum*) and bay leaf (*Cinnamomum tamala)* and a control treatment were used *C. maculatus* on black gram seeds. The experiment was carried out in the Crop Protection and Toxicology Laboratory, Department of Zoology, Rajshahi University, during 2006-2007. The experiment was conducted in a randomized complete block design. The spices and black gram seeds were obtained from a departmental store.

The spices were ground in an electric grinder into a fine powder and 0.5 g and 0.6 g (25 g/kg and 30 g/kg) fine powder of each spices were put in separate petridish (9 cm x 9 cm). Black gram seeds were weighted on an electric balance and 20g seeds were put in each petridish and mixed with the spice powder properly. Three petridishes contained untreated black grams, serving as controls. Five pairs of adult beetles were released in each petridish and the petridishes were covered with lids.

Data were recorded on days to 100% mortality, number of adults emerged and per cent weight loss of black gram. The beetles were checked daily to count the member of adults emerged and the member died and to remove the dead beetles from the petri dishes. Weight loss was recorded at the end of the experiment. The weight loss caused by the pulse beetles was determined by the formula:

$$\text{Weight loss (\%)} = \frac{\text{Initial weight - Final weight}}{\text{Intial weight}} \times 100$$

Results and Discussion

Days to 100% mortality: Highly significant differences ($P<0.001$) were found among all the treatments to get 100% mortality of *C. maculatus* at 25 g/kg and 30 g/kg doses (Table.1). The order of days of 100% mortality of the spices at 25 g/kg was: clove and black pepper > ceylon cinnamon > black cardamom > nutmeg > black cumin > turmeric > red pepper > cumin > green cardamom > bay leaf. However, the maximum of 14.67 days to 100% mortality was observed in the control treatment. The order of days of 100% mortality of the beetles on the spices at 30 g/kg was: clove and black pepper > ceylon cinnamon > black cardamom > nutmeg > black cumin > turmeric > red pepper > cumin > green cardamom > bay leaf. However, a maximum of 14 days to 100% mortality was observed in the control treatment.

Number of adults emerged: All the treatments against *C. maculatus* produced lesser number of adults as compared to the control treatment (Fig.1).

Table 1. Days to 100% mortality of *C. maculatus* in different spices at 25 g/kg and 30 g/kg doses.

Spices	Dose 25 g/kg	Dose 30 g/kg
	Day of 100% mortality (Mean ± SE)	Day of 100% mortality (Mean ± SE)
Clove	2.67±0.67	2.00±0.58
Black Pepper	3.00±0.58	2.33±0.67
Ceylon Cinnamon	5.00±0.58	4.00±0.58
Black Cardamom	6.33±0.67	5.00±0.58
Nutmeg	7.00±1.00	5.67±0.67
Black Cumin	7.333±0.33	6.00±0.58
Turmeric	7.67±1.45	7.00±0.58
Red Pepper	11.67±1.33	10.00±0.58
Cumin	13.00±0.58	11.00±0.58
Green Cardamom	13.33±0.67	11.33±1.45
Bay Leaf	14.00±0.00	13.00±0.58
Control	15.67±0.33	16.00±1.00
F= 59.717***/11, 59.946***/11 (between groups)		

The order of number of adults emerged at 25 g/kg was: clove and black pepper > ceylon cinnamon > black cardamom > nutmeg > black cumin > turmeric > cumin > green cardamom > bay leaf > red pepper. The order of number of adult emerged at 30 g/kg was: clove and black pepper > ceylon cinnamon > black cardamom > nutmeg > black cumin > turmeric > cumin > green cardamom > bay leaf > red pepper.

Weight loss (%) **of black gram:** There was a significant weight loss of black gram due to spice treatments (Fig.2.). The order of weight loss (%) of black gram at 25 g/kg was: clove > black pepper > ceylon cinnamon > black cardamom > nutmeg > black cumin > turmeric > cumin > green cardamom > bay leaf > red pepper. The order of weight loss (%) of black gram at 30 g/kg was: black pepper > clove > ceylon cinnamon > black cardamom > nutmeg > black cumin > turmeric > cumin > green cardamom > bay leaf > red pepper. The pungent smell of clove due to eugenol and of black pepper due to piperine might have killed the beetles earlier. These results are also supported by Iqbal & Poswal (1995), who reported that cloves and black peppers gave equal results for controlling *C. maculatus*. Jilano & Hassan (1984) stated that different plant materials with different percentage caused 100% mortality in Coleoptera in 9 to 43 days as against 45 days in the control.

Clove and black pepper treated black gram produced lower number of adults. These results are in conformity with Miah *et al.* (1993) who observed that different plant materials tested against *C. chinensis* on chickpea seeds were effective in reducing adults emergence. The possible reason could be that the active components of both the spices might have affected the physiology of the beetles.

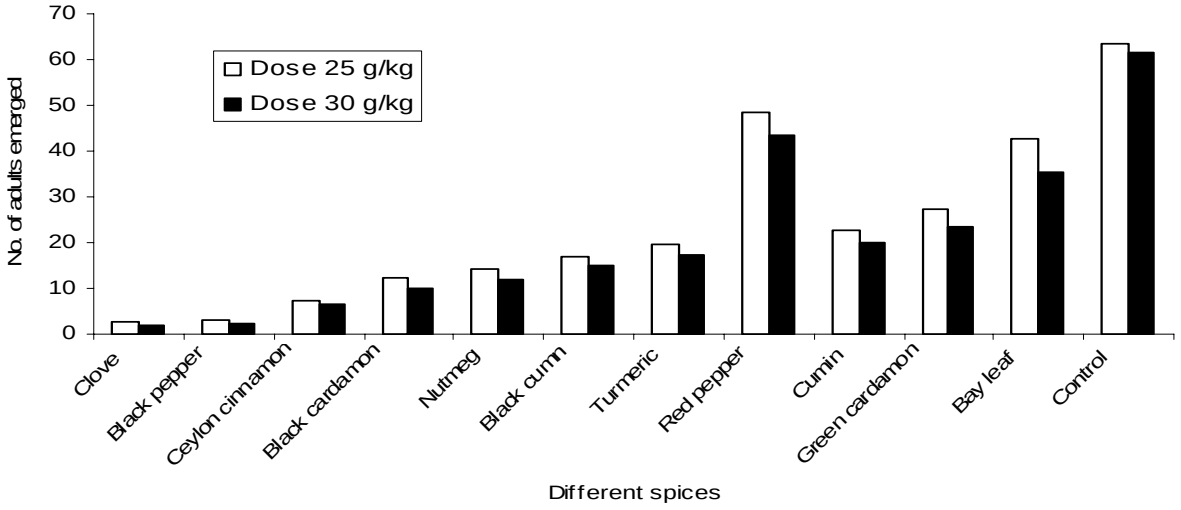

Fig. 1: Number of *C. maculatus* adults that emerged from spice-treated black gram seeds.

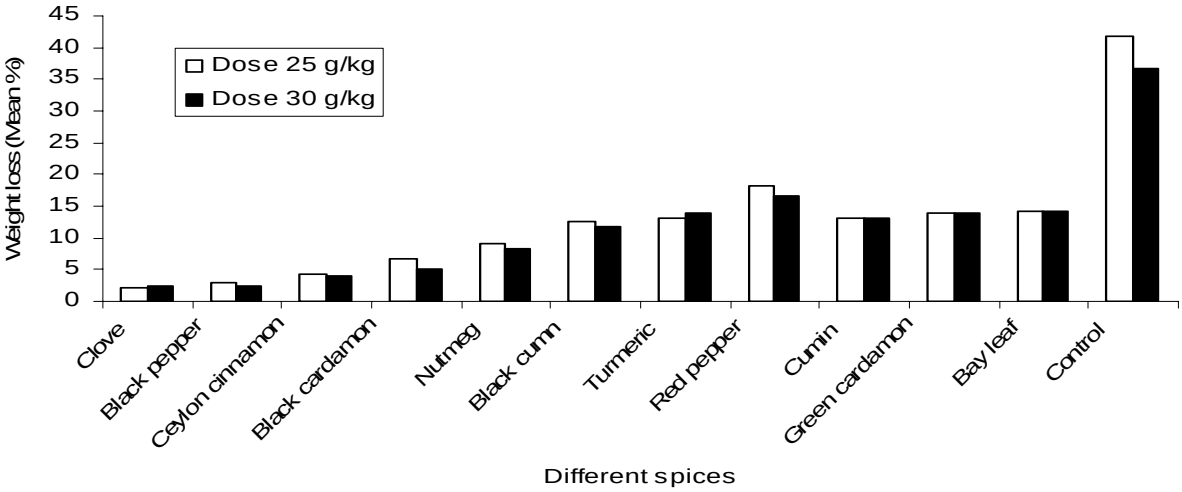

Fig. 2: Weight loss (%) of black gram due to the infestation of *C. maculatus* following treatment with spices.

The weight loss (%) of black gram seeds was significantly lower following treatments with clove and black pepper powders as compared to the untreated control. The early mortality of the treated beetles and the consequent production of lower beetle populations could have been the reasons.

After a perusal of the data it could be concluded that clove and black pepper could be used as protectants of black gram seeds against *C. maculatus*.

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