Nat. Volatiles & Essent. Oils, 2022; 9(2): 148-159

Effect Of Powders Of Three Plants On Some Biological Characteristics Of The Cowpea Beetle Callosobruchus Maculate (Fabricius) (Coleoptera: Bruchidae)

Juma'a T. Muhammad* , Ibrahim A. Hassan and Basem A. Taha

Plant Protection Department/ College of Agriculture and Forestry/University of Mosul, Nineveh, Iraq.

ABSTRACT

Laboratory study was conducted at Plant Protection Department/ College of Agriculture and Forestry/ University of Mosul, Iraq, during 2021, to investigate the bioactivity of powders from Fenugreek, Trigonella foenum-graecum L. (seed) (Fabaceae), Oleander, Nerium oleander L. (leave) (Apocynaceae) and Coriander, Coriandrum sativum L. (seed) (Apiaceae) against the reproduction and damage of Callosobruchus maculatus F. (Coleoptera: Bruchidae) on cowpea seed (Vigna unguiculata (L.) walp), based on the rate of egg-laying performance, the emergence of the adult, the percentage of decrease in the first generation, seed damage, weight loss of cowpea seed, weevil perforation index (WPI)% and the percentage of germination of seeds infected by this insect. The powders were incorporated at rates 0.0 (control), 0.2, 0.5, 0.7, 1.0 g/10 g cowpea seeds. Results of this studies revealed that C. sativum at concentration 1.0g/10g seed had significantly negative effects on C. maculatus for all parameters measured. T. foenum-graecum and N. oleander also showed significant effects but with less effect. The results indicate that these botanical powders have the potential to protect cowpea seeds from cowpea weevils damage compared to when the seeds stored unprotected. They should, therefore, be included in pest management strategies for C. maculatus in grains stored on-farm in rural tropical and subtropical regions.

Keywords: Callosobruchus maculatus, Trigonella foenum-graecum, Nerium oleander, Coriandrum sativum.

INTRODUCTION

The Fabaceae family is the second most important plant family worldwide, and they are excellent sources of protein (20-40%) and carbohydrates (50-60%) as well as good sources of thiamine, niacin, calcium and iron (Daniel et al. 2015; Dinesh and Deepshikha, 2012). Cowpea (Vigna unguiculata (L.) walp) is a staple legume food crop of significant economic and nutritional importance worldwide (Akunne et al., 2013). Cowpea seeds, pods, and leaves are consumed fresh as a green vegetable in many parts of the world, especially in tropical and subtropical regions, while the rest of the plant after harvesting the pods is used as nutritious fodder for livestock (Abebe et al., 2005 ; Oladipupo and Sanni, 2019).

One of the major problems encountered agriculture in developing countries is the post-harvest losses that usually occur during storage (Adedire et al., 2011). Insect pests pose a major threat to cowpea production and storage in developing countries in tropical and subtropical regions, including Iraq, Cowpea beetle, Callosobruchus maculatus (Fab.) (Coleoptera: Bruchidae) is a major pest of a wide range of stored legume seeds, especially cowpea Vigna unguiculata (Ileke et al., 2012). The cowpea beetle C. maculatus alone is responsible for more than 90% of the damage to cowpea seeds by insect pests (Ekeh et al., 2013).

Generally, infestation with cowpea beetle C. maculatus begins in the field just before harvest, the female beetles laid eggs on the surface of gram seeds, the eggs looked like white dots clearly visible on the seeds, upon hatching the larvae chewed into seeds directly below the eggs, the life cycle was completed into a single seed and finally the beetle came out from the seeds by making a circular feeding/emergence holes, the weight losses were caused by feeding of larva inside the seeds (Islam et al., 2013).

When such seeds are harvested and stored, the larvae continue to feed. It is inside the seeds and consumes all its contents (as a hidden infestation) and emerge as an adult, causing secondary pest infestation and may cause complete destruction of stored seeds within 3-4 months, thereby rendering the grains/seeds unfit for human consumption, as well as for agricultural purposes, it causes quantitative and qualitative losses manifested by seed perforation, reductions in weight, market value and germination of seeds, The insect pest can cause severe losses up to 100% in unprotected cowpea (Oluwafemi, 2012).

Effective control of insect pests in stored products has long been the goal of entomologists worldwide, synthetic insecticides have been used for many years to control stored insect pests (Ileke et al., 2013), which has caused many problems such as high toxicity to mammals, high level of persistence in the environment, health risks, residual effects, poor knowledge of application, increased application costs, re-emergence of pests, resistant strains, and lethal effects on non-target organisms (Ileke & Oni, 2011; Ileke et al., 2012). Furthermore, pulses specially stored for the purpose of human consumption should not be treated with toxic chemicals because residues of these chemical compounds may pose a serious risk to human health (Nair et al. 2020).

One solution to these problems might be to replace completely synthetic chemical pesticides with natural compounds of plant origin that are biodegradable and often have low toxicity to mammals (Kéita et al., 2001), inexpensive, available in the environment, and is an environmentally safer method for controlling insect pest infestations of stored cereal and grains especially in tropical regions (Adedire et al., 2011; Ileke & Oni, 2011; Ileke et al., 2012). Results of recent studies revealed that vegetable oils, plant extracts, and dry powders of different plant parts can give an effective protection to stored cowpea seeds (Akinkurolere, 2007; Oluwafemi, 2012).

In view of the great damage caused by the cowpea beetle to legumes in general and the fact that synthetic chemical pesticides affect human health, and to find alternatives of plant origin, powders of fenugreek, oleander and coriander plants were used and their effect was studied in the least possible quantity on some aspects of the cowpea beetle's biology and does it give adequate protection to the seeds in stores, thus their use to protect stored seeds from infestation, and this study will also create awareness of the value of plant compounds as a method for controlling cowpea beetle in smallholder farmers' storage facilities.

MATERIAL AND METHODS

Culturing of Insects

The cowpea beetle was obtained from the Insect Laboratory/ Plant Protection Department/ College of Agriculture and Forestry/ University of Mosul, Iraq, and the insect was diagnosed by reference to the taxonomic keys. Cowpea beetle was reared in 1 kg plastic containers covered with muslin cloth to ensure ventilation, and kept under laboratory temperature (25±5 °C) and relative humidity (70±5%). 500 g of clean and uninfected cowpea seeds (Vigna radiata L.) were used sterilized in an electric oven at 60 °C for two hours in order to obtain a pure colony of the insect. With constant regeneration of the colony in mind, the newly emerging subsequent generations were used for the subsequent experiments.

Sources and Preparation of Plant Materials

The oleander leaves used in the study was collected from the gardens of the University of Mosul during the spring season. As for the seeds of the fenugreek, they were obtained from a field planted in the fenugreek after harvesting them as part of a master's student project at the University of Mosul. Cowpea and Coriander seeds were purchased from local markets (Table 1). The botanical materials were cleaned of impurities, washed well in tap water and were shade-dried for 10 days until a constant weight was maintained, and milled by a household electric grinder into a very fine powder, each separately. It was kept in sealed plastic bottles under cooling (4 ± 2 °C) until needed.

Cleaned the cowpea seeds of impurities and add 10g to each Petri dish. Quantities (0.2, 0.5, 0.7, 1.0) g of plant powders / 10 g of seeds were prepared by weighing each powder separately using a sensitive balance and the powders were placed in Petri dishes containing 10 g of cowpea seeds, and the contents of each Petri dish were mixed well (seeds + plant powder) to allow an even distribution of the powder in the whole seed mass. As for the control, it was without adding any powder to it, after which ten pairs (10 males + 10 females) 1-3 days old of adult cowpea beetle were added to the Petri dishes with treated or untreated seeds (control). The experiment was conducted with three replicates for all treatments and the control. Readings were taken after a generation of cowpea beetle (42 days). And then the following biological characteristics were calculated:

Table 1: Botanical powders used in the study

Common Name	Scientific Name	Family	Used Part
Fenugreek	Trigonella foenum-graecum L.	Fabaceae	Seeds
Oleander	Nerium oleander L.	Apocynaceae	Leaves
Coriander	Coriandrum sativum L.	Apiaceae	Seeds

a. Average number of eggs laid by the females on seeds for each treatment separately.
b. The average number of adults emerging from the laid eggs after 42 days (after all the adults have emerged), number of exit holes on the seeds.
c. The F1 progeny population was assessed by keeping each sample in the laboratory until the emergence of new adults. Percentage reduction in adult emergence or inhibition rate (% IR) was calculated using the methods of Tabu et al. (2012) as following equation:

$$\text{\% Reduction in the first generation (F1) [Inhibition Rate (\% IR)]} = \frac{\text{Number of adults in control - Number of adults in treatment}}{\text{Number of adults in control}} \times 100$$

d. At day 42, the cowpea seeds were re-weighed and the % loss in weight was determined and recorded The percentage seed damaged were also evaluated as follows:

$$\text{\% Seed damage} = \frac{\text{Number of perforated grains}}{\text{Total number of grains counted}} \times 100 \quad \text{(Ileke and Oni, 2011)}$$

$$\text{\% Seed weight loss (\%WL)} = \frac{\text{Initial weight - final weight}}{\text{Initial weight}} \times 100 \quad \text{(Keita et al., 2001)}$$

e. Weevil Perforation Index (WPI) of the weevil to cowpea seeds were calculated using the methods of Fatope et al., (1995); Adedire and Ajayi (1996) respectively. The weevil perforation is define as follows:

$$\text{Weevil Perforation Index (\%WPI)} = \frac{\text{\% treated cowpea seeds perforated}}{\text{\% control cowpea seeds perforated}} \times 100$$

f. Effect of the number of holes in the seed on the germination percentage.

The number of holes in the infected cowpea seeds was counted and then they were classified into six groups, the first without holes (uninfected seeds), second containing one, third containing two, forth containing three, five containing four and six containing more (5-8) holes /seed. These seeds were cleaned with tap water, dried and sterilized, and 10 seeds were added to each petri dish that contained sterile, clean filter papers saturated with distilled water, and allowed to germinate, as for the control treatment. The experiment was conducted with three replications, and the percentage of germination was estimated after a week as follows:

$$\text{\% viability} = \frac{\text{Number of germinated seed}}{\text{Total number of seeds planted}} \times 100$$

(Ileke and Oni, 2011)

STATISTICAL ANALYSIS

The data were statistically analyzed using SAS ready statistical program according to Antar (2010). ANOVA tables were performed, and the mean values of the parameters were compared based on Duncan Multi-Range Test (P≤0.05).

RESULTS

Effect of botanical powders on oviposition, adult emergence and percentage reduction in the first generation (F1) of C. maculatus.

All concentrations of the botanical powders had a significant effect in reducing the number of eggs laid by the females of C. maculatus when compared with a untreated seed (control). Treatment with coriander (C. sativum) seed powder gave the lowest average number of eggs laid by one female, which amounted to 18.07, 13.67, 11.13, and 3.73 eggs at concentrations of 0.2, 0.5, 0.7, and 1.0 g, respectively, while it amounted to 36.60 eggs in the control. Number of eggs increased gradually with the decrease of concentration.

The treatment with botanical powder used in the study led to a decrease in the number of emergence adults when compared to the control, The lowest average number of adults when cowpea seeds were treated with coriander (C. sativum) seed powder that recorded 97.00, 78.00, 47.33, 26.33 adults at concentrations of 0.2, 0.5, 0.7 and 1.0 g, respectively, while it was 173.00 adults in the control.

Table 2: Effect of botanical powders on oviposition, adult emergence and percentage reduction in the F1 of C. maculatus.

Botanical Powder	Concentration (g/10g Seed)	Average No. of Eggs/Seed	Average No. of Adults Emerging	% Reduction in the First Generation (F1)
Control	0	36.60 a	173.00 a	
T. foenum-graecum	0.2	25.87 c	129.33 bc	25.24 ghi
	0.5	23.33 d	115.00 cde	33.53 fg
	0.7	21.37 e	98.33 def	43.16 ef
	1.0	18.47 f	63.67 gh	63.20 cd
	Average	**22.26 b**	**101.58 a**	**41.28 b**
N. oleander	0.2	29.73 b	146.67 b	15.22 i
	0.5	29.13 b	134.00 bc	22.54 hi
	0.7	28.13 b	122.00 bcd	29.48 gh
	1.0	25.27 c	44.67 hi	74.18 b
	Average	**28.07 a**	**111.84 a**	**35.36 c**
C. sativum	0.2	18.07 f	97.00 ef	43.93 e
	0.5	13.67 g	78.00 fg	54.91 d
	0.7	11.13 h	47.33 hi	72.64 bc
	1.0	3.73 i	26.33 i	84.78 a
	Average	**11.65 c**	**62.17 b**	**64.07 a**

Values followed by different letter in each column are significantly different $P \leq 0.05$ according to Duncan's Multiple Range Test.

The powders in all concentrations used in this study had a significant effect on the decrease in the average of the first generation adults and the average percentage reduction in the first generation (F1), The treatment with coriander seed powder was superior when compared to the rest of the powders, and the highest reduction in the average of the first generation was 43.93, 54.91, 72.64 and 84.78% at concentrations of 0.2, 0.5, 0.7 and 1.0 g, Respectively, followed by oleander (N. oleander) leaves powder, then fenugreek (T. foenum-graecum) seed powder when used in the same concentrations.

In general, the treatment with coriander (C. sativum) seed powder gave a significant effect in decreasing the general average number of eggs and adult emergence, which amounted to 11.65 eggs/seed and 62.17 adults, while it gave the highest average in the percentage of reduction in the first generation adults, which amounted to 64.07%, when compared with other treatments (Table 2).

Damage assessment of cowpea seeds treated with botanical powders.

Cowpea seeds treated with botanical powder showed a significant difference in the average number of damaged seeds, percentage of damaged seeds, weight of seeds, percentage of weight loss and %WPI caused by cowpea beetle infestation when compared with the control. The treatment with coriander seed powder was significantly superior when compared with other treatments and the control, as the general averages were 24.85 seeds, 49.67 %, 8.89 g., 11.15%, 55.18% for the number of damaged seeds, percentage of damaged seeds, weight of seeds, percentage of weight loss and WPI, respectively. While it was 45 seeds, 90.00%, 5.78 g., 42.17% for the above traits, respectively in the control.

Table 3: Protectantability of the botanical powder of cowpea seed.

Botanical Powder	Conc. (g/10g Seed)	Total No. of Seeds	Average No. of Damaged Seeds	% Average Seed Damaged	Average Seed Weight/g	% Weight Loss	Weevil Perforation Index (WPI)% *
Control	0	50	45.00 a	90.00 a	5.78 f	42.17 a	
T. foenum-graecum	0.2	50	39.67 b	79.33 b	6.31 ef	36.87 abc	88.15 a
	0.5	50	37.00 b	74.00 bc	6.31 ef	36.87 abc	82.22 ab
	0.7	50	34.00 b	68.00 cd	7.09 cd	29.13 cd	75.56 bc
	1.0	50	26.67 c	53.33 e	8.18 bc	18.23 e	59.26 d
	Average		**34.34 a**	**68.67 a**	**6.97 b**	**30.23 a**	**76.30 a**
N. oleander	0.2	50	36.67 b	73.33 bc	5.67 f	40.23 ab	81.48 ab
	0.5	50	35.33 b	70.67 cd	6.25 ef	37.97 abc	78.52 bc
	0.7	50	33.67 b	67.33 cd	7.04 de	30.37 bcd	74.82 bc
	1.0	50	28.00 c	56.00 e	8.45 bc	15.53 ef	62.22 d
	Average		**33.42 a**	**66.83 a**	**6.85 b**	**31.03 a**	**74.26 a**
C. sativum	0.2	50	32.00 b	64.00 d	7.77 cd	22.30 de	71.11 c
	0.5	50	28.00 c	56.00 e	8.72 bc	12.80 ef	62.22 d
	0.7	50	24.67 c	49.33 e	9.21 ab	7.93 fg	54.82 d
	1.0	50	14.67 d	29.33 f	9.84 a	1.57 g	32.59 e
	Average		**24.85 b**	**49.67 b**	**8.89 a**	**11.15 b**	**55.18 b**

Values followed by different letter in each column are significantly different P≤0.05 according to Duncan's Multiple Range Test.

*Weevil Perforation Index (WPI). Value lower than 50 is an index of positive protectant effect while WPI greater than 50 is an index of negative protectant ability.

The treatment with coriander seeds at a concentration of 1% gave positive protection (WPI)% for cowpea seeds from being infected by the pest, which amounted to 32.59% compared with other concentrations, treatments and controls (Table 3).

Effect of botanical powder concentration on C. maculatus F. and the viability of cowpea seed.

The results showed that the concentrations of botanical powders differed significantly among themselves and when compared with the control in the averages number of eggs, the number of adults emergence, the percentage of reduction in the first generation, number of damaged seeds, percentage of damaged seeds, weight of seeds and percentage of weight loss. The concentration of 1g/10g seed was superior to the rest of the concentrations in the above-mentioned traits, which amounted to 15.82 eggs, 44.89 adults, 74.05%, 23.11 seeds, 46.22%, 8.82 g, 11.78%, respectively, and the powders at a concentration of 1g/10g seed gave positive protection (WPI) 51.36%, which is a good efficiency to protect cowpea seeds from infection. While in control it was 36.60 eggs, 173.00 adults, 45.00 seeds, 90.00%, 5.75 g., 42.17% for the averages number of eggs, adult emerging, percentage of reduction of the first generation, number of damaged seeds, percentage of damaged seeds, weight of seeds and percentage of weight loss, respectively. The effect of powder concentration of fenugreek, oleander and coriander on above traits by cowpea beetle attack was statistically significant and showed inversely proportional to concentration of plant powders (Table 4).

Table 4: Effect of botanical powder concentration on C. maculatus F. and the viability of cowpea seed.

Conc. (g/10g Seed)	Average No. of Eggs/Seed	Average No. of Adults Emergence	% Reduction in (F1)	Average No. of Damaged Seeds	% Average Seed Damaged	Average Seed Weight/g	% Weight Loss	Weevil Perforation Index (WPI)% *
0	36.60 a	173.00 a		45.00	90.00 a	5.75 d	42.17 a	
0.2	24.56 b	124.33 b	28.13 d	36.11	72.67 b	6.69 c	33.13 b	80.25 a
0.5	22.04 c	109.00 c	36.99 c	33.44	66.44 c	7.09 c	29.21 b	74.32 b
0.7	20.21 d	89.22 d	48.42 b	30.78	61.56 d	8.00 b	22.48 c	68.40 c
1.0	15.82 e	44.89 e	74.05 a	23.11	46.22 e	8.82 a	11.78 d	51.36 d

Values followed by different letter in each column are significantly different P≤0.05 according to Duncan's Multiple Range Test.

* Weevil Perforation Index (WPI), Value lower than 50 is an index of positive protectant effect while WPI greater than 50 is an index of negative protectant ability.

Effect of botanical powder and number of holes/seed on the percentage germination of cowpea seed.

The results indicate that coriander seed powder maintained the highest average percentage of healthy seeds, which amounted to 19.18%, which differed significantly compared to powdered fenugreek seeds and oleander leaves and the control which reached 3.64, 4.80, and 4.66%, respectively. Also, coriander seed powder gave the highest average for the percentage of seeds containing one hole/seed, which amounted to 41.68%, and the lowest average for the percentage of seeds containing 3 or more holes/seed compared to the treatment of cowpea seeds with powdered fenugreek seeds and oleander leaves and the control. This reflected positively on the percentage of seed germination, therefore, infected seeds can be used in cultivation.

It is clear from the results of the study that the number of holes/seed and the type of plant powder showed significant differences between the treatments and the control, and the highest average percentage of germination of cowpea seeds when treating the seeds with coriander seed powder was 100.00, 93.33, 86.67, 43.33, 33.33%, which contains 0, 1, 2, 3 and 4 holes/seed, respectively. While the lowest average percentage of germination of cowpea seeds in the control was 23.33, 16.67, 13.33 and 10.00%, which contain 1, 2, 3 and 4 holes/seed, respectively.

In general, the highest average percentage of germination of cowpea seeds when treating seeds with coriander seed powder was 59.44%, which differed significantly compared to seeds treated with fenugreek seed powder and oleander leaves powder and the control, which amounted to 45.56, 48.33, 27.22%, respectively. The number of holes/seed showed significant differences in the general average percentage of cowpea seed germination, which amounted to 100.00, 65.00, 51.67, 33.33, 20.83 and 0.00 % in the seeds containing 0, 1, 2, 3, 4 and more (5-8) holes/seed, respectively (Table 5).

Table 5: Effect of botanical powder and number of holes/seed on the percentage germination of cowpea seed.

es /Se	Control	T. foenum-graecum	N. oleander	C. sativum	Overall average

	% of Seed	% Germination	% of Seed	% Germination	% of Seed	% Germination	% of Seed	% Germination	effect of holes/seed
0	4.66 d	100.00 a	3.64d	100.00 a	4.80d	100.00 a	19.18c	100.00 a	100.00 a
1	13.34c	23.33 gh	21.14b	60.00 c	15.58c	83.33 b	41.68a	93.33 ab	65.00 b
2	20.66b	16.67 h	26.80b	50.00 cde	22.90b	53.33 cd	21.28b	86.67 ab	51.67 c
3	22.00b	13.33 h	26.50b	40.00 def	24.64b	36.67 efg	10.96c	43.33 def	33.33 d
4	21.34b	10.00 h	14.16c	23.33 gh	19.24c	16.67 h	6.90d	33.33 fg	20.83 e
more	18.00c	0.00 i	7.76d	0.00 i	12.84c	0.00 i	0.00e	0.00 i	0.00 f
Average		**27.22 C**		**45.56 B**		**48.33 B**		**59.44 A**	

Values followed by different letter are significantly different P≤0.05 according to Duncan's Multiple Range Test.

DISCUSSION

Among the tested powders, coriander (C. sativum) powder showed the highest effect significantly compared with the treatment of seeds with fenugreek (Trigonella foenum-graecum) and oleander (N. oleander) plant powder in all studied traits.

Coriander, C. sativum, caused a mean percentage of expulsion of 45 and 9.4% for both the minor grain borer Rhyzopertha dominica and the rice weevil Sitophilus oryzae after 1 hour, respectively (Swami, et al., 2013). Numbers of eggs laid on seeds treated with Black pepper (Piper nigrum L.), Black cumin (Nigella sativa L.), Methi (Trigonella foenum-graecum) and Garlic (Allium sativum L.) powder were found ranging from 0-10 per seed in all treatments, the numbers of eggs laid on seeds of different treatments were significantly different, number of eggs increased gradually with the decrease of doses (Islam et al., 2013). Al-Hadidi et al. (2014) also found that Coriandrum sativum seed powder caused the repellents Tribolium castaneum of 8% at concentration 4%. Laizu, (2009) found that Bankolmi (Ipomoea aquatica), Dhatura (Datura gardneri) and Korobi (Narium oleander) 1g plants powder/50g mungbean grains were the most effective botanicals for the management of pulse beetle in storage.

If the plant powders reduce adult longevity and fitness, the number of eggs laid will often be lower as well. Moreover, the mechanical effect of large quantities of powders themselves could have an effect on oviposition (Rajapakse, 2006). Devi and Devi (2013) reported that spices protect to wheat up to 9 months without affecting seed germination. Plant powders often reduce the emergence of adult beetles from the seed (Rajapakse, 2006). Some of these plant powders were found to have effect on adult emergence of insect pests attacking stored grains such as cowpea and maize. In many areas of Africa and Asia locally available plants and materials are being widely used to protect stored products against damage by insect infestations, as alternatives to chemical insecticides. These botanical powders should be incorporated into grain protection practice of resource-poor farmer (Suleiman and Yusuf, 2011).

The toxic principles in botanicals are mostly alkaloids-heterocyclic nitrogenous compounds with marked physiological activity e.g. nicotine, rotenone, sabadilla, rynia and pyrethrum (Saxena, 2016). The plant powder is normally a mixture of tens to hundreds of individual constituents. The insecticidal constituents of plant powder are mostly monoterpenoids (Fouad, et al., 2020). Upadhyay and Ahmad (2011) explained that plant products show enormous toxicity against several stored product pests and provide prolonged protection to the grains. Bioactive compounds kill, repel, inhibit oviposition, and reduce larval development, fecundity and adults' fertility (Oliveira et al., 1999). It was reported that when mixed with stored-grains, leaf, bark, seed powder or oil extracts of plants reduce oviposition rate and suppress adult emergence of bruchids, and also reduced seed damage rate (Keita et al., 2001).

Adult bruchids do not feed on stored cowpea seeds but only deposit their eggs. Thus, the use of oviposition inhibitors would be advantageous for the management of cowpea bruchids. The powders of these plants could be mixed with stored cowpea seeds before storage (Ileke et al., 2013). Significant reduction in oviposition performance and emergence revealed the toxic effect of the botanicals power towards the pulse beetle eggs. These results supported by the reports of (Chaubey, 2008) who observed that the black pepper was effective in reducing adult's emergence. The possible reason could be that the active components of the spice might have affected the physiology of the beetle.

Oleander (Nerium oleander L.), Azedarach (Melia azedarach L.) and Chilipepper (Capsicum annuum L.) powders showed a repellent effect of Oryzae surinamensis L. Which oleander plant gave the highest percentage of repellency of 72%, while Rocket (Eruca sativa) and peppermint (Mentha piperta L.) plants showed an attractive effect of 45 and 36%, respectively, Rearing adults of O. surinamensis L. on rice grains treated with the plant powders (Oleander, Azedarach, Rocket, peppermint, and Chilipepper) effect on the biology of the insects, The adults gave a progeny of 13.5, 35, 77.5, 73.6 and 33.3 individuals from two pairs of insects respectively in comparison with 143 individual in control (rice only) (Karso, 2018). The grains mixed to the powder of C. sativum were more oviposited (195.50 eggs) by C. maculatus, contrasting with the results of Baldin et al. (2009), where this treatment stood out among the ones that reduced most the oviposition of Acanthoscelides obtectus Say, in common beans, using the same concentration of the powders. It is possible that vegetable powder affects weevil species differently, which may justify the variations observed in treatments with C. sativum. Moreover, the fact that the mixture of the volatiles of the powders with that of the grains (common beans and cowpea beans) may produce behavioral variations in the weevils should be taken into account. The viability of the eggs varied between 87.67 and 96.08%, being higher in Piper nigrum L. and lower in C. sativum L. (Pannuti et al., 2012).

Thus, our findings revealed adequate insecticidal activities of plant powders according to their efficacy C. sativum, T. foenum-graecum and N. oleander against C. maculatus, making them suitable tools that can be integrated into C. maculatus management programs, especially for storage facilities. Further studies are needed to test the applicability and efficacy of different formulations of these plant powders under different types of storage facilities.

CONCLUSION

The results of the current investigations indicate that plant parts may be useful as an protecting stored cowpea seeds from damage by C. maculatus without any deleterious effects on viability of seeds even at low concentrations. Powders of Fenugreek, Coriander seeds and Oleander leaves effective to some degree in reducing the ovipositional preferences and increasing the inhibition rates. Significantly fewer F1 adults emerged from seeds treated with powders. It is an inexpensive and effective technique, and its easy adaptability will give additional advantages leading to acceptances of the technology by farmers. There is a need to find out the natural origin potential molecule is to be safe, eco- friendly and stable to check insect damage at post-harvest condition. It may be possible because plant possesses several alkaloids, terpenoids, glucocinolates, phenols and other secondary metabolites. We therefore recommend the use of these plant materials especially coriander (C. sativum) seeds powder in the control of C. maculatus in storage as against synthetic insecticides, since it is available in the local environment, safe, cheaper, and easy to use.

ACKNOWLEDGMENT

The authors are very grateful to the University of Mosul/College of Agriculture and Forestry for supporting and providing facilities to improve the quality of this work.

REFERENCES

Abebe G, Hattar B and At-Tawah A (2005) Nutrient availability as affected by manure application to cowpea (Vigna unguiculata L. walp.) on calacarious soils. Journal of Agriculture Science and social Science **1**, 1 – 6.

Adedire C O, Obembe O O, Akinkurolele R O and Oduleye O (2011) Response of Callosobruchus maculatus (Coleoptera: Chrysomelidae: Bruchidae) to extracts of cashew kernels. Journal of Plant Disease and Protection **118**(2), 75–79.

Adedire C O and Ajayi T S (1996) Assessment of the insecticidal properties of some plant extracts as grain protection against the maize weevil, Sitophilus zeamais. Nigerian Journal of Entomology **13**, 93-101.

Akinkurolere R O (2007) Assessment of the insecticidal properties of Anchomanes difformis (P. Beauv.) powder on five beetles of stored produce. Journal of Entomology **4**, 51-55.

Akunne C E, Ononye B U, Mogbo T C (2013) Evaluation of the efficacy of mixed leaf powders of Vernonia amygdalina (L.) and Azadirachta indica (A. Juss) against Callosobruchus maculatus (F.) (Coleoptera: Bruchidae). Advances in Bioscience and Bioengineering **1**(2), 86–95.

Al-Hadidi S N, Khamas N A and Mtunai H A (2014) Effect of using some spices to control the adults of red flour beetle Tribolium castaneum (herbest) (Coleoptera: Tenebrioidae). Diyala Journal of Agriculture Science **6**(2), 248–257.

Antar S H (2010) Statistical analysis in scientific research and SAS program. Dar Ibn Al-Atheer for Printing and Publishing, University of Mosul, Mosul, Iraq. 192 pp.

Baldin E L L, Prado J P M, Christovam R S and Dal Pogetto M H F A (2009) Use of powders from plant origin in the control of Acanthoscelides obtectus Say (Coleoptera: Bruchidae) in common bean grains. BioAssay **4**, 1–6.

Chaubey M K (2008) Fumigant toxicity of essential oils from some common spices against pulse beetle, Callosobruchus chinensis (Coleoptera: Bruchidae). Journal of Oleo Science **57**(3), 171 – 179. DOI: 10.5650/jos.57.171

Daniel C C, Zoclanclounon Y A, Agbaka A and Togola A (2015) Toxicity of two plant powders as biopesticides in the management of Callosobruchus maculatus F. (Coleoptera: Chrysomelidae, Bruchinae) on two stored grain legumes. Journal of Applied Biosciences **86**, 7900 – 7908. doi:10.5539/ijb.v4n2p125

Devi K C and Devi S S (2013) Insecticidal and oviposition deterrent properties of some spices against coleopteran beetle, Sitophilus oryzae. Journal of Food Science and Technology (Mysore) **50**(3), 600 – 604. DOI: 10.21608/jppp.2020.96011

Dinesh L and Deepshikha V R (2012) Efficacy of application of four vegetable oils as grain protectant against the growth and development of Callosobruchus maculatus and its damage. Advances in Research **3**, 55-59.

Ekeh F N, Ikechukwu E O, Chinedu I A, Njoku I and Joseph E E (2013) Effectiveness of botanical powders against Callosobruchus maculatus (Coleoptera: Bruchidae) in some stored leguminous grains under laboratory conditions. African Journal of Biotechnology **12**(12), 1384 – 1391. DOI: 10.5897/AJB12.2784

Fatope M O, Mann A and Takeda Y (1995) Cowpea weevil bioassay: A simple prescreen for plants with grain protectant effects. International Journal of Pest Management, **41**: 44-86. http://dx.doi.org/10.1080/09670879509371928

Fouad H A, Hasnaa B A and Salman A M A (2020) Insecticidal activity of six botanical powders against the cowpea seed beetle Callosobruchus maculatus F. (Coleoptera: Bruchidae). Journal of Plant Protection and Pathology, **11**(4): 237 – 240.

Ileke K D, Daniel S B and Ayisat Y A (2013) Effects of three medicinal plant products on survival, oviposition and progeny development of cowpea bruchid, Callosobruchus maculatus (Fab.) [Coleoptera: Chrysomelidae] Infesting Cowpea Seeds in Storage. Jordan Journal of Biological Sciences **6**(1), 61 – 66.

Ileke K D, Odeyemi O O and Ashamo M O (2012) Insecticidal Activity of Alstonia boonei De Wild Powder against Cowpea Bruchid, Callosobruchus maculatus (Fab.) [Coleoptera: Chrysomelidae] in stored Cowpea Seeds. International Journal of Biology, **4**(2): 125 – 131. doi:10.5539/ijb.v4n2p125

Ileke K D and Oni M O (2011) Toxicity of some plant powders to maize weevil, Sitophilus zeamais (motschulsky) [Coleoptera: Curculiondae] on stored wheat grains (Triticum aestivum). African Journal of Agricultural Research **6**(13), 3043 – 3048. DOI: 10.5897/AJAR11.622

Islam M S, Md Azizul H M, Kazi S A, Fuad M M and Chandra, K D (2013). Evaluation of some spices powder as grain protectant against pulse beetle, Callosobruchus Chinensis (L.). Universal Journal of Plant Science **1**(4), 132-136. DOI: 10.13189/ujps.2013.010404

Karso B A (2018) Bioassay of some extract plants on saw toothed grain beetle Oryzaephilus surinamensis L. (Coleoptera : Silvanidae). Journal of Kirkuk University for Agricultural Sciences **9**(4), 164 – 170.

Kéita S M, Charles V, Jean-Pierre, S. ; John, T.A. ; André, B. (2001). Efficacy of essential oil of Ocimum basilicum L. and O. gratissimum L. applied as an insecticidal fumigant and powder to control Callosobruchus maculatus (Fab.) [Coleoptera: Bruchidae]. Journal of Stored Products Research, **37**:339 – 349. DOI: 10.1016/s0022-474x(00)00034-5

Laizu M (2009) Effect of some botanicals on mortality, adult longevity and oviposition of pulse beetle on mungbean. MSc. Thesis, Sher-e-Bangla Agricultural University Dhaka, Bangladesh. pp. 76.

Nair N, Dilip N, Sahini R and Prasenjit P (2020) Management of pulse beetle, Callosobruchus maculatus (Chrysomelidae: Coleoptera) using local natural products in Tripura. Journal of Entomology and Zoology Studies **8**(6), 100 – 103.

Oladipupo J A and Sanni A Y (2019). Evaluation of powder mixtures of selected plants as protectants of cowpea (Vigna unguiculata [L.] Walp.) Against Callosobruchus maculatus (F.). Acta Entomologica Slovenica **27**(2), 117 – 135.

Oliveira J V, José Djair V, Marinéia L H (1999) Bioatividade de pós vegetais sobre o caruncho do feijão em grãos armazenados. Revista de Agricultura, Piracicaba **74**(2), 217 – 227.

Oluwafemi A R (2012) Comparative effects of three plant powders and pirimiphos-methyl against the infestation of Callosobruchus maculatus (F.) (Coleoptera: Bruchidae) in cowpea seeds. Signpost Open Access Journal of Entomological Studies **1**(2), 108 – 117.

Pannuti L E R, Marchi L S and Baldin E L L (2012) Use of source powders plant as an alternative for the control of Callosobruchus maculatus. Bull. San. Veg. Plagues **38**, 33-40.

Rajapakse R H S (2006) The potential of plants and plant products in stored insect pest management. The Journal of Agricultural Sciences **2**(1), 11 – 20.

Saxena A (2016) Efficacy of Indian spices against Tribolium castaneum (Herbst) (Coleoptera : Tenebrionidae) as third generation insecticides. Ph.D. thesis, University of Kota, Kota, Rajasthan. pp. 128.

Suleiman M and Yusuf M A (2011) The potential of some plant powders as biopesticides against Sitophilus zeamais (Motsch.) (Coleoptera: Curculionidae) And Callosobruchus maculatus (F.) (Coleoptera: Bruchidae) on stored grains: A Review. Bayero Journal of Pure and Applied Sciences **4**(2), 204 – 207. DOI: 10.4314/bajopas.v4i2.41

Swami V P, Amrita S, Ashok K and Tabrez A (2013). Toxic, repellent and population suppressant activities of selected spice powders towards coleopteran beetles infesting stored grains. International Journal of Agricultural Science & Technology, **2**(1): 34 – 45.

Tabu D, Selvaraj T, Singh S K and Mulugeta N (2012). Management of Adzuki bean beetle (Callosobruchus chinensis L.) using some botanicals, inert materials and edible oils in stored chickpea. Journal of Agricultural Technology **8**(3), 881- 902.

Upadhyay R K and Ahmad S (2011) Management strategies for control of stored grain insect pest in farmer stores and public ware houses. World Journal of Agricultural Science **7**(5), 527–549.