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BIO-RESIDUAL STUDIES AND TREATING GUNNY SACKS WITH COUMARINS EXTRACT ON SEED PROTECTION AGAINST COWPEA BEETLE, *CALLOSOBRUCHUS MACULATUS* (FAB.)

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Abstract

Cowpea beetle, *Callosobruchus maculatus* (Fab.) (Coleoptera: Bruchidae), is the most important storage pest of cowpea. The quantification of cowpea losses through *C. maculatus* is very desirable. Coumarins possess controlling cowpea beetle. Both Ethanol and Chloroform extracts of Murraya, Kumquat and Celery plants were studied. Murraya ethanol extracts was more efficient than chloroform, as it induces higher percentage of reduction in the progeny, also protects cowpea seeds till 6 months when using the higher concentration (4%). Gunny sacks were treated with different extracts of the three of plants as an application method for protecting stored grain from infestation and ethanol extracts was a more effective than chloroform. The effect of the extracts on the weight loss of cowpea seeds was studied. The reduction percentage in weight increased from zero to 13% and 17.10% after nine months for both chloroform and ethanol kumquat extracts, respectively at the higher concentration used.

Keywords: Callosobruchus maculatus, Coumarins, Bio-residual, seed protection

Introduction

Cowpea, *Vigna unguiculata* (L.) (Leguminosae), is the major grain legume crop in many countries in the tropics and subtropics regions for human as well as for animal food. Its value lies in its high protein content (23-29%, with potential for perhaps 35%); and its ability to fix atmospheric nitrogen, which allows it to grow on, and improve poor soils (Steele, 1972 and Duke, 1990, Parck et al. 2003 and Rahman and Talukader, 2006). Cowpea plant, *Vigna spp* greatly suffered from the attack by several insect pests, especially of family Bruchidae, *Callosobruchus maculatus* (Fab.) which induce higher damage to the yield of one of great protein source.

Cowpea seed beetle, *C. maculatus* (Fab.), is the most important storage pest of cowpea throughout the tropics (NRI, 1996). *C. maculatus* consumed 50-90% of cowpea in storage annually (IITA, 1989). Frequently, farm storage for six months was accompanied by 70% seed infestation and about 30% weight loss and virtually unfit for consumption (Singh and Len, 1985). These percentage losses are mere estimates. The quantification of cowpea losses through *C. maculatus* is very desirable. The control of the cowpea beetle in developing countries depends mainly on chemical insecticides and fumigation. These methods, however, cause serious problems such as development of insect resistant strains and toxic residue. Therefore, it is necessary to develop more selective and safer materials which might fulfill

these requirement natural products incuding plant constituents and formulations appear to be promising in this respect (Ismail and Shahat, 1996; Dimetry et al. 2007 and Ismail et al., 2011). In the present study three plants i.e. Murraya, Kumquat and Celery were chosen to elucidate their anti-feedant and protectant against cowpea beetles *C. maculatus* that destroy cowpea seeds. As well as application of the plant extracts (ethanol and chloroform) as a protectant from cowpea seeds in storage.

Materials and methods

Bio-residual effect

Seed treatments

In this experiment, 250 grams of treated and untreated seeds were stored for 1, 3, 6 and 9 months after treatment and before exposing to the insect infestation. Treated seeds were placed in glass jars (250cm^3), using 25 g of the seeds/jar. All treatments were replicated 3 times. Five pairs of the newly emerged beetles were released in each replicate for five days. At the end of the five days, the infested seeds were taken out and kept in clean jars. When the adults started to emergence, they were counted until no more emergences occurred.

The persistence activity of plant extract for protecting stored cowpea seeds against the beetle's *C. maculatus* was estimated by the use of the following equation:

% Reduction in emergence = B-A/B x 100

Where: B= Number of adults emerged in control.

A= Number of adults emerged in treatment.

The application of plant extract to protect stored seeds in gunny sacks:

Water emulsion of the tested plant extract was used for sack impregnation for 30 seconds, then they were dried using a fan. Six gunny sacks were used for each treatment and a similar number of control, which impregnated in water and emulsifier only. Following treatment, the gunny sacks (20x20 cm) were filled, each with 250 grams of cowpea seeds. Seeds of each treatment were placed in the experimental storage cage. Control sacks were placed as well as separately in other cage. Fifteen pairs of newly emerged adults were immediately released after treatment in each cage, including the control ones. Treated gunny sacks containing seeds as well as the untreated gunny sacks (control) were stored for nine months under laboratory conditions. All sacks were investigated monthly until nine months. The number of seeds with holes on seeds was counted. The effectiveness of tested extracts on protecting stored seeds in gunny sacks was estimated by calculating the percentage of reduction in seeds infestation and reduction in the total output of eggs.

% Reduction of cowpea with eggs =

Cowpea seeds with eggs in control – Cowpea seeds with eggs in treated / Cowpea seeds with eggs in control x 100.

% Reduction of cowpea with holes =

Cowpea seeds with holes in control – Cowpea seeds with holes in treated / Cowpea seeds with holes in control x 100.

Also, the percentage of weight loss of seeds caused by *C. maculatus* was determined during storage. The percentage of reduction in the cowpea seeds weight was estimated according to the following equation:

Weight reduction (%) = Initial weight – final weight /initial weight x 100.

Results and discussion

Bio-residual studies

Table (1) described the bio-residual effect of both extracts of three plants, Murraya, Kumquat and Celery. Murraya ethanol extracts was more efficient than chloroform, as it induces higher percentage of reduction in the progeny, also protects cowpea seeds till 6 months when using the higher concentration (4%).

The effectiveness of the extracts decreased by long storage of the seeds, through the different concentration used. The same trend was obtained with chloroform extract, however with lower effect than ethanol.

Kumquat, ethanol extract was efficient as protectant. The effect lasts for three months with 87.14 % reduction of the progeny at 4% concentration. The decrease in bio-residual effect was in parallel with increase in storage period. Ethanol extract was more active than chloroform one.

Celery, ethanol extract at 4% reduced the progeny of cowpea beetles by 78.86 % after one month and decreased to 66.16 % after nine months.

So, it could be concluded that murraya, ethanol had a bio-residual till six months when using 4 % as it gave 93.06 % reduction in progeny, followed by kumquat, then celery at the same concentration.

The data obtained in this investigation were in good agreement with those of **Risha et al., (1990)** who found that soybean oil caused higher percentage reduction of *Callosobruchus chinensis* progeny when applied on faba bean seeds. They also added that, increase of storage period of treated seeds, its efficiency decreased significantly.

Bhaduri et al., (1985) proved that extracts of *Tridax procumbeus* were significantly efficient in reducing the population of *Callosobruchus maculatus* and protecting the cowpea seeds for 6days after treatment.

Sharma, (1985) reported that extracts of three flours decreased adult emergence of *Rhizopertha dominica***.**

El-Kholy, (1997) found that the extract of *Brassica napus* achived different reduction in F1 progeny of *Sitophilus oryzae*. The reduction reached 100 % at 4% concentration.

The tested *Rosmarinus officinalis* (L)) (Lamiaceae) demonstrated an insecticidal activity vis-à-vis the parameters of the *C. maculatus*. Their use in stored legumes protection is a promising alternative to synthetic pesticides without adverse effects on the environment and consumers, their constituents are biodegradables with short half-lives, **Douiri, et al. 2013 and 2014**.

Effect of treating gunny sacks with plant extract on seed protection:

Gunny sacks were treated with different extracts of the three of plants as an application method for protecting stored grain from infestation. The sacks were filled with constant weight of cowpea seeds and were subjected to the infestation with the beetles, and kept for nine months. Percentages of reduction in seeds with eggs and with holes were counted every month and reductions (%) of seeds weight were determined.

From table (2) it was noticed that murraya, both extracts kept its seeds healthy without any infestation (100% reduction in infestation) for one month, then began to decreased gradually with storage period: till it reached 37.0, 39.0 and 40.0 for ethanol

Table (1) Efficiency of tested plant extracts on cowpea seeds protectant against *C. maculatus* during storage (Bio-residual effect).

Duration of storage after seed treatment	Treatment	Concentration % W/ V	Mean number of adult emergence		Reduction of progeny (%)	
			Ethanol	Chloroform	Ethanol	Chloroform
One month	Murraya	1	118±2.03	145±2.31	39.17	25.25
		2	112±1.07	55±1.98	42.27	20.10
		4	9±0.99	56± 2.13	96.36	71.13
	Kumquat	1	76±1.94	81±1.39	60.86	58.24
		2	74±1.32	74±1.45	61.82	60.30
		4	12±1.14	22±1.21	93.81	88.65
	Celery	1	111±2.03	132±2.35	42.29	31.63
		2	109±2.01	121±2.112	43.78	37.96
		4	41±2.11	78±1.42	78.86	59.80
	Control	----	194±2.34	194±2.34	--	--
Three month	Murraya	1	136±3.14	167±1.77	35.24	20.71
		2	130±2.10	156±2.11	38.11	25.48
		4	11±2.25	78±1.79	95.67	62.85
	Kumquat	1	99±1.79	89±2.37	52.81	57.00
		2	97±2.73	84±1.66	53.85	60.61
		4	27±1.23	33±1.98	87.14	84.28
	Celery	1	122±3.11	143±2.99	41.90	31.62
		2	119±1.22	131±1.55	43.33	37.90
		4	53±1.71	85±2.39	74.76	59.52
	Control	----	210±2.16	210±2.16	--	--
Six month	Murraya	1	140±1.99	174±1.87	30.69	13.27
		2	134±3.01	157±1.97	33.66	22.86
		4	14±1.34	84±2.35	93.06	58.41
	Kumquat	1	117±2.64	102±2.36	42.54	49.98
		2	110±0.10	97±2.98	45.07	51.50
		4	44±1.79	41±1.44	78.21	79.70
	Celery	1	127±2.00	145±2.37	37.13	28.63
		2	124±2.07	128±1.58	38.62	36.21
		4	59±2.67	84±1.33	70.79	58.42
	Control	---	202±3.01	202±3.01	--	--
Nine month	Murraya	1	199±2.01	200±122	11.95	10.16
		2	195±2.01	194±1.50	12.16	11.71
		4	98±3.01	104±2.38	56.25	53.57
	Kumquat	1	144±2.66	147±1.58	35.71	34.16
		2	`139±1.79	143±2.35	37.95	36.37
		4	79±2.19	104±1.11	64.73	53.57
	Celery	1	145±2.13	162±2.74	35.27	27.27
		2	139±1.79	165±2.97	37.94	35.68
		4	74±2.23	93±0.90	66.16	58.48
	Control	---	224±2.70	224±2.70	--	--

Table (2) Efficiency of tested plant extracts of murraya on cowpea seeds stored in gunny sacks protectant against *C. maculatus* during storage.

Plant extract	Duration of storage after treatments (month)	Concentration (%,W/V)	Reduction in cowpea with eggs (100%)		Reduction in cowpea with holes (%)	
			Ethanol	Chloroform	Ethanol	Chloroform
Murraya	1	1 2 4	100.00 100.00 100.00	100.00 100.00 100.00	100.00 100.00 100.00	100.00 100.00 100.00
	2	1 2 4	91.00 93. 00 94.00	89.50 89.50 91.00	95.20 97.40 98.00	93.00 94.00 95.00
	3	1 2 4	84.24 86.67 87.66	82.00 83.21 85.51	86.70 88.20 90.00	86.40 87.10 88.20
	4	1 2 4	78.70 80.00 81.74	74.50 77.00 79.97	80.50 82.44 84.50	79.50 80.00 81.00
	5	1 2 4	70.00 72.50 74.00	65.00 76.50 68.50	79.50 81.00 82.33	77.50 78.50 80.00
	6	1 2 4	65.10 68.20 69.70	53.20 55.40 56.00	78.21 79.43 79.90	75.40 77.34 78.00
	7	1 2 4	58.71 60.41 62.50	49.50 51.00 53.50	67.00 69.00 70.50	63.00 65.00 66.60
	8	1 2 4	48.50 50.10 52.40	39.00 40.50 43.40	63.00 65.50 66.70	44.50 47.50 48.00
	9	1 2 4	37.00 39.00 40.00	29.00 31.00 32.50	38.50 39.50 41.00	32.00 33.40 34.50

extract of 1, 2 and 4 % concentrations, respectively after nine months. From table (2) it is clear that 69.7 % reduction in cowpea with eggs (%healthy seeds) after 6 months at 4% ethanol extract. However, 79.90 % reductions in cowpea with holes in the same time with the same concentration used from ethanol extract. In all cases, ethanol extracts was a more effective than chloroform.

When the sacks were treated with kumquat extract, (Table 3) it showed that these extracts kept seeds un-infested totally by the beetles for one month. After nine months, the healthy seeds reached 55.44 % (reduction in cowpea with eggs) and 56.5 % (reduction in cowpea with holes) at 4 % with ethanol extract.

Table (3) Efficiency of tested plant extracts of Kumquat on cowpea seeds stored in gunny scks protectant against *C. maculatus* during storage.

Plant extract	Duration of storage after treatments (month)	Concentration (%,W/V)	Reduction in cowpea with eggs (100%)		Reduction in cowpea with holes (%)	
			Ethanol	Chloroform	Ethanol	Chloroform
Kumquat	1	1 2 4	100.00 100.00 100.00	100.00 100.00 100.00	100.00 100.00 100.00	100.00 100.00 100.00
	2	1 2 4	85.44 88.50 89.40	82.00 84.50 85.70	87.00 89.00 90.50	85.40 87.50 88.50
	3	1 2 4	78.20 80.40 81.22	76.66 76.71 79.48	84.67 86.21 88.21	82.00 85.00 86.20
	4	1 2 4	75.00 76.90 77.50	72.50 74.00 75.50	82.40 84.00 86.50	79.50 81.00 83.00
	5	1 2	74.00 75.00	71.00 71.00	81.50 82.00	77.50 78.50

		4	76.00	72.00	83.50	79.00
	6	1 2 4	71.70 72.00 72.50	68.00 70.50 71.50	79.77 80.44 82.00	76.00 76.90 77.77
	7	1 2 4	66.66 68.00 69.50	65.00 66.00 67.00	77.00 78.00 78.50	74.00 75.00 75.50
	8	1 2 4	56.00 57.50 58.77	52.00 53.00 55.55	63.00 65.50 67.00	61.00 62.00 62.50
	9	1 2 4	52.70 54.50 55.44	49.00 51.55 52.31	54.00 55.77 56.50	52.74 53.66 54.00

On the other hand, chloroform extract caused 52.31 % and 54.0 % reduction in the infestation either with eggs or holes, respectively at the end of the experiment. In the period of storage, ethanol extract was superior than chloroform. From table (4) celery treatment kept the seeds un- infested for 1 month, with all the concentrations used.

The infestation reached 67.99 % (with eggs) and 69.00 % (with holes) for ethanol extract after storage for nine months, while it was 63.17 % and 65.50% for chloroform one, using the higher concentration which prove to be safe from the pharmacological point of view.

Celery can also be used as a protectant agent for cowpea seeds for a period of eight month storage from beetle infestation (table 4, 7). In the second rank came kumquat, than murraya with nearly equal protection degree.

Dimetry, et al. 2007 stated that the efficacy of different formulations of the *Citrullus colocynthis* active ingredients in powder or emulsifiable concentrate in cowpea stored in different storage sacks (damour, polyethylene, gunny plastic and jute) protection against *Callosobruchus maculatus* attack was evaluated. All the formulations used were effective bioinsecticides against *C. maculatus*. And no adult *C. maculatus* was recorded during seven months of storage when damour sacks for storing cowpea seeds treated with alcohol or chloroform extract powder formulations were used. Different formulations used had no adverse effect on seeds' germination.

Study the effect of the extracts on the weight loss of cowpea seeds

To study the effect of the extracts on the weight loss of cowpea seeds, table (5) presented the data obtained. The seeds in sacks treated with murraya extracts, chloroform and ethanol decreased in weight from 250 grams till 147.6 and 175.0 grams respectively after storage for nine months at 1% concentration, the percentage
reduction of weight increased from zero at the beginning of the experiment to 41.60 and 30.0% for chloroform and ethanol extracts respectively after nine months.

From table (6), kumquat when used to treat the gunny sacks protected the seeds from infestation and in turn from seed weight loss. `No loss in weight was observed after 2 months storage, however low decrease in weight began after that time, from 247.5 g. for the chloroform extract at 4% concentration.

On the third month, the weight began in decreasing till reached 217.5 g. after nine months. For ethanol kumquat extract, the decrease in seed weight started after 4 months from 245.00 g. till reached 217.55 at the end of the experiment, versus 132.57 g. for the control. The reduction percentage in weight increased from zero to 13% and 17.10 % after nine months for both chloroform and ethanol kumquat extract, respectively at the higher concentration used.

The results of the present investigation go parallel with those reported by Ismail et al., (1995), they reported that eucalyptus, dodonea, guava powdered leaves and orange fruit peel

were toxic to (*Challosobruchus quadrimaculatus* Fab.) under laboratory condition, however orange fruit peel and eucalyptus leaves were more repellent.

On the same subject, Iehrer, (1983) on his investigation on the toxicity of the plant material to *Challosobruchus maculatus* beetles, concluded that neem oil protected the cowpea throughout six months storage period and only 5% of their initial weight was last after six months of storage and 18% after 10 months. With peanut oil 27% of cowpea weights were lost after 6 months. It appears that neem oil has insecticidal properties.

Recently, many authors investigated different plants containing different organic chemical groups to protect cowpea seeds from infestation with *Challosobruchus maculatus*, from these , Shaaya et al., (1997) in Botswana used powdered plants widely distributed is southern Africa to control *Challosobruchus maculatus* in cowpea seeds.

Table (4) Efficiency of tested plant extracts of Celery on cowpea seeds stored in gunny scks protectant against *C. maculatus* during storage.

Plant extract	Duration of storage after treatments (month)	Concentration (%,W/V)	Reduction in cowpea with eggs (100%)		Reduction in cowpea with holes (%)	
			Ethanol	Chloroform	Ethanol	Chloroform
Celery	1	1	100.00	100.00	100.00	100.00
		2	100.00	100.00	100.00	100.00
		4	100.00	100.00	100.00	100.00
	2	1	94.50	92.50	96.50	94.00
		2	96.50	93.70	97.00	95.00
		4	97.50	95.00	98.50	96.00
	3	1	90.00	87.01	90.50	89.44
		2	91.22	88.36	93.24	91.00
		4	92.78	88.73	94.21	92.46
	4	1	88.86	85.00	90.00	87.00
		2	90.00	87.44	91.00	88.00
		4	90.50	88.80	92.50	89.50
	5	1	83.50	81.00	86.00	83.00
		2	84.00	82.00	87.50	85.00
		4	86.50	83.50	89.50	87.77
	6	1	81.60	78.00	85.00	81.00
		2	82.00	80.50	86.44	82.77
		4	82.50	81.00	86.90	84.00
	7	1	77.60	75.00	80.00	77.55
		2	79.50	77.00	82.00	79.00
		4	80.00	79.00	83.50	80.11
	8	1	69.00	66.50	74.00	72.00
		2	71.00	67.00	75.50	74.50
		4	73.00	69.50	77.70	75.00
	9	1	61.00	57.00	65.70	61.00
		2	62.77	59.21	67.99	62.77
		4	67.99	63.17	69.00	65.50

Table (5) Efficiency of tested plant extracts of murrya on the percentage of weight loss of cowpea seeds caused by *C. maculatus* during storage (Initial weight 250grams).

Plant extract	Duration of storage after treatment (month)	Concentration (%, W/V)	Weight of seeds after storage		Reduction of weight (%)	
			Ethanol	Chloroform	Ethanol	Chloroform
Murraya	1	1	250.00	250.00	0.00	0.00
		2	250.00	250.00	0.00	0.00
		4	250.00	250.00	0.00	0.00
		Control	250.00	250.00	0.00	0.00
	2	1	247.50	242.50	1.00	3.00
		2	250.00	242.50	0.00	3.00
		4	250.00	245.50	0.00	2.00
		Control	242.00	242.50	3.00	3.00
	3	1	240.00	227.50	4.00	9.00
		2	245.00	227.50	2.00	9.00

		4	247.00	230.00	1.00	8.00
		Control	225.00	225.00	10.00	10.00
	4	1	227.00	225.00	9.00	10.00
		2	242.00	225.00	3.00	10.00
		4	242.00	225.00	3.00	10.00
		Control	225.00	225.00	10.00	10.00
	5	1	232.50	230.00	7.00	8.20
		2	237.50	232.00	5.00	8.10
		4	240.00	232.00	4.00	7.00
		Control	227.50	227.50	9.00	9.00
	6	1	221.30	220.00	11.70	12.00
		2	224.50	220.00	10.20	12.00
		4	227.70	224.25	8.70	10.30
		Control	217.50	217.50	13.00	13.00
	7	1	208.75	202.50	17.50	19.30
		2	211.00	206.50	16.60	11.40
		4	235.00	213.50	6.80	14.60
		Control	197.50	197.50	21.00	21.00
	8	1	191.00	173.00	24.60	31.80
		2	193.00	178.75	23.80	29.50
		4	206.00	181.00	18.30	28.60
		Control	167.50	167.00	33.00	33.00
	9	1	175.00	147.60	30.00	41.60
		2	182.50	152.60	27.00	39.50
		4	195.00	162.50	22.00	35.50
		Control	132.75	132.75	47.30	47.30

Table (6) Efficiency of tested plant extracts of kumquat on the percentage of weight loss of cowpea seeds caused by *C. maculatus* during storage (Initial weight 250grams).

Plant extract	Duration of storage after treatment (month)	Concentration (%, W/V)	Weight of seeds after storage		Reduction of weight (%)	
			Ethanol	Chloroform	Ethanol	Chloroform
Kumquat	1	1	250.00	250.00	0.00	0.00
		2	250.00	250.00	0.00	0.00
		4	250.00	250.00	0.00	0.00
		Control	250.00	250.00	0.00	0.00
	2	1	250.00	250.00	0.00	0.00
		2	250.00	250.00	0.00	0.00
		4	250.00	250.00	0.00	0.00
		Control	242.50	242.50	3.00	3.00
	3	1	250.00	245.00	0.00	2.00
		2	250.00	245.00	0.00	2.00
		4	250.00	247.50	0.00	1.00
		Control	225.00	225.00	10.00	10.00
	4	1	242.50	237.50	3.00	5.00
		2	242.50	242.50	3.00	3.00
		4	245.00	242.50	2.00	2.00
		Control	225.00	225.00	10.00	10.00
	5	1	240.00	230.00	4.00	8.00
		2	242.50	232.50	3.00	7.00
		4	242.50	242.50	3.00	3.00
		Control	227.50	227.50	9.00	9.00
	6	1	222.50	230.00	11.00	8.00
		2	225.00	231.00	10.00	7.60
		4	237.00	231.00	5.00	7.50
		Control	217.50	217.50	13.00	13.00
	7	1	214.25	213.25	15.30	15.70
		2	219.25	215.50	13.90	14.80
		4	224.50	224.25	11.20	11.30
		Control	197.50	197.50	21.00	21.00
	8	1	211.25	208.25	18.50	17.70
		2	210.00	213.00	17.60	15.80

		4	222.25	221.75	15.10	12.30
		Control	167.50	167.50	33.00	33.00
	9	1 2 4	212.00 212.50 217.55	210.50 212.50 217.50	18.10 18.00 17.10	16.50 15.00 13.00
		Control	132.75	132.75	47.30	47.30

Table (7) Efficiency of tested plant extracts of celery on the percentage of weight loss of cowpea seeds caused by *C. maculatus* during storage (Initial weight 250grams).

Plant extract	Duration of storage after treatment (month)	Concentration (%, W/V)	Weight of seeds after storage		Reduction of weight (%)	
			Ethanol	Chloroform	Ethanol	Chloroform
Celery	1	1 2 4	250.00 250.00 250.00	250.00 250.00 250.00	0.00 0.00 0.00	0.00 0.00 0.00
		Control	250.00	250.00	0.00	0.00
	2	1 2 4	250.00 250.00 250.00	250.00 250.00 250.00	0.00 0.00 0.00	0.00 0.00 0.00
		Control	242.50	242.50	3.00	3.00
	3	1 2 4	250.00 250.00 250.00	250.00 250.00 250.00	0.00 0.00 0.00	0.00 0.00 0.00
		Control	225.00	225.00	10.00	10.00
	4	1 2 4	250.00 250.00 250.00	242.50 246.70 250.00	0.00 0.00 0.00	3.00 1.80 0.00
		Control	225.00	225.00	10.00	10.00
	5	1 2 4	246.00 247.00 250.00	242.50 245.00 247.50	1.60 1.00 0.00	3.00 2.00 1.00
		Control	227.50	227.50	9.00	9.00
	6	1 2 4	241.00 242.50 247.50	235.00 240.00 246.00	4.00 3.00 1.00	6.00 3.00 1.00
		Control	217.50	217.50	13.00	13.00
	7	1 2 4	238.75 244.75 245.50	229.92 233.25 238.25	5.50 3.10 2.80	9.03 6.50 4.70
		Control	197.50	197.50	21.00	21.00
	8	1 2 4	232.50 237.50 243.75	224.75 226.00 233.00	7.50 5.50 2.50	11.10 8.00 6.80
		Control	167.50	167.50	33.00	33.00
	9	1 2 4	227.00 232.00 237.50	217.50 225.25 231.25	9.00 7.00 5.00	13.00 9.00 7.50
		Control	132.75	132.75	47.30	47.30

In small scale storage systems in Nigeria, Okonokwo and Okoye, (1996) used cheap and safe materials that would not contaminate food products in acting as grain protectants. Popoola (2013) concluded that the botanicals employed are potential insecticides for protection of stored dates form *Oryzaephilus. surinamensis* infestation and also, that botanicals have advantages over broad-spectrum
conventional pesticides, because they affect only target pest and closely related organisms, equally they are effective in very small quantities, decompose quickly, and provide the residue free food and a safe environment to live.

According to the obtained results, it could be stated that the tested compounds played an important role in controlling the bruchid *C. maculatus*. These compounds may be used as components in (IPM) programmes for controlling this insect pest and to avoid pollution of environment and hazards to man or animals.

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