Research Article

Efficacy of *Clerodendrum capitatum* and *Phyllantus fraternus* leaf powders on seed beetles of stored maize and cowpea

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Abstract: The effects of *Clerodendrum capitatum* (Willd.) and *Phyllanthus fraternus* (Webster) powders were evaluated in reducing *Callosobruchus maculatus* (F.) and *Sitophilus zeamais* (L.) adult emergence and cowpea and maize seed damage under laboratory conditions. The dried and powdered plant leaves were tested against the virgin weevils by exposing ten unsexed adults to concentration levels of 0, 500, 1000, 1500 and 2000 mg/kg of seeds in three replications. Results obtained showed that the plant powders did not cause significant adult mortality of either of the insects but, significant reductions were recorded in terms of weight loss, seed damage, adult emergence and number of exit holes in maize. The plant powders showed great potentials for use as plant derived insecticides for controlling *C. maculatus* and *S. zeamais* in stored seeds.

Keywords: *Clerodendrum capitatum; Phyllanthus fraternus*; leaves powder, *Callosobruchus maculatus*, *Sitophilus zeamais*

Introduction

Maize, *Zea may* L. is an important food and cash crop widely grown in Nigeria and regarded as the major staple food accounting for 65% of dietary calories of majority of the Nigerian teeming population (Abass *et al*., 2014). Similarly, cowpea *Vigna unguiculata* (L.) Walp is a major food crop cultivated in tropical and subtropical regions, with the most producing areas in Nigeria located in the savanna (Jackai and Daoust, 1986). Its grains serve as major source of protein for man and plant material serves as fodder for livestock (Egho, 2011). It is widely cultivated and consumed in various forms in Nigeria by the teeming population whose economic condition will not permit them to afford animal products as their protein source.

One of the main constraints to increase agricultural production and value-addition in the farm produce is insect pest attack. Meanwhile, preservation of the quality of the seeds for the following year is one of the worries of farmers. The heavy post-harvest losses and quality deterioration caused by storage pests are major problems facing agriculture in developing countries (Kesavan and Swaminathan, 2008). The most important storage pest of cowpea is *Callosobruchus maculatus* (F.). The larvae bore into grains throughout the tropics and subtropics (Jackai and Daoust, 1986; Kfir *et al*., 2002). Similarly *Sitophilus zeamais* (Motsch.) is the major storage pest of maize. These insects develop inside kernel and feed on starch content of the seeds. Adults hatch and eat the starchy interior and make their way out of the grain and continue to feed voraciously. Damages caused by these storage pests include weight loss, loss in quality and

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market value. This also results in promotion of mould development, reduced seed germination and nutritional value (Barr *et al*., 2013).

To reduce the losses, farmers are extensively using chemical pesticides at high concentrations, Though chemical control is effective, quick, secure and economical, its continuous use has some major drawbacks viz: They are highly expensive and also may result in toxicity to humans and other non-targeted species; presence of residues in different parts of the plants; development of resistance to pesticide, health related poverty and environmental degradation (Esser *et al*., 2012). The illegitimate use of chemical pesticides is due to unawareness of their toxicity, poor knowledge of application, aggressive marketing by dealers and profit interests.

Current extension and research approaches and global tendency of dumping relatively cheaper and environmentally unsafe pesticides in developing countries attribute to increased use of pesticides (Upadhyay, 2003). Consequently frequent pest outbreaks, pest resurgences, pesticide resistance issues occur. To handle these problems farmers and researchers are looking for less toxic/harmful alternatives (Ekstrom and Ekbom, 2011) for instance plant-derived substances with insecticidal properties which are being used for many years in developing countries (Paez *et al*., 1990 (Cantrell *et al*., 2012; Rajashekar *et al*., 2012; Miresmailli and Isman, 2014), that are more eco-friendly.

Clerodendrum capitatum (Willd) Schumach et. Thonn. var capitatum (Family: Verbenaceae), is an indigenous tropical African plant, which grows fast, erect, well branched, having perennial under shrub and grows up to 0.5-2 m high (Adeneye *et al.,* 2008). Its stem is quadrangular in transverse section and it is covered with soft hair. The plant leaf is simple, oval or elliptical, generally bent at the base, rigid, leaving an under thorn stab on the stem after the fall of the leaf. Its inflorescence is glomerular with globular terminal auxillage and flowers yearly (Adeneye *et al.,* 2008; Mahmoud *et al.,* 1995). Dried roots of this plant are used traditionally in the management of erectile dysfunction in male (Mahmoud *et al.,* 1995). In Nigeria, The plant though reputed for bone healing in fractures and as such popularly called medicinal magical plant (Adeneye *et al.,* 2008); it is equally reputed for local management of diabetes mellitus, obesity and hypertension.

Phyllantus fraternus Webster (Family: Euphorbiaceae) commonly called; gulf leaf flower, is a small, erect, annual herb that grows 30–40 cm in height (Wunderlin and Hansen, 2002) and widely distributed in most tropical and subtropical countries. It is indigenous to the rainforests of the Amazon and other tropical areas throughout the world and is quite prevalent in the Amazon and other wet rainforests, growing and spreading freely (much like a weed) (Leslie, 2003). It is extensively used in folk medicine in India and most other countries for the treatment of a broad spectrum of diseases, such as disturbances of the kidney and urinary bladder, intestinal infections, diabetes, and hepatitis (Calixto *et al.,* 1998; Unander *et al.*, 1995); fever, flu, tumors, jaundice, vaginitis, and dyspepsia, diabetes, dysentery. The plant also is considered analgesic and as an aperitif, carminative, digestive, laxative, stomachic, tonic, and vermifuge (Leslie, 2003).

In literature, there seem to be dearth of empirical information on the insecticidal efficacy of *C. capitatum* and *P. fraternus*; although both plants are used for ethno medicinal purposes in some South-Western states of Nigeria (Adeneye *et al*., 2008; Eldeen *et al*., 2011). However, there are no reports on use of these plants against the insect pests. Hence the present study aims to evaluate direct toxicological effect of *C. capitatum* and *P. fraternus* powders against *C. maculatus* and *S. zeamais*, infesting stored grains, on their adult emergence, and seed weight loss in treated grains.

Materials and Methods

Insect Culture

Initial stock used for the experiment was obtained from cowpea and maize seeds that were bought from Oja-Oba market, Owo, Ondo state. The maize and cowpea seeds were put in different jars covered with net and adult *S. zeamais* and *C. maculatus* were introduced into the jars respectively. The jars were kept at room temperature for the insects to breed and multiply. The population was recycled monthly.

Collection and preparation of plant materials
C. capitatum were collected from Ilu-titun in Okitipupa Local Government Area of Ondo State, Nigeria; while *P. fraternus* were collected from the polytechnics' community. Leaves were separated from the plant and were dried at room temperature for about 15 days, after which, the leaves were ground into powder using hammer mill.

Source of cowpea and maize substrate
The uninfested cowpea (drum variety) and maize (local variety) used for the experiment were procured from Oja-Ikoko, Owo, Ondo State, Nigeria. These were properly handpicked and sieved. Thus, ensuring that only whole and infestation-free seeds were used. Nevertheless, the maize and cowpea seeds were then sterilized in the electric oven for an hour at 80 °C. The seeds were then cooled at room temperature. Twenty g each of the uninfested cowpea and maize seeds were weighed separately and kept at room temperature. The experiment was carried out in triplicate for each treatment.

Toxicity effect of *C. capitatum* and *P. fraternus*
The plant powders were tested at varying concentration 0 to 2000 mg/kg of the uninfested cowpea and maize seeds in separate plastic petri-dishes. Petri dish containing uninfested seed without plant leaves powder served as control. Each petri-dish was tumbled several times to ensure homogenous mixing of the powder with the grains (Adesina *et al.,* 2012). Ten virgin *C. maculatus* and *S. zeamais* (3-5 days old) were introduced into each petri-dish and were kept for observation. Adult mortality was counted at 24, 48, 72, 96 and 120 h respectively after infestation and living insects were removed to give room for observation of emergence. Percentage adult mortality was calculated using the method by Abbott (1925).

Insects were considered dead on failure to respond to three probings using a blunt dissecting probe (Obeng-oforie *et al.,* 1997).

The number of emerged adults in maize was counted and recorded at the end of the experiment which was 45 d for maize. The number of emerged adults in the cowpea was also counted and recorded up to the end of the experiment, which was 35d. The following formula was used to calculate the percentage adult emergence in the cowpea seeds.

Percentage emergence =

$$\frac{Mean\ number\ of\ emerged\ adults}{Mean\ number\ of\ eggs\ laid} \times 100$$

Damaged and undamaged seeds were counted and used to determine the percentage seed damage.

Percentage seed damage =

$$\frac{Total\ number\ of\ treated\ seeds\ damaged}{Total\ number\ of\ seeds} \times 100$$

The number of exit holes was also counted and recorded to determine the extent of damage on the seeds by the weevils.

The final weight of the seeds in each of the treatments was determined and was used to calculate the percentage weight loss, (Enobakhare and Law-Ogbomo, 2002).

$$\text{Percentage weight loss} = \frac{W_i - W_f}{W_i} \times 100$$

where W_i = initial weight of seeds; W_f = final weight of seeds

Phytochemical Analysis of Plant Powders
Sample extraction: 50 g of the powdered leaves samples were weighed separately into five different containers. To which 300ml of each of the solvents (methanol, ethanol, n hexane, diethyl ether) and water was added, covered, shaken and kept for 72 h. The extracts were then obtained using WhatMan filter circle in a vacuum pump and the filtrates left to dry (i.e. The solvents were left to evaporate and later weighed to determine the percentage of yielded residues).

Phytochemical screening: Chemical tests were carried out using aqueous extracts to identify various constitutes using standard methods of Trease and Evans, (1989).

Test for Alkaloids: About 500 mg of the aqueous extracts of each sample was stirred with 5ml of 1% aqueous hydrochloric acid on a steam bath. Mayer and Wanger's Reagents was added to the mixture in drops. Turbidity of the precipitate was taken as an evidence for the presence of alkaloids.

Test for Saponins: 500 mg of the extracts was shaken vigorously with 5ml distilled water in a test tube and warmed. The formation of stable foam was taken as an indication of the presence of saponins.

Test for Tannins: About 2ml of the aqueous extracts were stirred with 2ml of distilled water in a test tube and warmed. The formation of green precipitate indicated the presence of tannins.

Test for Phlobatannins: About 2ml of the aqueous extracts were added to 2ml of 1% hydrochloric acid and the mixture was boiled. Deposition of a red precipitate was taken as an evidence for the presence of phlobatannins.

Tests of Salcowski: 500 mg of the extracts was dissolved in 2ml of chloroform, sulphuric acid was carefully added to form a lower layer. A reddish brown colour at interface indicated the presence of a steroidal ring (i.e. a glycone portion of glycoside).

Test of Kelakellani: 500 mg of the extracts was dissolved in 2ml of glacial acetic acid containing a drop of ferric chloride solution. This was then under layer with1ml of concentrated sulfuric acid. A brown ring obtained at the interface indicated the presence of deoxy sugar characteristics of cardenolides.

Statistical Analysis

Treatments were arranged in a Completely Randomized Design (CRD) and replicated three (3) times. Data collected were subjected to analysis of variance (ANOVA). While egg counts, damaged and undamaged seeds were subjected to square root transformation and percentages were arcsine transformed before analysis. Result means were separated using the LSD test ($p \leq 0.05$) (Zar, 1999).

Results

Mortality

The percentage mortality of *C. maculatus* and *S. zeamais* after treating seeds with different concentrations of *C. capitatum* and *P. fraternus* at 24 and 48h is summarized in Tables 1 and 2. The plant powders did not significantly ($P > 0.05$) affect the mortality of either of the insects at all levels. At 24h, the highest percentage mortality of *C. maculatus* was recorded at 1000 and 2000 mg/kg for *C. capitatum* (15%) and *P. fraternus* (18.44%) respectively. The highest percentage mortality recorded on *S. zeamais* was 6.14% at 1000 and 2000 mg/kg of *C. capitatum and P. fraternus* respectively. At 48h, *P. fraternus* had the highest percentage mortality effect on *C. maculatus* at 500 mg/kg *C. capitatum* recorded the highest mortality effect on *C. maculatus* at 1000 mg/kg while, the highest percentage mortality of *S. zeamias* for both powders remained at 6.14% for most concentrations of both powders.

The plants *P. fraternus* and *C. capitatum* leaf powders have significant ($P < 0.05$) mortality effect on *C. maculatus* and *S. zeamais* respectively, with the highest percentage mortality of *C. maculatus* (30.0%) recorded at 500 mg of *P. fraternus* and 2.14% recorded at 500 mg/kg of *C. capitatum* on *S. zeamais*, (Tables 1 and 2). At 96h, significant difference ($P < 0.05$) in percentage mortality was only recorded from *P. fraternus* on *C. maculatus* (Table 1), with highest value obtained (43.07%) recorded at 500 mg, while the lowest value (26.56%) was recorded at 0 mg. The percentage mortality of *C. maculatus* due to *C. capitatum* (30.99%) was recorded at 1500 mg. The highest percentage mortality of *S. zeamais* under the effect of *C. capitatum* (28.07%) was recorded at 0.5 and 2.0g respectively 30.00%, the highest percentage mortality of *S. zeamais* due to *P. fraternus* was recorded at 1000 mg (Table 2).

Table 1 Mean percent mortality (± SE) of *Callosobruchus. maculatus* after different exposure times to leaves powder of *Phyllantus fraternus* and *Clerodendrum capitatum.*

Plant leaf powders	Dosage (mg/kg)	24 h	48 h	72 h	96 h	120 h
P. fraternus	0	0.0	0.0	0.7 ± 0.01	0.8 ± 0.1	0.3 ± 0.06
	0.5	0.0	6.29 ± 0.2	17.2 ± 0.1	23.4 ± 1.0	26.6 ± 0.8
	1.0	0.0	8.85 ± 0.2	18.4 ± 0.7	23.4 ± 1.1	32.3 ± 1.6
	1.5	14.0 ± 0.6	12.29 ± 0.2	23.4 ± 1.0	31.0 ± 0.6	39.2 ± 2.6
	2.0	15.0 ± 0.2	17.70 ± 0.12	28.3 ± 0.9	33.0 ± 2.5	41.8 ± 2.5
	LSD	ns	ns	ns	ns	ns
C. capitatum	0	0.0	0.0	0.0	0.6 ± 0.2	1.0 ± 0.8
	0.5	6.14 ± 0.2	6.14 ± 0.6	21.2 ± 0.4	28.8 ± 0.9	31.0 ± 1.1
	1.0	14.66 ± 0.4	12.2 ± 0.2	23.4 ± 1.0	31.0 ± 1.1	39.0 ± 0.3
	1.5	18.25 ± 0.8	21.1 ± 0.4	23.9 ± 1.0	34.0 ± 1.8	42.9 ± 2.6
	2.0	18.40 ± 0.6	28.8 ± 0.8	33.8 ± 0.6	43.1 ± 0.6	52.9 ± 4.5
	LSD	ns	ns	10.87	8.68	12.96

Table 2 Mean percent mortality (± SE) of *Sitophilus zeamais* after different exposure times to leaves powder of *Phyllantus fraternus* and *Clerodendrum capitatum*.

Plant leaf powders	Dosage (mg/kg)	24 h	48 h	72 h	96 h	120 h
P. fraternus	0	0.0	0.0	0.3 ± 0.01	0.4 ± 0.1	1.2 ± 0.06
	0.5	0.0	6.14 ± 0.2	1.3 ± 0.02	6.2 ± 0.3	15.2 ± 0.2
	1.0	0.0	6.14 ± 0.2	6.1 ± 0.2	17.2 ± 1.1	17.2 ± 0.1
	1.5	0.0	6.14 ± 0.2	11.1 ± 1.0	22.2 ± 0.2	30.2 ± 1.3
	2.0	6.14 ± 0.2	6.14 ± 0.2	12.3 ± 0.2	30 ± 1.0	38.8 ± 0.3
	LSD	ns	ns	ns	ns	ns
C. capitatum	0	0.0	0.0	0.0	0.0	0.4 ± 0.04
	0.5	0.0	0.0	1.1 ± 0.6	28.1 ± 0.3	23.4 ± 1.1
	1.0	0.0	0.0	6.3 ± 0.2	17.2 ± 0.1	28.1 ± 0.3
	1.5	0.0	6.14 ± 0.2	12.3 ± 0.2	15.0 ± 1.2	34.9 ± 1.6
	2.0	6.4 ± 0.2	6.14 ± 0.2	21.4 ± 0.6	28.1 ± 0.3	39.9 ± 2.0
	LSD	ns	ns	15.46	ns	12.96

While, at 120 h, significant difference ($P < 0.05$) in percentage mortality was observed from *P. fraternus* on *C. maculatus* only, with highest value (52.86%), recorded at 500 mg and lowest value (30.99%) recorded at control. High values were also recorded from *C. capitatum* on *C. maculatus* and both powders on *S. zeamais* but, values recorded were not significantly different ($P > 0.05$) from lower values.

Adult emergence

The percentage adult emergence of *C. maculatus* after the application of *C. capitatum* and *P. fraternus* is presented in Table 3. The plant powders had significant ($P < 0.05$) effect of the adult emergence of *C. maculatus*, with the highest values of *C. capitatum* on *C. maculatus*, 23.05% and 0% recorded at 0 mg and 2000 mg/kg respectively. *P. fraternus* recorded the highest value of 44.61% at 0 mg and lowest value of 19.50% at 1000 mg/kg. The table shows that both powders had significant ($P > 0.05$) effect on the emergence of adult *C. maculatus*. Both powders had significant ($P < 0.05$) effect on the emergence of adult *S. zeamais* (Table 3). The highest values were recorded in control and lowest values recorded at the highest concentration, (2000 mg/kg). Thus, showing that both powders had significantly (P < 0.05) inhibited the emergence of adult *S. zeamais*.

Damage assessment

Significant differences (P < 0.05) in percentage weight loss was observed in maize with both plant powders significantly suppressing weight loss as highest weight loss were recorded at lower concentrations and least weight loss were recorded at the highest concentration (2000 mg/kg). There was no weight loss in maize seeds treated with *C. capitatum*. This showed that both powders effectively reduced weight loss in infested maize seeds. Values recorded in cowpea were low and at close range (Table 3).

The summary of percentage damaged seeds of infested cowpea and maize seeds treated with *C. capitatum and P. fraternus* is presented in Table 4. Both powders significantly (P < 0.05) inhibited seed damage, in maize at high concentration. Both powders also reduced damage in cowpea with no seed damage recorded at 2000 mg/kg but, this was not significantly different (P > 0.05) from values recorded across the remaining concentrations.

The two plant powders significantly reduced the number of exit holes of *S. zeamais* in the infested maize, as significant differences (P < 0.05) were observed between the concentrations. The number of exit holes in the maize seeds was reduced with increase in the concentration of the two plant powders, with *C. capitatum* and *P. fraternus* recording the lowest values of 6.65 and 11.37 respectively at 2000 mg/kg and highest value of 32.67 and 34.00 respectively in control. The plant powders also inhibited exit holes in cowpea as *C. capitatum* totally inhibited exit hole at 2000 mg/kg and *P. fraternus* reduced the number of exit holes at 2000 mg/kg when compared with the control, (Table 4) yet, the two plant powders only recorded significant effect in maize and marginal effect on cowpea in terms of number of exit holes.

Phytochemicals contents of the plant powders

Table 5 shows the phytochemical composition of both plant powders. *C. capitatum* was observed to contain tannins, glycosides (kelakellani) and saponins in high concentration while, alkaloids, glycosides (kelakellani), saponins were found to be present in *P. fraternus* with tannins at higher concentration.

Discussion

The present study has shown that *C. capitatum* and *P. fraternus* are capable of reducing adult emergence, seed damage and weight loss by *C. maculatus* and *S. zeamais* in stored cowpea and maize seeds respectively. The toxicity of the plant powders could be attributed to the toxic effects of their various phytoconstitutes. Similar observations were made by Ofuya and Dawodu, 2002; Adedire and Ajayi, 1996, who reported the use of plant materials as insect protectants against cowpea and maize weevils. The results of this study also correlate with Fasakin and Aberejo, (2002) who reported that pulverized plant material from *Piper guineense* inhibited egg hatch and adult emergence of *Dermestes maculatus* Degeer in smoked catfish (*Clarias gariepinus* (Clariidae) during storage.

Table 3 Mean percent mortality, adult emergence and weight loss (± SE) on treated grains after application of leaves powder of *Phyllantus fraternus* and *Clerodendrum capitatum*.

Dosage (mg/kg)	Adult emergence (%)				Seed weight loss (%)			
	C. maculatus		*S. zeamais*		*C. maculatus*		*S. zeamais*	
	P. F	C. C	P. F	C. C	P. F	C. C	P. F	C. C
0	44.6 ± 1.2	23.1 ± 0.9	24.0 ± 0.4	23.3 ± 0.4	7.4 ± 0.1	2.1 ± 0.03	10.4 ± 0.1	16.5 ± 0.2
0.5	31.1 ± 1.0	19.8 ± 0.5	19.3 ± 0.2	20.7 ± 0.6	4.9 ± 0.12	1.9 ± 0.06	10.8 ± 0.14	15.3 ± 0.2
1.0	28.1 ± 0.3	15.8 ± 0.3	15.3 ± 0.2	10.3 ± 0.1	4.6 ± 0.11	1.1 ± 0.04	10.0 ± 0.33	6.2 ± 0.02
1.5	25.6 ± 1.1	10.8 ± 0.9	11.4 ± 0.4	2.5 ± 0.01	4.1 ± 0.2	1.0 ± 0.02	5.7 ± 0.04	4.7 ± 0.3
2.0	19.5 ± 1.1	0.0	5.2 ± 0.03	2.1 ± 0.5	3.9 ± 0.03	0.0	0.06 ± 0.02	0.0
LSD	24.7	21.9	17.9	15.5	ns	ns	3.06	2.81

P. F: *P. fraternus*, C. C: *C. capitatum.*

Table 4 Mean percent mortality, seed damaged and adult exit hole (± SE) on treated grains after application of leaves powder of *Phyllantus fraternus* and *Clerodendrum capitatum*.

Dosage (mg/kg)	Seed damage (%)				Adult exit hole (%)			
	C. maculatus		*S. zeamais*		*C. maculatus*		*S. zeamais*	
	P. F	C. C	P. F	C. C	P. F	C. C	P. F	C. C
0	11.4 ± 0.2	19.1 ± 0.8	38.5 ± 0.9	34.6 ± 0.6	5.3 ± 0.01	1.77 ± 0.1	34.0 ± 0.7	32.6 ± 0.6
0.5	15.8 ± 0.7	11.2 ± 0.6	34.4 ± 0.7	32.5 ± 0.5	5.6 ± 0.1	1.69 ± 0.1	27.4 ± 0.3	26.0 ± 0.3
1.0	13.9 ± 0.02	10.2 ± 0.3	27.9 ± 0.3	25.4 ± 0.3	2.3 ± 0.1	1.49 ± 0.03	16.2 ± 1.0	14.7 ± 0.5
1.5	5.3 ± 0.7	5.3 ± 0.2	27.2 ± 0.2	19.2 ± 0.2	2.1 ± 0.1	0.80 ± 0.05	12.1 ± 0.3	7.8 ± 0.03
2.0	9.9 ± 0.8	0.0	22.2 ± 0.3	18.6 ± 0.1	1.5 ± 0.1	0.0	11.4 ± 0.2	6.6 ± 0.02
LSD	ns	ns	15.9	15.7	ns	ns	19.4	16.3

P. F: *P. fraternus,* C. C: *C. capitatum.*

The non-significant mortality effect observed might be due to the hard exoskeleton of the weevils which may have hindered the proper penetration of the plant powders. This exoskeleton is not found in the eggs and is not well developed in the young ones. Also, it is possible that the plant powders settled at the bottom of the petri dishes and the insects might have crawled to the top of the seeds, thereby reducing contact with the plant powders (Ekaette *et al.,* 2012). In addition to this, all insects of the genus *Sitophilus* have the habit of moving away from their substrate to hide at the upper cover of Kilner-jars or at any available crevices. This reduces the mingling of the insects with powders and hence, low mortality rate as reported by Ogunleye, (2011). It is also known that *C. maculatus* only feeds at the larval stage (Bier and Kaweck, 2013).

Table 5 Phytocchemical analysis of *Clerodendrum capitatum* and *Phyllantus fraternus leaves*.

Phytoconstitutes	*C. capitatum*	*P. fraternus*
Saponins	++	+
Tannins	+	++
Flavonoid	-	-
Salkowoski (glycosides)	-	-
Kelakellani (glycosides)	+	+
Phlabatanins	-	-
Alkaloids	-	+

+: Positive, ++: Strongly Positive, -: Negative.

The significant reduction recorded in adult emergence could be as a result of high larval mortality caused by the treatment thereby disrupting mating and sexual communication or that the plant powder reduced the viability of eggs laid (Akinwunmi *et al.,* 2006). Adesina *et al.* (2014) reported that some plants may have strong activity on adults and may be less active on larval growth and development; while some that may be weak in controlling the adults may strongly suppress larval growth, development and adult emergence,thus inhibiting seed damage and weight loss. *C. capitatum* and *P. fraternus* apparently fall into this category of plants.

The suppression recorded in percentage seed damage and weight loss could be linked to the reduced adult emergence and attributed to the fact that plants are known to possess secondary chemical compounds which are used as a part of their defense against plant-feeding insects and other herbivores (Lupina and Cripps, 1987). These secondary compounds give plant materials or their extracts, some insecticidal properties. Plant substances such as terpernoids, alkaloids, glycosides, phenols and tannins affect insects in several ways. They may affect nerve axons and synapses, muscles, respiration, hormonal balance, reproduction and reproductive behaviour (Bell *et al.,* 1990), and saponins, tannins, alkaloids and glycosides (kelakellani) have been found to be present in both plant powders. Rastogi and Mahrotra, (1990) reported that *P. fraternus* possess the chemical constituents;-phyllanthin, hypophyllanthin, niranthin, nirtetralin, phyltetratralin, kaempferol-4-rhamnopyranoside, erio dictylol–7- rhamnopyranoside, etc. While, Shrivastava and Patel, (2007) reported the major class of chemical constituents present in the *Clerodendrum* to include the following: Hispudilin, 5-*O*-ethylclerodendricin, Iridiod diglucoside, Colebrin, 1 (R) Lucumin, Clerodermic acid, Jionoside D, 2(R) Prunasin, Uncinatone, Apigenin, Acacetin-7-*O*-methylglucuronate, Neolignan I, II and III, Serratagenic acid, Verbacoside and Scutellarin. These bioactive agents could possess among other pharmaceutical properties, a depolarizing neuromuscular blocking quality which could result in mortality of insects (Udoh *et al.,* 1999).

The plant powders of, *C. capitatum* and *P. fraternus* are toxic to *C. maculatus* and *S. zeamais,* which are pests of stored cowpea and maize seeds respectively. Both powders can be used as protectants by local farmers in small farm holdings as they are easily available biopesticides and are environmentally friendly. It is recommended that further work be done on the bioactivity of both plant powders as admixture and as extracts against weevils and various pests of stored grains.

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تأثیر پودر برگ گیاهان *Clerodendrum capitatum* و *Phyllantus fraternus* روی سوسک‌های آفت انباری ذرت و لوبیا چشم‌بلبلی

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چکیده: اثرات پودر گیاهان *Clerodendrum capitatum* (Willd.) و *Phyllanthus fraternus* (Webster) در کاهش ظهور حشرات کامل سوسک چهارنقطه ای‌حبوبات *Callosobruchus maculatus* (F.) و شپشه ذرت *Sitophilus zeamais* (L.) و خسارت در بذور ذرت و لوبیا چشم‌بلبلی مورد ارزیابی قرار گرفت. برگ پودر شده گیاهان در غلظت ۰، ۵۰۰، ۱۰۰۰، ۱۵۰۰، ۲۰۰۰ میلی‌گرم برای هر کیلوگرم بذر در سه تکرار روی حشرات کامل باکره مورد آزمایش قرار گرفت. نتایج نشان داد که پودر گیاهان تأثیر معنی‌داری روی مرگ و میر حشرات کامل نداشتند اما ظهور حشرات کامل، میزان خسارت به بذور و تعداد دانه‌های ذرت سوراخ شده کاهش یافت. بنابراین پودر گیاهان فوق از قابلیت بالایی به‌عنوان حشره‌کش با منشاء گیاهی برای کنترل سوسک چهارنقطه‌ای حبوبات و شپشه ذرت برخور دارند.

واژگان کلیدی: *Clerodendrum capitatum*، *phyllanthus fraternus*، برگ پودر شده، سوسک چهارنقطه‌ای حبوبات، شپشه ذرت