COMPARATIVE EFFICACY OF EDIBLE PLANT POWDERS OBTAINED FROM *PIPER GUINEENSE* AND *MORINGA OLEIFERA* IN THE CONTROL OF THE COWPEA BRUCHID, *CALLOSOBRUCHUS MACULATUS* INFESTING COWPEA SEEDS IN STORAGE

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Abstract

Two edible plant product powders, West Africa black pepper (Piper guineense Schum and Thorn) and Horseradish (Moringa oleifera Lam) were studied for effectiveness in controlling the cowpea seed bruchid (CSB) Callosobruchus maculatus (F.) in the Agronomy Laboratory, Collage of Agriculture, Lafia. A completely randomized design (CRD) consisting of three treatments (root–bark, leaf and seed powders) each at three dosage rates of 0.5, 0.75, 1.00 g were admixed with 30 g of cowpea seeds in three replications contained in plastic cups with a lid. Untreated control was also provided. 10 pairs of 3 day old adult C. maculatus were introduced into each plastic container and allowed to mate and oviposit. Adult mortality was taken at 24 hourly for a period of 7 days. Number of eggs laid was taken from 10 randomly selected seeds from each treatment and replicate. The entire plant product powders significantly ($p < 0.05$) reduced oviposition by C. maculatus. Also, significant ($p < 0.05$) result was observed in grains treated with seed powders of the two plants. Adult emergence decreased with time among seeds treated with the plant products and increased in time among the seeds without treatment (control). There were however significant differences ($p < 0.05$) between the edible plant powders and the control treatment at all dosage rates tested. The effectiveness of the seed powders for the two edible plants was significantly higher when compared with the leaf powder and the root bark. Thus, can be ranked as follows: seed powder > root–bark > leaf powder.

Keywords: Cowpea beetle, *Callosobruchus maculatus*, *Moringa oleifera*, *Piper guineense*.

INTRODUCTION

Cowpea, *Vigna unguiculata* (L.) Walp. is an important source of dietary protein of plant origin. In Nigeria, its availability continues to be hampered by storage pests of which particularly problematic accounting for over 90 % of the insect damage to stored cowpea (Caswell & Akibu, 1981). Infestation of pods usually originated from the farm. Eggs are stuck on the outside of the pods by the female but if the pods have dehisced, the eggs are laid directly on the seeds. Each female bruchid may lay up to 100 eggs (Beck & Blumer, 2007). The infested pods are harvested and taken into farm stores where insect development further takes place. The larvae spend their entire life (about 20 days) within the cowpea seed. Population takes place in a chamber just under the testa of the seed. The pupal stage is about 7 days. The entire life cycle takes between 4 and 5 weeks with the adults emerging through circular exit holes. The damage caused by the cowpea bruchid are seed weight loss, reduced viability and reduced commercial value (Hill, 1983) and these negate efforts at self–sufficiency in food production and poverty alleviation (Emeasor *et al.*, 2007).

Stored cowpea seeds are protected from insect infestation and damage usually by using synthetic insecticides such as hexachlorocyclohexane (HCH), fenitrothion, malathion, chloropyrifos, piriimiphos–methyl and tetra–chlorides (Apeji, 1988). These insecticides have, however, become largely inaccessible to resource–poor farmers due to their high cost (Afun *et al.*, 1991) and they leave residues that are hazardous to the ecosystem (Schwab *et al.*, 1995). These constraints and negative effects have led to renewed interest in the search for botanical insecticides as alternative to synthetic chemicals. Plant parts used as protectants of stored commodities are usually leaves, roots, flowers, fruits, seeds, and to a lesser extent, bark and stem (Dupriez & De–Leener, 1989; Ogunwolu *et al.*, 1998). The seeds and fruits appear to be the commonest and perhaps the most important sources of natural pesticide (Taylor, 1975). Irrespective of part of the plant from which they are obtained, powders, oils, and aqueous solutions are the three main formulations used for protection of field crops and stored commodities (Lale, 1995).

This study focused on the potential use and effect of powdered components from *P. guineense* and *M. oleifera* in protecting cowpea seeds against the cowpea bruchid, *Callosobruchus maculatus* (F.).

MATERIALS AND METHODS

Insect Culture

The laboratory culture of *C. maculatus* was started with adult insects collected from infested cowpea seeds from Lafia market in Nasarawa State, Nigeria. The culture was maintained on seed of Ife brown, a susceptible cultivar collected from the Savannah Seed and Livestock Limited, Jos, Plateau State, Nigeria under ambient temperature of and relative humidity in the laboratory. The bruchid culture was maintained over three generations before being used for the bioassay

Test Plant Powders

Plant materials used in the study include fresh leaves, root bark, dried seeds of West Africa black pepper of *Piper guineense* Schum and Thorn and Horseradish, *Moringa oleifera* Lam., respectively were collected from different locations in Lafia, Nasarawa State, Nigeria. Before being used the plant materials were treated according to the method of Sharma (1982). The plant were washed separately with distilled water and dried in the laboratory at ambient temperature for a period of four weeks. Then each of the dried plant part was pulverized into fine powder using a Philips electric blender, and later sieved through 10–micron mesh sieve. Plant powders obtained from each plant product was collected and sealed in cellophane bags and kept in the fridge until ready for use.

Preparation of Cowpea Seeds

Three kilograms of pristine seeds of local variety of cowpea (Kanenede) was purchased from the open market in Lafia. The seed was fumigated with phostoxin tablet® in an air–tight Kilner jar for 48 h in order to kill any insect present. The seeds were later air–dried for five days under screen in the laboratory in order to allow for dissipation of fumigant effect. Thereafter, the cowpea seeds were stored in a blank polypropylene bag until ready for use.

Bioactivity Tests

Pulverized plant materials were admixed with cowpea seeds at the rate of 0.5, 0.75, and 1.0 g/30 g of cowpea seeds (Kanenede) in transparent plastic jars each of 0.62 L capacity with tight fitting lids. Each plastic jar lid was perforated and bore 50 equidistant holes measuring 2 µ and the lids were covered from under surface with fine muslin nylon mesh to allow inflow of air and preclude entry or exit of insects. Treatment consists of admixing separately each of root–bark, seed and leaf powders of *M. oleifera* and *P. guineense* applied at the rate of 0.5, 0.75 and 1.0 g/30 g cowpea seeds in the plastic jars. The experiment was laid out in a complete randomized designed with each treatment being replicated three (3) times. Control treatment without any admixture of plant product was also set up along with the treatments. Cowpea seeds in the jars were shaken thoroughly to ensure even spread of the edible plant product powder. Thereafter, five pairs 3 day adult *C. maculatus* were introduced into each treatments bearing admixtures of edible plant product plant powders and the control treatment. The adult cowpea bruchids were allowed to mate and oviposit for 7 days before all insects both dead and alive were removed from the treatments.

Data Collection and Analysis

Effect of plant powder product on mortality of adult *C. maculatus* was carried out at every twenty four (24) hours, in both treated and untreated control seeds. All dead adult *C. maculatus* were removed at each time of observation. An adult *C. maculatus* was considered dead if gently probed with a fine bristle brush and there was no response (Su, 1972). At day 7 post–infestation, both live and dead *C. maculatus* were removed from the treatments. Ten (10) seeds were selected randomly from each treatment and spread on a clean white sheet to count the number of eggs laid per seed and the number of seeds that had eggs on them. All the infested seeds were constantly observed for emergence of first fillia (F_1) generation adults. Adults that emerge were counted and recorded for every treatment and control. Adults of F_1 generation were left for one week from the date of first emergence and then removed. Both treated and untreated controls were observed and the seeds with exit–holes were counted and recorded. The experiment was left till the emergence of second fillia (F_2) generation adults, which were also counted and recorded. Mean number of mortality, mean number of eggs and mean number of adult emergence for each treatment or control were transformed by use of square root transformation. Percentage data were arc–sine transformed and the entire data was subjected to one–way ANOVA and mean separation was carried out using Duncan New Multiple Range Test (DMRT).

RESULTS AND DISCUSSIONS

Table 1 compares the adult mortality of *C. maculatus* for 96 hrs, after treating cowpea seeds with *Moringa oleifera* and *P. guineense*. It also shows increase in percentage mortality of adult *C. maculatus* for 96 h after treating cowpea grains with two plant products. There was however significant ($p < 0.05$) differences between all the treatment level and untreated control. For each powered product and each dosage rate, mortality increased with time (hours) after treatment. Adult mortality was 100 % after 72 h of treatment with seed power of *P. guineense*. Seed powered *P guineense* followed by seed powder *M. oleifera* caused highest adult mortality rate among the powered products. Percentage mortality was significantly higher ($p < 0.05$) at 0.5 level in grains treated with powder products of *P. guineense* than when compared with seeds treated with powder products of *M. oleifera,* while percentage mortality was lowest in control when compared to that observed at each treatment level. Adult mortality was significantly different in grains treated with root–powder of *P. guineense* and that of *M. oleifera* (Table 2).

Table 1: Mean Percentage Mortality of Adult *C. maculatus* Treated with Two Edible Plant Powder Products

Plant Product (g/30 g)	Exposure Duration (h)			
P. guineense	**24**	**48**	**72**	**96**
Root–bark (0.5)	25.1^{b*}	46.3^{b}	55.5^{ab}	65.1^{ab}
Root–bark (0.75)	30.2^{b}	58.9^{b}	61.8^{ab}	76.5^{a}
Root–bark (1.00)	38.4^{b}	60.9^{b}	69.7^{ab}	77.8^{a}
Leaf powder (0.5)	60.5^{b}	92.6^{a}	96.5^{a}	99.0^{a}
Leaf powder (0.75)	66.1^{ab}	92.6^{a}	97.5^{a}	99.0^{a}
Leaf powder (1.00)	70.2^{ab}	95.6^{a}	98.5^{a}	100.^{a}
Seed Powder (0.05)	80.6^{a}	92.1^{a}	100.0^{a}	100.0^{a}
Seed Powder (0.75)	84.5^{a}	96.1^{a}	100.0 ^{a}	100.0^{a}
Seed Powder (1.00)	90.1^{a}	97.1^{a}	100.0^{a}	100.0 ^{a}
M. oleifera	**24**	**48**	**72**	**96**
Seed Powder (0.05)	30.1^{b}	40.2^{ab}	55^{ab}	69.1^{ab}
Seed Powder (0.75)	69.3^{a}	70.1^{a}	82.1^{a}	99.1^{a}
Seed Powder (1.00)	70.1^{a}	80.8^{a}	99^{a}	100^{a}
Leaf powder (0.5)	34.2^{b}	50.2^{ab}	60.3^{ab}	66.7^{ab}
Leaf powder (0.75)	40.1^{b}	55.9^{a}	69.1^{ab}	70.1^{ab}
Leaf powder (1.00)	46.7^{b}	60.1^{a}	68.2^{ab}	79^{a}
Root–bark (0.5)	21.2^{bc}	31.1^{ab}	42.7^{ab}	49.1^{ab}
Root–bark (0.75)	25^{bc}	44.1^{ab}	49^{ab}	50.1^{ab}
Root–bark (1.00)	29b^{c}	50.2^{ab}	59.1^{ab}	69.1^{ab}
Control	11.1^{bcd}	25^{abc}	27.2^{abc}	27.3^{abc}

*Means with the same letter within each column and each role are not significantly different from each other at 5 % (DMRT).

Table 3 shows the number of eggs laid in cowpea seeds treated after infestation had taken place. There were no significant differences ($p > 0.05$) among the treatment levels of the plant products and control; also, there is no significant difference ($p < 0.05$) among the dosage rates. Nevertheless, egg production by female *C. maculatus* in untreated control was significantly ($p < 0.05$) higher than that recorded in each treatment level of both plant products. Egg oviposition was lowest in seeds treated with seed–powder of *P. guineense* compared to grain treated with other product part of *P. guineense* and products of *M. oleifera*, respectively. Also the number of eggs laid decreased with increase in dosage rate.

Table 2: Mean Mortality of Adult *C. maculatus* after 96 hours Exposure to Two Edible Plants Powder Products Treated on Cowpea Seeds

Treatment	Rates /30g Seeds		
	0.5	**0.75**	**1.0**
M. oleifera			
Root Bark	41.03^{a*}	42.05^{ab}	51.85^{ab}
Leaf Powder	54.1^{a}	58.8^{a}	63.5^{a}
Seed Powder	48.6^{a}	80.15^{a}	87.48^{a}
P. guineense			
Root Bark	48.0^{b}	56.9^{b}	61.7^{b}
Leaf Powder	87.2^{a}	88.8^{a}	91.1^{a}
[illegible]	[illegible]	[illegible]	[illegible]

***Means with the same letter within each column and each role are not significantly different from each other at 5 % (DMRT).

Table 3: Mean Number of Eggs Laid by Adult *C. maculatus* on Cowpea Seeds Treated with Two Edible Plant Powder Products

Treatment	Rates /30g Seeds		
	0.5	**0.75**	**1.0**
M. oleifera			
Root Bark	1.52^{a*}	1.35^{a}	1.10^{a}
Leaf Powder	1.31^{a}	1.20^{a}	1.00^{a}
Seed Powder	0.79^{a}	0.69^{a}	0.55^{a}
P. guineense			
Root Bark	1.11^{a}	1.15^{a}	0.90^{a}
Leaf Powder	1.05^{a}	1.00^{a}	0.79^{a}
Seed Powder	0.51^{a}	0.62^{a}	0.43^{a}
Control	5.33^{b}	5.33^{b}	5.33^{b}

*Means with the same letter within each column and each role are not significantly different from each other at 5 % (DMRT).

Table 4 shows the effect of plant product on adult emergence of F_1 progeny among treated and untreated seeds. The emergence of first generation adult bruchid was not significant ($p > 0.05$) among the treatments. Although, the number of adults that emerged in the untreated control was significantly ($p < 0.05$) higher than those recorded for the treated grains; there was no adult emergence in grains treated with seed powder of *P. guineense* and seed powders of *M. oleifera,* respectively. Generally, the number of emergence decreases with increase in dosage levels. Emergence of the second generation adult bruchids (Table 5) showed no significant difference among treatments, but there was significant difference between grains treated with plant powders of (*P. guineense M. oleifera)* and the untreated control. Emergence from the untreated grain was significantly ($p < 0.05$) higher than that observed from the treatments. The mortality rate for both plant test (Table 1) showed that seed powder of *P. guineense* was highly effective, killing all *C. maculatus* adult exposed to a rate as low as 0.5 g/30 g of seed within 72 h. The plant products particularly the seed powder of *P. guineense* and seed powder of *M. oleifera* were effective in suppressing or inhibiting oviposition, while powders of other plant parts were only effective at high dosage rates.

Table 4: Efficacy of Two Edible Plant Powder Products on Emergence F_1 Progeny of *C. maculatus* on Treated Cowpea Seeds

Treatment	Rates /30g Seeds		
	0.5	**0.75**	**1.0**
M. oleifera			
Root Bark	1.90^{a*}	1.80^{a}	1.30^{a}
Leaf Powder	1.83^{a}	1.67^{a}	1.21^{a}
Seed Powder	0.95^{a}	0.75^{a}	0.50^{a}
P. guineense			
Root Bark	1.70^{a}	1.60^{a}	0.90^{a}
Leaf Powder	1.61^{a}	1.51^{a}	0.79^{a}
Seed Powder	0.41^{a}	0.40^{a}	0.40^{a}
Control	4.53^{b}	4.53^{b}	4.53^{b}

*Means with the same letter within each column and each role are not significantly different from each other at 5 % (DMRT).

Table 5: Efficacy of Two Edible Plant Powder Products on Emergence F_2 Progeny of *C. maculatus* on Treated Cowpea Seeds

Treatment	Rates /30 g Seeds		
	0.5	**0.75**	**1.0**
M. oleifera			
Root Bark	1.95^{a*}	1.70^{a}	1.30^{a}
Leaf Powder	1.89^{a}	1.70^{a}	1.25^{a}
Seed Powder	0.99^{a}	0.50^{a}	0.50^{a}
P. guineense			
Root Bark	1.80^{a}	1.50^{a}	1.00^{a}
Leaf Powder	1.75^{a}	1.40^{a}	1.00^{a}
Seed Powder	0.67^{a}	0.40^{a}	0.40^{a}
Control	4.55^{b}	4.55^{b}	4.55^{b}

*Means with the same letter within each column and each role are not significantly different from each other at 5 % (DMRT).

The components of the two plant products have proved to be relatively effective in the control of *C. maculatus*; this is because each of the powdered components of these plants significantly caused adult mortality, low oviposition, and low adult emergence of *C. maculatus.* The effectiveness of a low rate of *P. guineense* seed powder in deterring oviposition is consistent with the earlier findings of Olaifa & Erhum (1988). The potency of *P. guineense* has been attributed to piperine acting in synergism with guineensine (Okogun *et al.*, 1977). Su (1977) had also reported the fumigant and contact action of *P. guineense* which are similar to those of synthetic organochlorines and organophosphates. Ojiako & Adesiyun (2008) identified active components such as isopongaflavone in the seeds of *P. guineense.* It is most likely such active components are present in different proportions in different parts of the plant trees, and which may explain why some powdered products were more effective than others in this study. The effect of *M. oleifera* on *C. maculatus* oviposition and infestation were also statistically comparable with those of *P. guineense*. Olayemi & Alabi (1994) had shown that seeds of *M. oleifera* contained a steroidal and alkaloid glycoside that have been used to inhibit the growth of the red flour beetle, *Tribolium castaneum* and the tobacco horn worn, M*anduca sexta* (Wiesenberg *et al.*, 1998). The use of *P. guineense* powder at the rate of 1.5 g/20 g of cowpea seeds was reported to cause 100 % egg mortality of *C. maculatus* and also significantly reduced F_1 progeny emergence (Ivbijaro & Agbaje, 1986). In another report powder of *Aframomum melegueta* Schum, *Eugenia aromatica* (Syn. *S. aromaticum*) and *Piper umbellatum* (syn. *P. guineense*) were reported to cause high mortalities in adult *Sitophlilus oryzae* with subsequent result of lack of F_1 progeny (Lajide *et al.*, 1998). Okunade *et al.* (2002a,b) had also shown that *Parkia* spp. can be used to control *Tribolium castaneum* and *Rhyzopertha dominica.*

Since the two plant trees have been in use in almost all houses in Guinea savannah, the fear to recommend the products of such botanicals as protectant for stored grains may be removed. And in case of any fear to consume seeds surface–treated with products of *M. oleifera* and *P. guineense*, they could easily be cleaned/washed off since they are like dust particles. These plant materials are easy to come–by more so that a number of farmers do cultivate them year in year out. The good protection of the cowpea seed from the cowpea bruchid afforded by different powdered products of *M. oleifera* and *P. guineense* observed in this study could make either of the powdered plant materials a substitute for any synthetic insecticide that has a comparable insecticidal activity against *C. maculatus* There were hardly any observable significant differences between the results obtained among the treatment level of the seeds powder of *P. guineense* and that of *M. oleifera*, the lowest dosage of 0.50 g may be recommended for the control of this pest, *C. maculatus* using any of these plant products at this dosage rate

CONCLUSION

In this study, the use of these plant powders were able to effectively control the ability of *C. maculatus* to perpetuate on cowpea seeds during storage. This is very important in reducing damage caused by the pest in storage. Also considering their ease of availability, safety, low cost and low technological requirement in processing as against the synthetic insecticides, there is need for their adoption for the preservation of stored crop products particularly cowpea. Thus so far, no harmful side effect has been reported in the use of these two plant products (*M. oleifera* and *P. guineense*) as they form part of the condiments for human consumption.

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