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Evaluation of two phyto powder combinations (*Azadirachta indica* and *Zingiber officinale*) and a synthetic insecticide (Primiphos methyl powder) in the control of cowpea weevil *Callosobruchus maculatus* (Fab.)

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ABSTRACT

Cowpea (*Vigna unguiculata L. walp*) is one of the most important leguminous crops that are widely grown throughout the tropics. The aim of the study is to evaluate the combination of two botanical powders and a synthetic insecticide in the control of cowpea weevil (*Callosobruchus maculatus*) on stored cowpea grain. The botanical powders were admixed with the cowpea grain at a combination of 3:7, 7:3 and 5:5 per 50g of beans while the primiphos methyl powder was admixed at 0.25g per 50g of cowpea. In the control, no treatment was used. The experimental design adopted for the experiment was Complete Randomized Design (CRD) and each treatment was replicated four times for each experiment. Twenty (20) adults of *C. maculatus* unsexed (taken from stock culture kept in the laboratory) were introduced into each vial including the control and were covered with muslin cloth held tightly in place with rubber band to prevent the weevils from escaping. The experiments were monitored for 72 hours. The results showed that the plant powders and primiphos methyl powder were good grain protectants. The highest mortality recorded was in primiphos methyl powder (78) followed by the combination of *Azadirachta indica* and *Zingiber officinale* powder at the ratio of 5:5 (76), 7:3 (68) while the least was 3:7 which recorded 62. The mean mortality of *C. maculatus* caused by primiphos methyl powder (6.50), was significantly ($P < 0.05$) different from the untreated control (0.00), but was not statistically different from the combination of *Azadirachta indica* and *Zingiber officinale* in the ratio of 5 to 5, but the combinations of *A. indica* and *Z. officinale* in the ratio of 3:7 and 7:3 were significantly different. The study suggests that botanicals should be incorporated into grain protection as alternatives to chemical insecticides in the control of *C. maculatus* in cowpea grain during storage.

Keywords: Botanical powder, efficacy, *Callosobruchus maculatus*, cowpea, mortality

Introduction

Cowpea (*Vigna unguiculata L. walp*) is one of the most important leguminous crops that is widely grown throughout the tropics, especially in the Savanna zone of the West Africa and other parts of the world (Singh *et al.*, 1990; Amadi *et al.*, 2018). Cowpea is highly palatable, providing plant protein for human and animals, very nutritious and

relatively free of anti-metabolites. In West Africa, cowpea is the major source of protein in diet where they are consumed in different forms (Uwaegbute *et al.*, 2000). In Nigeria, Cowpea can be consumed, boiled as (porridge) or boiled and eaten with stew, it can also be ground, processed into flour, and used to make many traditional foods: for example,

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“akara” (bean balls) or “moi-moi” (bean cake) (Amadi, *et al.*, 2018). In Sudan and Ethiopia, its roots are eaten as vegetable and in Ghana, the leaves are eaten as vegetable (Asawalam and Dioko, 2012). Apart from the traditional products, Cowpeas are processed into flour for the production of bakery products such as cookies and breads (Kethireddipalli *et al.*, 2002; Hallen *et al.*, 2004; Mcwatters *et al.*, 2005) as well as comminuted meat product such as chicken nugget and meat balls (Serdaroglu *et al.*, 2005). Apart from the grains, farmers also benefit from the fodder yields which they use to feed their livestock. However, in spite of the high nutritional values and usefulness of cowpea, a wide range of insect pests, which significantly reduce the yield, attacks the plant. The best control of the numerous pests that attack cowpea is largely controlled by the use of synthetic insecticides (Dzemo *et al.*, 2010). The use of insecticides increases cowpea yields tremendously (Karungi *et al.*, 2000). However, because of the high cost implication, these synthetic insecticides are out of the reach of most resource poor farmers and small-scale dealers. The use of chemicals for the control of cowpea weevil has many challenges including human and animal health hazards arising from their toxicological nature through their abuse, in addition to their persistence in the environment. Furthermore, development of insecticide resistance by the weevil renders chemical control measures less effective (Oliverira *et al.*, 2007; Dzemo *et al.*, 2010). Cowpea grain yield in Africa are very low, in the West African sub-region, low levels of cowpea yield (200 – 350 kg/ha) obtained by some farmers are directly attributed to insect pest damage in the field (IITA, 2007). The major insect of cowpea is *Callosobruchus maculatus* which infect cowpea and severely reduce the quantity both the grains and fodder yields. This implies losses in both grain and fodder. Also grain loss in Africa due to insects' damage in storage system is estimated at 20 to 30% (Isman, 2006). Worldwide, grain weevils cause more than 20% grain loss for untreated grain

(Nukenine *et al.*, 2002). Control measures used in reducing insect damage to cowpea are bio-intensive approaches that rely more on manipulating the plant or its environment. These include the use of resistant varieties, habitat modification, cultural and biological control. In spite of the use of these methods, Epidi, *et al.* (2008), observed that the control may not be optimal because of the wide diversity of pests involved. Different varieties of botanicals such as *Azadirachta indica*, *zingiber officinale* and *piper guineense* and others are being used by resource poor farmers in different parts of Nigeria in single treatment in the control of weevil infestation (Gadzirayi *et al.*, 2006; Ukpai *et al.*, 2017). The study is aimed to investigate the efficacy of the combination of *Azadirachta indica* and *Zingiber officinale* and primiphos methyl powder (synthetic insecticide) in the control of *Callosobruchus maculatus*.

Materials and Methods

This experiment was carried out in the Final Year Laboratory of the Department of Zoology and Environmental Biology, Michael Okpara University of Agriculture, Umudike, Abia State. Umudike is located in the tropical rainforest zone of Nigeria on latitude 05°26' – 5°25'N and longitude 07°34' - 7°36'E (NRCRI, 2003). *C. maculatus* were obtained from the infested stock of cowpea from traders in Ubani market of Abia State.

Insect Culture

The method of Amadi *et al.* (2018) was adopted in the mass production of *C. maculatus*. The adult *C. maculatus* were cultured for four weeks in a plastic container covered with muslin cloth in the laboratory.

Cowpea seeds used for the experiment

The *Vigna unguiculata* (Bean) used for the experiment was purchased from Ubani main market in Umuahia North Local Government Area of Abia State. A pre-experiment was conducted to ascertain

whether the bean seeds were free from chemicals to avoid altering the results. The experiment was conducted in the laboratory for 3 days (same as in control). After the pre-experiment, no mortality was recorded, hence the bean seeds were free from chemicals and they were used. The beans were further disinfected by putting in an oven at 60°C for 4 hours to destroy any hidden infestation.

Collection and preparation of plant materials

The fresh leaves of *Azadirachta indica* and rhizome of *Zingiber officinale* are collected from Michael Okpara University Umudike and National root crops research Institute Umudike respectively. The leaves and the rhizome of the various plants were dried under room temperature to ensure that the active ingredients were not lost. The dried leaves and the rhizome were ground separately with a hand grinder into powder and these were sieves to obtain fine powders using 0.20 mesh sieves (Lale, 2000). The botanical powders were put into air tight containers separately to ensure that the active ingredients were not lost. The powders were stored in a cool dry place until when needed.

Table 1: List of the botanicals tested for their effectiveness against *Callosobruchus maculatus* in stored bean seeds.

Scientific name	Common name	Family	Parts used
<i>Zingiber officinale</i>	Ginger	Zingibaraceae	Rhizome
<i>Azadirachta indica</i>	Neem	Meliaceae	Leaves

Synthetic Insecticide used

The synthetic compound used for the experiment is pirimiphos methyl powder (PMP) and it was purchased from a dealer in the market.

The efficacy tests

The efficacy of the combination of the two plant powders (*Zingiber officinale* and *Azadirachta indica*) in the ratio of 3 is to 7, 7 is to 3 and 5 is to

5 respectively were tested against *Callosobruchus maculatus*. The powders (*Zingiber officinale* 3+ 7 *Azadirachta indica*, *Zingiber officinale* 7+ 3 *Azadirachta indica* and *Zingiber officinale* 5+ 5 *Azadirachta indica*) were introduced into 50g of clean beans and thoroughly mixed together by agitating the vials manually (Ukpai *et al.*, 2017). A control in which no powder was included was also set up. The primiphos methyl powder (PMP) was applied at the rate of 0.25g per 50g (Standard control) Ekeh *et al.* (2013). The treatments were replicated four times for each experiment. Twenty (20) (black coloured) adults of *C. maculatus* unsexed (taken from the stock culture kept in the laboratory), were introduced into each vial including the control and were covered with muslin cloth held tightly in place by a rubber band to avoid the weevil from escaping. Using the method reported by Ekeh *et al.*, (2013), the mortality counts of the weevils were recorded at 24, 48- and 72-hours post treatment. The numbers of dead insects which did not respond to pin probes were counted. The counting was done by pouring the content of each vial on a small white tray and insects sorted out of the mixture using a pin probe.

Statistical analysis

The data obtained were subjected to analysis of variance (ANOVA) and significant means ($P < 0.05$) were separated using Fishers LSD (Williams and Abdi, 2010) and the result was presented in table

Results

The results of the evaluation of combination of the two botanical powders and a synthetic insecticide in the control of *Callosobruchus maculatus* within 72 hours are shown in the Table 2. The primiphos methyl powder caused the highest mean mortality of 6.50 (± 1.4), followed by the combination of *Azadirachta indica* and *Zingiber officinale* in the ratio of 5:5 which recorded 6.33 (± 1.3), *Azadirachta indica* and *Zingiber officinale* in the ratio of 3:7 recorded 5.17 (± 1.1) while the least was the combination of *Azadirachta indica* and *Zingiber*

officinale in the ratio 7:3 which gave 4.83(±0.6). No mortality was recorded in the control experiments rather mating was observed. The mean mortality of *C. maculatus* caused by primiphos methyl powder (PMP) (6.50), was significantly (P<0.05) different from the untreated control (0.00), but was not statistically different from the combination of

Azadirachta indica and *Zingiber officinale* in the ratio of 5to5, but the combinations of *Azadirachta indica* and *Zingiber officinale* in the ratio of 3:7 and the ratio of 7:3 were significantly different.

Table 2: Mean mortality (±SE) of *C. maculatus* cowpea treated with *A. indica*, *Z. officinale* and primiphos methyl powder in stored cowpea

Time (hour)	Treatment Dosage (g)					Mean
	AI 3 + ZO 7	AI 7 + ZO 3	AI 5 + ZO 5	PMP	Control	
24	7.75	9.00	10.00	12.00	0.00	7.75(±1.1)
48	4.50	4.00	6.25	6.50	0.00	4.25(±0.68)
72	3.25	1.50	2.75	1.00	0.00	1.70(±0.32)
Mean	5.17(±1.1)	4.83(±0.6)	6.33(±1.3)	6.50(±1.4)	0.00(±0.0)	

LSD Treatment 1.87; LSD Duration 1.62; LSD TxD 3.25

Key: Ai = *Azadirachta indica*; Zo = *Zingiber officinale*; Pmp= Primiphos methyl powder
LSD Least significant difference; TxD Treatment x Duration

Discussion

The present study on the evaluation of the combination of two botanical powders and a synthetic insecticide, primiphos methyl powder showed that both the botanicals and the synthetic insecticide are good protectants of cowpea (*Vigna unguiculata*) against *Callosobruchus maculatus*.

Mortality rates of *Callosobruchus maculatus* with primiphos methyl powder were quite high. This supports the fact that primiphos methyl powder is effective against *C. maculatus* in stored beans which had led it being sold in the market for pest control of stored bean seeds. The highest mortality rate of *C. maculatus* with primiphos methyl powder was recorded within 24 hours. This agrees with the work of Omotoso (2014), Ukpai *et*

al. (2017) and Amadi *et al.* (2018) who reported that chemical insecticide work effectively in the control of weevil.

All the botanicals used in this study showed some insecticidal properties by significantly reducing the number of cowpea weevils. The results lend credence to the fact that botanical dust can be used to control *C. maculatus* in stored cowpea grains. The utilization of different plant products as stored crop grain protectants has been reported by Araya and Eman (2009); Ukpai *et al.* (2017) and Amadi *et al.* (2018). This shows that the resource poor farmers can use botanicals in the control of stored product weevils. The observed efficacies of the botanicals used were fascinating especially the combination of *A. indica* and *Z. officinale* 5+5g respectively) gave a high mortality rate. This

agrees with Ukpai *et al.* (2017) and Amadi *et al.* (2018) who reported that higher dosage of treatment work effectively in the treatment of stored grains. Apart from the fact that *A. indica* and its combination with *Z. officinale* are effective against *C. maculatus*, the botanicals are locally available, cheaper to get, and environmentally friendly compared with synthetic powder. The *A. indica* has antimicrobial and protective properties and is very useful traditionally in the prevention and treatment of malaria (Okore *et al.*, 2017).

The combination of different powdered botanicals (*A. indica* 7g and *Z. officinale* 3g) and (*A. indica* 3g and *Z. officinale* 7g) gave a good reduction of the weevil. The use of the plant powders could have resulted in death of insects as a result of physical barrier effects of the plant materials (Muzemu *et al.*, 2013). This is because the powder has the tendency of blocking the spiracles of the insects thus impairing respiration leading to the death of insects. While feeding on whole grains, the weevils can pick up lethal doses of the treatment thus resulting in stomach poisoning (Law-Ogbomo and Enobakhare, 2007) and subsequent death.

Bean weevils treated with the synthetic insecticide primiphos methyl powder had the highest weevil mean mortality (6.50) compared to the botanicals. This result is in agreement with the works of Simbarashe *et al.* (2013); Danjumma *et al.* (2009) which showed that synthetic pesticides had the highest mortality rate compared with the botanicals used. However, the difference in effectiveness was significant between primiphos methyl powder and the untreated control, but was not statistically different from the combination of *Azadirachta indica* and *Zingiber officinale* in the ratio of 5to5, but the combinations of *Azadirachta indica* and *Zingiber officinale* in the ratio of 3:7 and the ratio of 7:3 were significantly different.

Conclusions

The findings from this study give further credence to the insecticidal properties of the crude powders of *A. indica* and *Z. officinale* and should constitute a component of beans weevil management programme.

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Conflict of Interest:

The authors declare no conflicting interest in the publication.

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