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## EVALUATION OF PLANT POWDERS *AZADIRACTA INDICA* AND *ZINGIBER OFFICINALE* AGAINST THE BEAN WEEVIL, *CALLOSBRUCUS MACULATUS* (FAB.) (COLEOPTERA) IN STORAGE OF BEAN GRAIN

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### ABSTRACT

*The study was carried out to investigate the efficacy of two botanical powders Azadiracta indica (A Juss) leaves and Zingiber officinale (Roscoe) rhizome in the control of Callosobrucus maculatus (Fabricius) damage on stored beans seed (Vigna unguiculata L. Walp). The two botanicals were applied at the rate of 0, 2, 4, 6 and 8 grams respectively for the control of C. maculatus, against a standard pesticide. The botanical powders were introduced into 50 g of clean beans and thoroughly mixed together by agitating the vials manually, 20 unsexed adult C. maculatus were introduced into each vial and kept under ambient conditions (27 ± 3° C and 80 ± 10 RH) for a period of 96 hours in July 2016. Each set of experiment was laid out in a completely randomized design comprising six treatments with each treatment having four replicates. Results from the data analyses showed that treated bean grains in storage recorded significantly higher (p<0.05) mean mortality of adult C. maculatus than the untreated controls. Batches treated with higher doses (4, 6, 8 g) had comparatively higher and significant total mortality of adult C. maculatus than those treated with smaller dosages (0 and 2 g).*

**Keywords:** Botanicals, *Azadiracta indica*, *Zingiber officinale*, Efficacy, *Vigna unguiculata* *Callosobrucus maculatus*

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### 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 West Africa and other parts of the world (Singh *et al.*, 1990). 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 plant protein in diet (Uwaegbute *et al.*, 2000), where they are consumed in different forms. 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, "akara" (bean balls), "moi-moi" (bean cake) etc. (Taiwo, 1998). 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.*, 2004) 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 obtained 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 cowpea farmers, considering their small holder-ship scale of production (Dzemo *et al.*, 2010). As a result, cowpea grain yields in Africa are very low (50 – 150 kg/ha). 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).

Several control measures are available but chemicals are most effective, giving several fold increase in grain yield. These insect pests infest cowpea and severely reduce the quantity and quality of both the grains and fodder yields. This implies losses in both grain and fodder. Other measures used to reduce 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, Epedi *et al.* (2008) observed that the control may not be optimal because of the wide diversity of pests involved. Varieties of botanicals such as *Azadiracta indica*, *Zingiber officinale* and *Piper guineense* and other botanicals are being used by resource poor farmers in different parts of Nigeria (Gadzirayi *et al.*, 2006; Ekeh *et al.*, 2013; Ukpai *et al.*, 2017). The objectives of this study were therefore to determine the effectiveness of these botanicals for the control of *C. maculatus*, a major pest of stored cowpea.

## MATERIALS AND METHODS

This experiment was carried out in a laboratory of the Department of Zoology and Environmental Biology, Michael Okpara University of Agriculture, Umudike, Abia State,

Nigeria. 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).

**Insect Culture:** The method of Ousamn *et al.* (2007) 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 with relative humidity and temperature of 60 to 65% and  $27 \pm 2^{\circ}\text{C}$ , respectively. *C. maculatus* were obtained from the infested stock of beans purchased from Ubani market, Umuahia, Abia State, Nigeria.

**Bean Seeds:** The *Vigna unguiculata* used for the experiment was purchased from Ubani main market in Umuahia North L.G.A 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. 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  $60^{\circ}\text{C}$  for 4 hours to destroy any hidden infestation.

**Plant Materials:** The fresh leaves of *Azadiracta indica* and rhizome of *Zingiber officinale* were 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 a constant weight to ensure that the active ingredients were not lost. The dried leaves and the rhizome were ground separately into powder using a hand grinder and these were sieved to obtain fine powders using 0.20 mesh sieves (Lale and Mustapha, 2000). The botanical powders were put into airtight containers separately to ensure that the active ingredients were not lost. The powders were stored in a cool dry place pending use.

**Synthetic Insecticide:** The synthetic compound used as the standard control for the experiment was pirimiphos methyl powder (PMP).

**Efficacy Assay:** The efficacy of plant powders *Z. officinale* and *A. indica* (Table 1) of different dosages (0, 2, 4, 6 and 8 g) were tested against *C. maculatus*.

**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	Zingiberaceae	Rhizome
<i>Azadiracta indica</i>	Neem	Meliaceae	Leaves

The powders were introduced into 50 g of clean beans and thoroughly mixed together by agitating the vials manually (Ekeh *et al.*, 2013; Ukpai *et al.*, 2017). An experimental control in which no powder was included was also set up. The standard control having PMP applied at the rate of 0.25 g per 50 g grain was equally set up (Ekeh *et al.*, 2013). All treatments were replicated four times for each experiment. Twenty unsexed adults of *C. maculatus* (taken from the stock culture kept in the laboratory) were introduced into each vial and covered with muslin cloth held tightly in place by a rubber band to avoid escaping of the weevils. Using the method reported by Ekeh *et al.* (2013), the mortality counts of the weevils were recorded at 24, 48, 72 and 96 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.

**Data Analysis:** The data obtained were subjected to central tendency analysis and analysis of variance (ANOVA) and significant means were separated using Fisher's LSD (Williams and Abdi, 2010). The result was presented in percentages.

## RESULTS

The use of *A. indica* powder as a biopesticide revealed that the quantity of bean seed mixed with 8 g of *A. indica* powder had the highest

mortality of *C. maculatus* of 80(100.0 %) throughout the 96 hours. This was followed by 6 g *A. indica* powder which had 75(93.9 %) mortality, then 4 g *A. indica* powder which had 71(88.9 %) mortality. The least was 2 g *A. indica* powder which had 58(72.6 %) mortality (Table 2).

Furthermore, the use of *Z. officinale* powder as a biopesticide showed that the beans treated with 8 g of *Z. officinale* powder had the highest mortality 75(93.8 %) of *C. maculatus*, while grains treated with 2 g *Z. officinale* powder had the least mortality 46(57.5 %). In grains treated with 8 g of *Z. officinale* powder the highest mortality 37(46.3 %) occurred at 24 hours after treatment, while the lowest mortality 10(12.5%) was at 72 hours post treatment. In grains treated with 2 g of *Z. officinale* powder the highest mortality 13(16.3 %) was recorded at 48 hours, while the least mortality 10(12.5 %) was at 96 hours (Table 2).

The result of the evaluation of the two botanical pesticides and synthetic insecticide in the control of *C. maculatus* within 96 hours indicated that PMP causes the highest mortality 320(100.0%) of *C. maculatus*. *A. indica* powder recorded 280(88.8 %) mortality of *C. maculatus*. The least was *Z. officinale* powder which had 227(71.0 %) mortality of *C. maculatus* (Table 3).

There was significant variation in the efficacy of the different botanical pesticides as probable toxicant against *C. maculatus* in comparison with each other and with the control. In all cases, ANOVA showed that the two botanical powders were significantly different ( $p < 0.05$ ) in inducing *C. maculatus* mortality compared with the experimental and standard controls.

## DISCUSSION

The results of the study revealed that the botanicals are good protectants of bean seeds against *C. maculatus*. The pirimiphosmethyl powder recorded the highest mortality in the control of *C. maculatus* after 96 hours. Both *A. indica* and *Z. officinale* were very effective in the control of *C. maculatus* in bean seeds during storage.

**Table 2: Percentage mortality of *Callosobruchus maculatus* exposed to varied concentrations of *Azadirachta indica* and *Zingiber officinale* powders between 24 – 96 hours intervals**

Duration of exposure (hours)	PMP (0.25 g)	Mortality of <i>C. maculatus</i> (%)				
		Concentration of neem powder (grams)				
		0	2	4	6	8
24	29 (36.3)	0(0.0)	16(20.0)	17(21.3)	27(33.8)	23(28.8)
48	30 (37.5)	0(0.0)	15(18.8)	19(23.8)	13(16.3)	21(26.3)
72	18 (22.5)	0(0.0)	9(11.3)	16(20.0)	16(20.0)	19(23.8)
96	3 (3.8)	0(0.0)	18(22.5)	19(23.8)	19(23.8)	19(23.8)
<b>Total</b>	80(100.0)	0(0.0)	58(72.6)	71(88.9)	75(93.9)	80(100.0)
Concentration of ginger powder (grams)						
24	29 (36.3)	0(0.0)	12(15.0)	22(27.5)	19(23.8)	37(46.3)
48	30 (37.5)	0(0.0)	13(16.3)	2(2.5)	18(22.5)	16(20.0)
72	18 (22.5)	0(0.0)	11(13.8)	10(12.5)	12(15.0)	10(12.5)
96	3 (3.8)	0(0.0)	10(12.5)	14(17.5)	9(11.3)	12(15.0)
<b>Total</b>	80(100.0)	0(0.0)	46(57.5)	48(60.0)	58(72.5)	75(93.8)

**Key:** PMP = Pirimiphos methyl powder; Number in parenthesis = percentage mortality

**Table 3: The total mortality rate of *C. maculatus* in botanicals and synthetic insecticides**

Treatment	Mortality
<b>PMP</b>	320(100)
<b><i>A. indica</i></b>	284(88.8)
<b><i>Z. officinale</i></b>	227(71.0)
<b>Control</b>	0(0.0)
<b>Total</b>	831

**Key:** PMP = Pirimiphos methyl powder; Number in parenthesis = percentage mortality

The treatments with higher dosages of botanicals recorded the higher mortality, this agreed with Omotoso (2014) and Ukpai *et al.* (2017) who reported that higher dosage of treatment work effectively in the protection of stored grains against stored products pests. Apart from the fact that *A. indica* is highly effective against *C. maculatus*, the botanicals are locally available, cheaper and environmental friendly compared with synthetic powder or chemical pesticides. The *A. indica* has antimicrobial and protective properties and is useful traditionally in the prevention and treatment of malaria (Alzohairy, 2016). *Z. officinale* is a common medicinal herb with various active ingredients that are also useful and are consumed by man to prevent and control one form of ailment or the other such as constipation, cold, etc. (Chaiyakunapruk *et al.*, 2006).

Although the mode of action of these botanicals was not determined in this trial, the death of *C. maculatus* might have been caused by blockage of the spiracles leading to asphyxiation and/or the insect ingesting lethal doses of the treatment thus resulting in stomach poisoning. Law-Ogbomo and Enobakhare (2007), Muzemu *et al.* (2013) and Ukpai *et al.* (2017) also made similar observations.

**Conclusion:** 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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