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Efficacy of Alligator Pepper (Aframomum Melegueta) L. Seed Powder against Maize Weevil (*Sitophilus Zeamais*) of Stored Maize

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Abstract:
This study, 'efficacy of alligator pepper (Affromomum melegueta) seed powder against Sitophilus zeamais of stored maize' was conducted in the laboratory, Department of Biology, Federal University of Technology, Owerri between August and September, 2017. The experimental design used was completely randomized design (CRD) in four (4) replications with four treatments. The treatments were 0g, 30g, 60g, and 90g of alligator pepper seed powder respectively. Seed powder of Affromomum melegueta was applied to different containers each containing 200g of maize grains weighed using an electronic weighing balance in the laboratory at the rates 30g, 60g, 90g respectively. The plastic white plates were shaken vigorously for optimum coverage of the grain surfaces. Seed powder of Affromomum melegueta was not applied to the control plate. Twenty-five (25) males and twenty-five (25) females of insect species Sitophilus zeamais was introduced into each plate containing the ground treatment powder and maize grain and the control. Each treatment and control were replicated three (3) times. The containers were covered with white netting material and held in place with rubber bands. The plastic containers were labeled respectively. After every forty-eight hours, the mortality of Sitophilus zeamais and other parameters in both treated and untreated plates were observed and recorded. The analysis of variance (ANOVA) showed that 90g of alligator seed powder gave a significant reduction in mean number of holes, and average weight loss of maize seeds followed by 60g, 30g, and 0g of alligator pepper seed powder at P= 0.05 level. The results also showed that the percentage mortality of Sitophilu szeamais was high in 90g (90%) mortality than other treatments used. The phytochemical analysis conducted showed the presence of the alkaloids, tannins, flavonoids and saponins. These compounds were the active ingredients present in alligator pepper seeds and were able to control stored product pests. The findings therefore present satisfactory importance of Afromomum melegueta for stored pests' control as its administration increased Sitophilus zeamais mortality and reduced natality in high grams. Also, seeds damaged as a result of perforations by pests was significantly(P=0.05) reduced, which as most probable, consequently led to a reduced seed weight loss in all the treated seeds.

Keywords: *Bioinsecticides, Aframomum melegueta, maize weevil, control*

1. Introduction

The maize weevil, *Sitophilus zeamais* Motschulsky (Coleoptera: Curculionidae) is a serious pest of stored maize, causing qualitative and quantitative losses. Bio-deterioration of stored grains, both marginal and comprehensive, has been

traced to the activities of insect pests such as the maize weevils (Ewete &Alamu, 1999; Rahman, *et al*., 2001). Post-harvest losses to storage insect pests such as the maize weevil have been recognized as an increasingly important problem in Africa (Markham *et al.*, 1994). Cheap and effective methods for reducing *S. zeamais* damage are needed in these countries (Danho *et al.*, 2002).

Corn is a staple food, and forms the bulk of cereal food for both children and adults. It is grown commercially and stored in Granaries and Silos. Unfortunately, due to the bio activities of weevils, farmers and corn dealers do suffer losses from time to time and from season to season (Rahman *et al*., 2001). Infestation by this weevil commences in the field (Demissie *et al.*, 2008), but most damage is done during storage. Damaged grains have reduced nutritional values, low percent germination and reduced weight and market values, respectively. In other to address these losses, farmers had resorted to the use of chemical insecticidal pesticides (El-Atta &Ahmed, 2002). However, these chemicals have attendant hazards like low affordability, resistance, environmental pollution, and other bio-hazards (UNEP,2002). The application of botanicals, as alternative substitutes to the conventional chemical agents has been reported by researchers (Jahromi *et al*., 2012; Nwachukwu & Okoro, 2013).

Maize is an important food crop grown commercially on a large scale and as a small garden crop throughout the world (Richard *et al*., 1994). Nearly one thousand species of insects have been found associated with stored products in various parts of the world (Gc, 2006). Many pests of stored maize are Coleopterans and the most destructive tropical species for maize belongs to the genus *Sitophilus* and *Tribolium* (Bello *et al*., 2000). The maize weevil, *Sitophiluszeamais* Mutschulsky is a serious and the most important pest of stored maize, causing considerable losses. Significant reduction in the viability of the grain is a common effect of infestation by *Sitophilus* species (Okiwelu *et al*., 1987). The weevil, *Sitophiluszeamais* Mutschulsky poses a serious threat to food security, particularly in developing countries.

Aframomum melegueta also known as alligator pepper (indigenous names include: atare in Yoruba, ose-oji in Igbo land, citta in Hausa) is used in Nigeria and some other parts of West Africa, as a spicy during entertainment and have a wide range of folkloric uses in traditional medicine. They are used as a remedy for treating stomach ache, diarrhoea and snakebite (Umukoro & Ashorobi, 2007; Ilic *et al*., 2010). The seed extract has been evaluated for anti-nociceptive, anti-ulcer, antimicrobial, anti-inflammatory, anti-oxidant and sexual performance enhancing activities (Ilic *et al*., 2010; Onoja *et al*., 2014). This study therefore is aimed at determining the pesticidal efficacy and antifeedant potentials of seed powder of *Aframomummelegueta*.

2. Materials and Methods

2.1. Study Area

This research work was carried out in the Biology laboratory, School of Biological Sciences, Federal University of Technology, Owerri. The mean temperature of the laboratory ranges from 27°C-30°C and the mean relative humidity 81%-90%. The Federal University of Technology Owerri lies between latitude 05° 21' and 05° 42'N and longitude 07° 48' and 06° 53'E. Owerri consists of tropical rainforest zone with average annual rainfall distribution of 2,250-2800mm. This region produces many agricultural products.

2.2. Experimental Materials

The experiment was performed using the following materials: Maize grain, variety-*Succharata* (sweet corn), Alligator pepper *(Affromomum meleguea)*, White plastic plates, Marking tape, Permanent marker, Insect species (*Sitophilus zeamais)*, White netting material, Rubber band, Weighing balance, Thermometer and Hygrometer.

2.3. Procurement of Alligator Pepper and Maize Grain

The alligator pepper and maize grain used in this research project were procured from the National Root Crops Research Institute (NRCRI), Umudike located at Km 8, Ikot-Ekpene Road, Umudike Umuahia, Abia State Nigeria.

2.4. Preparation of Alligator Pepper Powder

Freshly harvested fruit of alligator pepper (*Affromomum melegueta)* procured were washed and the fruits were dehauled, the seed air dried for 30 (thirty) days and ground into powder using an electric blender into various grams of 30g, 60g, and 90g of alligator pepper powder and placed in air tight containers for use.

2.5. Experimental Design

This study adopted a completely randomized design (CRD) with one maize variety (succharata) and four (4) treatments and one (1) control group.

All experimental treatments were replicated four (4) times with the following treatments;

T_0 = 0g control

T_1 = 30g alligator pepper powder

T_2 = 60g alligator pepper powder

T_3 = 90g alligator pepper powder

2.6. Experimental Procedure

Seed powder of *Affromomum melegueta* was applied to different containers each containing 200g of maize grains weighed using an electronic weighing balance in the laboratory at the rates 30g, 60g, 90g respectively. The plastic white plates were shaken vigorously for optimum coverage of the grain surfaces. Seed powder of *Affromomum melegueta* was

not applied to the control plate. Twenty-five (25) males and twenty-five (25) females of insect species *Sitophilus zeamais* was introduced into each plate containing the ground treatment powder and maize grain and the control. Each treatment and control were replicated three (3) times. The containers were covered with white netting material and held in place with rubber bands. The plastic containers were labeled respectively. After every forty-eight hours, the mortality of *Sitophilus zeamais* in both treated plates were observed and recorded. The sexes of *Sitophilus zeamais* was determined by examining the snout. The snout of females is longer and thinner while that of males are shorter and fatter (Kranz *et al., 1978*). Also, females have smooth textured bodies while that of the males are rough (Kranz *et al.,*).

2.7. Assessment Of Parameters

2.7.1. Number of Holes on Maize Grain

The number of holes on maize grains were determined by counting the number of holes on the grain and the number of holes were recorded.

2.7.2. Mortality Rate of *Sitophilus Zeamais*

The mortality rate of *Sitophilus zeamais* was recorded at 1week, 2weeks, 3weeks, 4weeks, 5weeks, 6weeks, 7weeks, and 8weeks intervals by counting the number of dead *Sitophiluszeamais.*

2.7.3. Weight Loss of Maize Grain

The weight loss of maize grain was determined by measuring the initial weight of the maize grain before infestation minus the final weight of the maize grain after infestation by *Sitophilus zeamais*.

2.7.4. Natality Rate of *Sitophilus zeamais*

The adult *Siophilus zeamais* emergence of F1 progeny was observed in the control and treated grains. The number of F1 progeny was counted and recorded.

2.8. Phytochemical Screening of Affromomum Melegueta

2.8.1. SEED

The phytochemical tests for the identification of various classes of secondary metabolites was carried out using standard prescribed method of Trease and Evans (1999) and Edeoga *et al.,* (2005).

2.8.2. Statistical Analysis

The data obtained were subjected to a one-way analysis of variance (ANOVA) procedure using SPSS version 20 and the effectiveness of the treatment means were compared using the least significant difference (LSD) test at P=0.05 level.

3. Results

3.1. Alligator Pepper Seed Powder against Morality Rate of Sitophilus Zeamais (Maize Weevil)

The mortality of *Sitophilus zeamais* showed significant difference when treated with 0g, 30g, 60g and 90g of alligator pepper seed powder. The 90g alligator pepper seed powder had the highest mean number of mortality rate (dead weevils) at 1week, 2weeks,3weeks, 4weeks, 5weeks, 6weeks, 7weeks, and 8weeks after treatments with alligator pepper seed powder (Table1). The mean number of *S. zeamais* alive after treatments with alligator pepper seed powder showed that 0g (control) recorded no deaths (50) of *S. zeamais* where there was no treatment application, followed by 30g alligator pepper seed powder (17.2) and 60g (15.9) and the least was 90g alligator pepper seed powder (5.0) respectively.

Alligator pepper seed powder (g)	**Mean number of weevils introduced**	**Mean number of dead weevils in weeks**								**Mean number alive**
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
`0	50	0	0	0	0	0	0	0	0	50
30	50	4.8	4.0	4.5	5.5	4.5	3.2	3.8	2.5	17.2
60	50	5.3	4.5	4.5	6.3	5.3	4.5	2.5	2.0	15.9
90	50	6.5	6.8	7.3	7.0	5.8	5.8	3.0	2.8	5.0

Table 1: Effects of Alligator Pepper Seed Powder on Maize Weevil Mortality

3.2. Number of Holes and Weight Loss of Maize Seeds

The mean number of holes or damage on the maize seeds by *S. zeamais* at weekly intervals are recorded in mean (Table4. 2). From the result, there were significant differences (P= 0.05). The control (84) showed a high increase in mean number of seed holes or damage followed by 30g alligator pepper seed powder (43), and 60g alligator pepper powder (40) and the lowest was 90g alligator pepper seed powder (15) respectively at probability of 0.05 level (Table 4. 2). The

mortality of *S. zeamais* showed that 0g had 0 mean number of dead weevils with 0 percentage mortality, while 90g alligator pepper seed powder had a significant high mean number of dead maize weevil (45.0) with the highest percentage mortality of 90%. The 30g and 60g alligator pepper seed powders showed no significant difference at P= 0.05 level (Table 4.2). Similar trend showed in average weight loss of maize seeds and treated with 90g alligator pepper seed powder (6.0g) gave the least average weight loss than other treatments used in the storage of maize seeds.

Alligator Pepper seed powder (g)	Average Initial weight of maize (g)	Average Final weight of maize (g)	Mean number of holes	Average weight loss (g)	Mean Number Of Dead Weevils	Mortality (%)
0	200	168.5^{c}	84^{a}	31.5^{a}	0.0^{c}	0.0^{c}
30	200	184.0^{b}	43^{b}	16.0^{b}	32.5^{b}	65.8^{b}
60	200	185.0^{b}	40^{b}	15.0^{b}	34.1^{b}	68.2^{b}
90	200	194.0^{a}	15^{c}	6.0^{c}	45.0^{a}	90.0^{a}

Table 2: Effects of Alligator Pepper Seed Powder on number of holes and weight loss of maize seeds

Mean along the column having different letters of superscript differ significantly at P =0.05 level

3.4. Alligator Pepper Seed Powder against Natality Rate of Sitophilus Zeamais

Table 4.3 showed the results on alligator pepper seed powder on natality rate of *Sitophilus zeamais*. The 0g alligator pepper seed powder (15.5) gave the highest mean number of natality with 31.0% natality of *S. zeamais*, followed by 30g alligator pepper seed powder (4.0) mean number of natality with 8.0% natality, 60g alligator pepper seed powder (3.5) with 7.0% natality and 90g alligator pepper seed powder (1.5) mean number of natality with 3.0% natality respectively.

Alligator pepper seed powder (g)	Mean number of natality	Natality (%)
0	15.5^{a}	31.0^{a}
30	4.0^{b}	8.0^{b}
60	3.5^{b}	7.0^{b}
90	1.5^{c}	3.0^{c}

Table 3: Effects of Alligator Pepper Seed Powder on Maize Weevil Natality (F1 progeny)

Mean along the column having different letters of superscript differ significantly at P= 0.05 level

3.6. Proximate Composition And Phytochemical Analysis Of Alligator Pepper Seeds (Affromomum Melegueta)

The proximate composition were dry matter (81.87%), crude protein (13.52%), crude fibre (12.22%) , ether extract (8.85%), ash (8.15%) and nitrogen free extract (49.10%) while phytochemical results showed that alkaloid was present, tannin was strongly present, flavonoid was present and saponin was moderately resent (Table 4. 4 and 4. 5).

Parameters (%)	*Affromomum Melegueta*
Dry mater	81.87
Crude protein	13.52
Crude fibre	12.22
Ether extract	8.85
Ash	8.15
Nitrogen free extract	49.1

Table 4: Proximate Composition of Affromomum Melegueta

Parameters	*Affromomum Melegueta*
Alkaloid	+
Tannins	+++
Flavonoids	+
Saponins	++

Table 5: Phytochemical Analysis of Affromomum melegueta

+++ = Strongly present
++ = Moderately present
+ = Present

4. Discussion

The effect of alligator pepper seed powder on weevil species has not been reported by many workers. This study showed significant high mortality and low natality of *S. zeamais* on the weevils treated with 90g of alligator pepper seed powder and low mean number of holes (seed damage) than 60g, 30g and 0g of alligator pepper seed powder. The potential for using tropical plants to control stored-product pests through repellency, immobilization or deterrent activity has been studied elsewhere.

The work of Ukeh *et al.,* (2010) on behavioural responses of the maize weevil, *Sitophilus zeamais*, to host (stored-grain) and non-host plant volatiles at University of Aberdeen, Aberdeen, United Kingdom, explained, at least in part, how the application of these plants may protect grain from insect infestation in storage. The result of their study corroborates the underpinning science for the ethno-botanical use of plant powders to repel insects from stored products by resource-poor farmers in West Africa and increase the potential practical value of using *A. melegueta, Z. officinale* and *P. guineense* for grain protection against *S. zeamais* infestation. The work of Adullahi *et at.,* (2011) on studies on the efficacy of lime peel oil in protecting stored maize against adult maize weevils, *Sitophilus Zeamais* Bayero University, Kano, Nigeria, demonstrated that lime peel oil may be very potent because of the odour they produce and which may have exerted a toxic effect by disrupting normal respiratory activity of the weevils, thereby resulting in asphyxiation and subsequent death. They reported the toxicity bioassay efficacy of the lime peel oil on the maize weevils and that adult mortality significantly increased with increase in concentration and days of exposure. In addition, the work of Edelduok *et al.,* (2012) on the bio-insecticidal potentials of testa powder of melon, *Citrullus vulgaris* Schrad for reducing infestation of maize grains by the maize weevil, *Sitophilus zeamais* at Akwa Ibom State University, Ikot Akpaden, Akwa Ibom State, Nigeria revealed that maize grains with testa powder of melon, *Citrullus vulgaris* at the dosage rates of 0.5g to 3.0g per 50g of maize gave promising levels of control of *Sitophilus zeamaiz* in terms of reduction in the number of eggs laid and reduction in the number of offspring. The toxicity of the testa powder observed in their study could be attributable to colocynthin, a toxic poisonous substance known to be present in the white fleshy pulp of the melon fruit. However, from their result, the adult mortality of *S. zeamais* in the present study was not very high and not statistically significant.

Studies on the weevil's behavioural vis-à-vis plant extracts and powder treatments also emphasized their importance in the control of pest storage crop. Silva *et at.,* (2013) work on the insecticide irritability of plant extracts against *Sitophilus zeamais* showed that behaviour avoidance of plant extract and permether in treated surface was recognized through the nine components used in the tests of insecticide irritability (that is, avoidance after contact).

However, the study demonstrated that the plant extract tested were effective against *S. zeamais* in stored maize with respect to insecticide irritability.

5. Conclusion

The present study evaluated the pesticidal potential of *Afromomummelegueta* on maize weevils, vis-à-vis their mortality and natality as well as ascertained the protective efficacy of the botanical against stored pest of maize. The findings therefore present satisfactory importance of *Afromomummelegueta* for stored pests' control as its administration increased *Sitophiluszeamais* mortality and reduced natality in high grams. Also, seeds damaged as a result of perforations by pests was significantly (P=0.05) reduced, which as most probable, consequently led to a reduced seed weight loss in all the treated seed

6. Recommendations

Given the need for more proactive measures and researches for the development of biopesticides for stored crops or agricultural products, the findings of this study therefore recommend the following:

- There is need for further research that will target using isolated bioactive compound of botanicals against the fertility genome or genetic makeup of common storage pests.
- There is need to seek out for botanicals with anti-oviposition and larvicidal efficacy to help break the life cycle and hinder development of the pest's metamorphic stages.

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