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Comparative Effects of Selected Botanicals as Substitute for Synthetic Insecticide in Controlling Maize Weevils (*Sitophilus Zeamais*) in Stored Maize Grain

Fatimah Abdussalam & Azeez Adeniji
Department of Science Laboratory Technology, Federal Polytechnic, Ilaro. Ogun State, Nigeria
fatimah.abdussalam@federalpolyilaro.edu.ng

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Abstract

A study was conducted to compare the efficacy of the powder of *Aframomum melegueta*, *Cymbopogon citrates*, *Moringa oleifera* and Actellic Dust Insecticide against adult *Sitophilus zeamais* in stored maize grain. Each of the treatments was admixed with 10maize grain and later infested with adult weevils**.** 5, 10, 15, 20, 25 and 30g of the plant powder and 0.2g of Actellic Dust Insecticide per 10grain was the ratio of mix. The treatments were kept in Petri-dishes in an incubator for a period of 96hrs. The experiment was laid out in a completely randomized design of 8 treatments and 3 replicates. The mortality of weevils to the plant powders and the synthetic powder were recorded. The highest percentage mortality of 80% was recorded in the plant powder at 25 and 30g dose respectively. The highest weevil mortality percentage recorded at 25 and 30g in all the plant treatments coincide with that recorded in the synthetic powder. Maize was not affected by weevil at doses 20 and 30g likewise at 0.2g of the synthetic powder. The results of the study show that all the botanicals were effective in the treatment and prevention of maize weevil from invading stored maize grain and their use could be adopted in prolonging the longevity of stored grains.

Keywords: *Aframomum melegueta***,** *Cymbopogon citrates*, *Moringa oleifera***,** Actellic Dust Insecticide, *Sitophilus zeamais.*

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1. Introduction

Maize is a staple cereal crop that is widely cultivated throughout the tropics in a range of agro-ecological environments. The quantity produced annually surpassed any other grain. It is the third most cultivated grain crop after rice and wheat (Lyon, 2000). Its kernels, like other seeds, are storage organs that contain essential components for plant growth and reproduction. Many of these kernel constituents, including starch, protein, and some micronutrients, are also required for human health. Its richness in energy makes it compete favourably with tubers especially in livestock feeds (Dasbak *et al.*, 2008). For this reason, and others, maize has become highly integrated into global agriculture, human diet, and cultural traditions.

Despite the prospect of maize grain being an essential food source in the food industry with the ability to withstand long storage, the preservation of quality is a key problem in most of the world especially in sub-Sahara Africa (Gras *et al.*, 2000). Thousands of tonnes of this food were being lost annually to weevils both in the field and in confinement due to poor storage facilities (Rajendran and Sriranjini, 2008). Integrated pest management is one of the widely used pest control methods that involve various contact and residual insecticides/pesticides in addition to the fumigants which have proved effective to prevent or suppress the menace of weevils in stored grain (Singh, 2017).

Long-term application and continuous use of synthetic insecticides have resulted in accumulating their residues in foods, water, and soil and cause adverse health effects to humans and ecosystems (Mossa *et al.*, 2018). The incidence of insecticide resistance by storage pests is also a growing problem in stored-product protection (Donahaye, 2000). Resistance to insecticides has been reported in several species of insects and mites. Botanicals were seen by several health organizations and researchers as a useful alternative to replace the use of synthetic insecticides as a control agent for weevils in stored grains. Botanicals have been reported in several works to be eco-friendly and cheap with little or no deleterious effects on both man and livestock animals (Owusu, 2001; Sim *et al*., 2006; Singh, 2017). This study intends to evaluate the efficacy of three botanicals; Alligator pepper (*Aframomum melegueta),* Lemongrass *(Cymbopogon citrates)* and Moringa (*Moringa oleifera*) as a replacement for synthetic pesticides and protective agent for stored maize grain.

2. Materials and Methods

Experimental site
This study was conducted in the Environmental Biology Laboratory of the Federal Polytechnic Ilaro, Ogun State, Nigeria.

Methodology
Sourcing of Plant materials and Identification
All the plant materials used for this study were locally sourced in Ilaro, Ogun State. The plant materials were identified in the Forestry Department at the Federal University of Agriculture, Abeokuta, Nigeria. Actellic® Dust Insecticide (ADI) was purchased from a reputable Agro-chemical store at Ifo, Ogun State, Nigeria. The shelf life of the product (ADI) was 2years from the year of manufacture.

Preparation of Maize Grain and Rearing of *S. zeamais*

Healthy maize grains were purchased from a local market in Ilaro, Ogun State. The grains were kept in a clean airtight transparent plastic for 2months to affect the infestation of grain weevil (*Sitophilus zeamais*). At two months, the grains were already attacked by grain weevil (*Sitophilus zeamais*). The newly emerged adult weevils were selected and used for the experiment.

Preparation of Plant Materials

Plant materials namely, Alligator pepper (*Aframomum melegueta), Lemongrass (Cymbopogon citrates)* and Moringa (*Moringa oleifera)* were air-dried in a well-ventilated room within the laboratory for about 2weeks before grinding into fine powder. The plant materials were ground using a laboratory blender and prepared into fine powder. Each plant powder was separately kept in clean polythene nylon under room temperature for further use.

Adult Mortality Assessment

The adult survival of *S. zeamais* was observed using the method of Dawit and Bekelle (2010). Twenty clean disinfected healthy maize grains were selected into sterilized petri-dishes. 5g, 10g, 15g, 20g, 25g and 30g of each of the plant powder were thoroughly mixed with the maize grain using a clean spoon to ensure admixture. A separate petri-dish containing maize grains was treated with Actellic® Dust Insecticide at 0.2g/10grains of maize to serve as positive control while another containing no treatment was used as a negative control. Treated grains were left undisturbed for 30minutes after which 10 adult *S. zeamais* was introduced into each of the Petri-dishes containing the treated maize. Treated and untreated grain in petri-dish was covered with a clean muslin cloth to avoid germs

interference and placed in an incubator. Observations were made at 96 hours to record weevil mortality and the number of damaged grains. Each treatment was replicated three times in Petri-dishes. The Petri-dishes were arranged in a Completely Randomized Design.
Note: The inclusion level of ADI used in this present study was informed by the manufacture's prescription.

Damaged Assessment

Observable damage caused by the weevils to the grains was assessed using the method described by Asawalam *et al*, (2007). Grains with holes were separated from healthy ones and counted, afterward, the percentage of grain damage was calculated using the formula of Fatope *et al.*, (1995).

$$\%Damage = \frac{\text{Number of grain perforated}}{\text{Number of grain sampled}} \times 100$$

Statistical analysis

Statistical analysis (Standard Deviation, Standard Error of Mean, % Mean Mortality and P-value) of the experimental data was performed using the computer software SPSS for windows version 16.0. Finney (1971) Probit table was used to find the Probit values, LC_{50} and $LC_{100.}$

Percentage mosquito larvae mortality was calculated by using the formula;

$$\% Mortality = \frac{\text{Number of dead weevil}}{\text{Number of weevils tested}} \times 100$$

3. Results

Table 1 shows the empirical probit and insecticidal activity of the leaf powder of *Moringa oleifera* on *S. zeamais* at 96hrs exposure. The botanical powder varying quantity applied showed a significant effect P<0.05 on the weevil. The result showed that weevil mortality is dose dependent. At the higher dose of 25 and 30g, the percentage mortality recorded were similar to that recorded in ADI. No significant effect (P<0.05) was observed at the control (0g). Lesser mortalities of 70% were recorded at doses 5, 10, 15 and 20g respectively.

The effects of the leaf powder of Moringa were similar to that observed in table 1. The results obtained at 25 and 30g doses were similar and also coincide with the mortality value recorded when the weevils were subjected to maize treated with ADI. Although lower percentage mortalities were observed when at dose 5 and 10g compared to that in table 1. There is an upward increment in the mortality percentage as the dose increase from 0 to 30g. No mortality was observed in the control.

Table 3 shows the efficacy of Lemongrass on maize weevil. The result obtained shows that lemongrass powder is also a promising botanical in the control of maize weevil. Dose 15, 25 and 30g shows a significant effect P<0.05 similar to that obtained in ADI. No mortality was recorded at the control. 60% mortality was recorded at 5g dose which is similar to that obtained in table 2 when weevil was exposed to maize grain treated with 5g of Moringa leaf powder.

All the results obtained in the botanicals used in this study shows significant effects P<0.05 especially at a higher dose of 25 and 30g.

Table 4 shows the efficacy of the three botanicals in preventing maize grain damage. All the botanicals show significant effects P<0.05 in preventing grain damage by adult *S. zeamais.* The results obtained were almost similar. No damage was observed on all the grains at doses 25 and 30 among all the 3 treatments. Lemongrass shows a better result at doses 15 and 20g (0% grain damage) compared to Alligator pepper powder (10% grain damage), although it shows similar results (0% grain damage) with Moringa leaf powder at 20g dose. At doses 25 and 30g, the three botanicals had similar results with ADI. This shows their potential to replace the synthetic ADI.

Table 1: Effects of Alligator pepper powder on mortality of adult *S. zeamais* at 96hrs

The quantity applied(g)	No of weevil introduced	No of affected weevil	% Mortality	Log_{10} Conc.	Empirical Profit	% Mean Mortality±SD	SEM	LD_{50}	LD_{100}
0 (Control)	10	0	-	-	-	65.00±2.812	1.063	2.55	35.72
5	10	7	70	0.70	5.52				
10	10	7	70	1	5.52				
15	10	7	70	1.18	5.52				
20	10	7	70	1.30	5.52				
25	10	8	80	1.40	5.84				
30	10	8	80	1.48	5.84				
ADI (0.2g)	10	8	80	-0.70	5.84				

*Significance level at P≤0.05

SD = Standard Error; SEM = Standard Error Mean; ADI = Actellic Dust Insecticide

Table 2: Effects of Moringa leaf powder on mortality of adult *S. zeamais* at 96hrs

Quantity applied (g)	No of weevil introduced	No of affected weevil	% Mortality	Log_{10} Conc.	Empirical Probit	% Mean Mortality±SD	SEM	LD_{50}	LD_{100}
0	10	0	-	-	-	62.50±2.77	1.047	3.50	37.22
5	10	6	60	0.70	5.25				
10	10	6	60	1	5.25				
15	10	7	70	1.18	5.52				
20	10	7	70	1.30	5.52				
25	10	8	80	1.40	5.84				
30	10	8	80	1.48	5.84				
ADI (0.2g)	10	8	80	-0.70	5.84				

Significance level at P≤0.05

SD = Standard Error; SEM = Standard Error Mean; ADI = Actellic Dust Insecticide

Table 3: Effects of Lemongrass powder on mortality of adult *S. zeamais* at 96hrs

The quantity applied (g)	Total No of weevil introduced	No of Affected weevil	% Mortality	Log_{10} Conc.	Empirical Probit	% Mean Mortality±SD	SEM	LD_{50}	LD_{100}
0	10	0	-	-	-	63.75±2.80	1.056	3.45	38.35
5	10	6	60	0.70	5.25				
10	10	7	70	1	5.52				
15	10	8	80	1.18	5.84				
20	10	7	70	1.30	5.52				
25	10	8	80	1.40	5.84				
30	10	8	80	1.48	5.84				
ADI (0.2g)	10	8	80	-0.70	5.84				

*Significance level at P$\leq$0.05
SD = Standard Error; SEM = Standard Error Mean; ADI = Actellic Dust Insecticide

Table 4: Effect of alligator pepper, moringa leaf powder and lemongrass applied at varying quantities on maize grain perforation caused by *S. Zeamais* (96hrs)

The quantity applied (g)	No of grain sampled	No of perforated grain			Grain damage (%)		
		Alligator pepper	Moringa leaf	Lemon grass	Alligator pepper	Moringa leaf	Lemongrass
0	10	3	4	3	30.00	40.00	30.00
5	10	1	1	1	10.00	10.00	10.00
10	10	0	1	1	0.00	10.00	10.00
15	10	1	1	0	10.00	10.00	10.00
20	10	1	0	0	10.00	0.00	0.00
25	10	0	0	0	0.00	0.00	0.00
30	10	0	0	0	0.00	0.00	0.00
ADI (0.2g)	10	0	0	0	0.00	0.00	0.00

ADI = Actellic Dust Insecticide

4. Discussion

Botanicals are now recognized as a potent alternative having strong insecticidal effects in various pest control programmes due to their excellent larvacidal, pupicidal and adulticidal properties. This present study shows that all the botanicals used are effective in controlling *S. zeamais* present in maize grain. The effects of the various botanicals on maize grain could be due to several factors such as the chemical composition of the plant and species susceptibility (Aktar and Isman, 2004). In most parts of the world, residual synthetic insecticides are currently the choice desired by many for the control of stored product insect pests. The prolonged uses of these chemicals have a pathway for many species of stored-product pest to develop resistance (Rahman *et al*., 2009). The residual effects in terms of environmental contamination and health hazards are also an issue of interest. All these gave researchers the insight to source for the alternative, which is eco-friendly, cheap and easy to prepare.

From the result tables, it can be deduced that all the plant's powder used in this study have significant effects on the mortality of adult *S. zeamais* and the longevity of the maize grain. The present study agrees with the work of Danjuma *et al*., (2009) who reported similar results ranging from 76-100% mortality using the powder of *A.sativum, N. tabacum,* and *Z. officinale* at a dose of 0.5, 1.0, 1.5 and 2g respectively, although at a period of 72hrs. Arannilewa *et al*., (2006) also reported about 85% mortality when adult *S. zeamais* were exposed to maize grain containing extract of *A. sativum* for 4days. Plant powders have been reported to often reduce adult weevil growth (Rajapakse, 2006). They have lethal effects on the adult emergence of insect pests such as *S. zeamais* attacking stored grains like maize and cowpea (Suleiman and Yusuf, 2011). The lethal ability of these plants could be attributed to their contact toxicity on the weevil (Muhammad and Babatunde, 2015). The botanicals at a higher dose of 25 and 30g appear to have similar effects with ADI which shows their ability to replace ADI and other synthetic chemicals. It was shown in this current finding that botanical treated grains showed reduced grain damage compared to the control group. The reduced number of perforated grain and grain damage percentage observed in the botanical treated group indicated the repellent potential of botanicals in controlling maize weevils in stored maize grain (Obeng-Ofori and Amiteye, 2005).

5. Conclusion

The three botanicals used in this study all showed promising effects and their use can be adopted in treating stored products to prevent an insect pest invasion. In addition, all the plants used are edible since they are used as either food ingredients or medicinal herbs for the treatment of various ailments in both humans and animals.

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