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Efficacy of some spices as sorghum grain protectants against *Sitophilus zeamais* Motschulsky [Coleoptera: Curculionidae]

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Studies were carried out to determine the efficacy of three spices (*Allium sativum* L., *Capsicum frutescens* L., and *Zingiber officinale* Rosc.) against *S. zeamais* reared on sorghum grains. Doses of 0.5, 1.0 and 1.5 g of each of *A. sativum, C. frutescens* and *Z. officinale* and 0.12 g of permethrin were applied to 20 g of sorghum grains infested with *S. zeamais* under constant conditions of 30 ± 2°C and 65 ± 5% R.H. In all the treatments, 100% mortality among adult of *S. zeamais* reared on sorghu treated with all the powders was obtained. The effect of the spices on adult mortality was significant ($p<0.05$) between the powdered spices and the control. The effect of the different spices applied at varying amounts on grain damage caused by *S. zeamais* was significantly ($p<0.05$) different with the highest (33.30%) in petri dishes with 1.5 g of *C. frutescens* and the least (3.30%) from treatments of 0.5, 1.0 and 1.5 g of *Z. officinale* and *C. frutescens,* respectively. The findings of this study indicated that the selected spices showed their potentiality in reducing sorghum grain damage caused by *S. zeamais*.

Key words: *Allium sativum, Capsicum frutescens,* Protectants, *Sitophilus zeamais,* Sorghum grain, *Zingiber officinale.*

INTRODUCTION

Sorghum is the primary food crop in virtually all parts of northern Nigeria (USDA, 2010). The whole grain may be ground into flour or decorticated before grinding to produce either a fine particle product or flour, which is then used in various traditional foods (Leder, 2004). Sorghum is also used extensively in brewing, and industrial demand for sorghum by beer manufacturers is rising steadily, in step with rising demand for their products (USDA, 2010).

Storage is an important activity, which enhances marketing efficiency by providing utility (Adejumo and Raji, 2007). The loss of food grain during storage due to various insect pests is a very serious problem. Climate and storage conditions, especially in the tropic countries like Nigeria, are often highly favourable for insect growth and development, which leads to their damages to the stored grains that ranges from 5 to 30% of the world's total agricultural production (Pugazhvendan et al., 2009). In sorghum, the losses incurred through insect damage in store, is estimated to be in the region of 35% of total production (NAERLS, 2002).

The grain weevils (*Sitophilus* spp.) and the grain moth (*S. cerealella*) were the major pests of sorghum (NAERLS, 2002). The species of the genus *Sitophilus* (grain weevils) feed on cereals (Abate et al., 2000), causing serious management problem facing agriculture

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in developing countries.

The use of botanical products is more prevalent in the control of insect pests in storage systems, farmers can grow them and then can also be cheaper and easier to use than the synthetic insecticides (Govindan et al., 2010). Plant materials with insecticidal properties are one of the most important locally available, biodegradable and inexpensive methods for the control of pests of stored products (Jayakumar, 2010). Resource poor farmers in developing countries use different plant materials to protect stored grains against pest infestation by mixing grains with protectants made up of plant products (Udo, 2005). Many plant powders were evaluated and found effective in the management of *S. zeamais,* attacking maize grains in the stores (Danjumma et al., 2009; Suleiman et al., 2011). Spices are one of the important plant powders tested and found efficacious against insect pests of stored products (Rajapakse and Ratnasekera, 2008; Ukeh et al., 2008; Danjumma et al., 2009). This study describes laboratory bioassays to evaluate the efficacies of three local spices; *Allium sativum* (L.), *Capsicum frutescens* (L.) and *Zingiber officinale* (Rosc.) as possible stored sorghum grains protectants against *S. zeamais* in the tropics.

MATERIALS AND METHODS

Rearing of *S. zeamais*

Adults of *S. zeamais* were cultured in the laboratory at 30 ± 2°C in the Biology Laboratory 2, Umaru Musa Yar'adua University, Katsina. The food media used was whole maize grains. Fifty pairs of *S. zeamais* were introduced into 1 L glass jar containing 400 g weevils susceptible sorghum grains. The jars were then covered with muslin cloth held in place with rubber bands, newly emerged adults of *S. zeamais* were then used for the experiment.

Collection and preparation of spices

Spice materials namely; Garlic (*Allium sativum* L.), Chilli pepper (*Capsicum frutescens* L.) and Ginger (*Zingiber officinale* Rosc.) used in this experiment were purchased from Katsina central market. The spices were dried in a well ventilated area in the Laboratory for seven days before grinding into fine powder. The spices were ground using laboratory blender and made into fine powder. The powders were separately kept in polythene bags under room temperature for use during the experiment.

Adult mortality test

To study the adult survival of *S zeamais*, methods of Dawit and Bekelle (2010), was employed. Twenty gram of clean disinfested sorghum grains was weighed into sterilized petri dishes. Quantities (0.5, 1.0 and 1.5 g) of each of the spices were added to first three petri dishes separately, 0.12 g of permethrin as chemical check to the fourth and zero spices was added to the fifth (control). The spices were thoroughly mixed with the disinfested sorghum grains with the aid of glass rod to ensure thorough admixture. The treated sorghum was left undisturbed for an hour. Thereafter five pairs of newly emerged adult weevils were introduced into each of the treated and untreated sorghum in the petri dishes. Each of the petri dishes was covered with muslin cloth and tied with rubber band. All the petri dishes were then kept in the incubator. Each treatment was replicated four times. The petri dishes were arranged in Completely Randomized Design (CRD). Observations were made on adult mortality daily for 14 days during which dead adults were removed. The petri dishes were kept in the incubator at 32 ± 2°C and 65 ± 5% R.H for another 14 days for damage assessment.

Damage assessment

Damage caused by the weevils to the sorghum grains was assessed using the methods of Adedire and Ajayi (1996) and Asawalam et al. (2007). Ten grains were sampled randomly from each petri dish. Grains with characteristics hole were separated from healthy ones and counted then percentage grain damage was calculated using the formula (Fatope et al., 1995):

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

The weevil perforation index (WPI) is defined as follows:

$$\text{WPI} = \frac{\% \text{ Treated grains perforated}}{\% \text{ Control grains perforated} + \% \text{ Treated grains perforated}} \times 100$$

Statistical analysis

Data obtained were subjected to analysis of variance (ANOVA) using a general linear model procedure (SAS, 2000) at 5% level of significance. Significantly different means were separated by using least significant difference (LSD).

RESULTS

The effect of the spicy powders on mortality of adults of *S. zeamais* is shown in Table 1. The Table shows that all the spices applied at varying amounts (0.5, 1.0 and 1.5 g/20 g) resulted in 100% adult mortality 14 days after application, while 13.3% adult mortality was observed in the control at the same period. The spices were observed to show similar effects to the conventional insecticide (Permethrin). Adult mortality was observed to be significantly ($p<0.05$) different between the spices and control.

The effect of the different spices applied at varying amounts on sorghum grain damage caused by *S. zeamais* is presented in Table 2. The Table indicates that the least damage (3.30%) was observed from sorghum grains treated with 1.0 g of *C. Frutescens* and 0.5 g and 1.5 g of *Z. officinale* respectively, while the highest grain damage (33.3%) was obtained from sorghum grains treated with 1.5 g of *C. frutescens*. There grain damage caused by *S. Zeamais* was significantly ($p<0.05$) different between the treatments and the control.

Table 1. Effect of the spices on mortality of adults of *S. zeamais* on sorghum grains.

Test powders	Amount applied (g/20g)	No of weevils introduced	Adult mortality (percent)
	0.5	10	100.00
A. sativum	1.0	10	100.00
	1.5	10	100.00
	0.5	10	100.00
C. frutescens	1.0	10	100.00
	1.5	10	100.00
	0.5	10	100.00
Z. officinale	1.0	10	100.00
	1.5	10	100.00
Permethrin	0.12	10	100.00
Control	0.00	10	13.30
S. E.	-	-	14.33

Table 2. Effect of the spices applied at varying amounts on sorghum grain perforation caused by *S. Zeamais.*

Test powder	Amount applied (g/20 g)	Mean No. of grain sampled	Mean no. of perforated grain	Grain damage (Percent)
	0.5	10	1.00	10.00
A. sativum	1.0	10	1.67	16.70
	1.5	10	1.00	10.00
	0.5	10	0.67	6.70
C. frutescens	1.0	10	0.33	3.30
	1.5	10	3.33	33.30
	0.5	10	0.33	3.30
Z. officinale	1.0	10	0.67	6.70
	1.5	10	0.33	3.30
Permethrin	0.12	10	0.00	0.00
Control	0.00	10	5.33	53.30
S. E.	-	-	1.15	11.51

Table 3 shows the weevil perforation index (WPI) obtained from the study conducted. The least (0.00) WPI value was obtained in petri dishes treated with 1.5 g of *C. frutescenc*e and 0.12 g of permethrin respectively, while the highest (23.86) WPI value was observed in 1.0 g of *A. sativum*. Statistical analysis showed that there was a significant ($p<0.05$) difference between the WPI values from the different spices applied and the control.

DISCUSSION

From the results obtained it shows that all the plant powders used during the investigation have significant ($p<0.05$) effect on the mortality of adult *S. zeamais* in which all the test powders resulted in 100% mortality. Arannilewa et al. (2006) reported that 1.5 g of *A. sativum* applied to 25 g of maize grains caused mortality of 85% in adult *S. Zeamais,* 14 days after application. Similarly, Danjumma et al. (2009) reported that *A. sativum* gave 90% mortality at 1.5 g per 50 g of maize grain followed by *Z. officinale* with 86% after 7 days of application. *A. sativum* may have been very potent because of its strong odours which may have exerted a toxic effect by disrupting normal respiratory acting of the weevils as

Table 3. Effect of the spices on weevil perforation index (WPI) of sorghum grains.

Test powder	Amount applied (g/20 g)	No of sampled sorghum grains	Mean WPI
	0.5	10	15.80
A. sativum	1.0	10	23.86
	1.5	10	15.80
	0.5	10	11.17
C. frutescens	1.0	10	5.83
	1.5	10	0.00
	0.5	10	5.83
Z. officinale	1.0	10	11.17
	1.5	10	5.83
Permethrin	0.12	10	0.00
Control	0.00	10	50.00
S. E.	-	-	9.57

suggested by Adedire and Ajayi (1996). The present findings agree with that of Al-Moajel (2004) who reported 100% mortality of *S. zeamais* 14 days after application of *C. frutescens*. Asawalam et al. (2007) also reported that application of 0.4 g of *C. frustecens* caused 75% mortality on adult *S. zeamais* in 20 g maize grains. The ability of these plants to cause mortality of *S. zeamais* adult on maize grains might be attributed to the contact toxicity of powder on the weevil. The findings of this study also revealed that the selected spices applied at varying amounts were effective in reducing sorghum grain damage caused by *S. zeamais*. Among the spices applied *Z. officinale* was found to be the most effective spices in reducing grain damage which was in agreement with the findings of Asawalam et al. (2007) who recorded 7% grain damage on maize grains treated with *C. frutescens* at the rate of 0.4 g/20 g. *A. sativum* was also found promising in reducing grain damage. This agrees with the findings of Arannilewa et al. (2006) who reported 2.81% grain damage of maize when 1.5% of *A. sativum* was applied. This is due to the strong aroma of the powder which might have served as feeding deterrent to the weevils. The reduction in grain damage was observed to be directly proportional to the amount of the spices applied.

The results obtained revealed that all the spices applied had positive protectant ability of sorghum grains against *S. zeamais* by resulting in WPI value of <50 as suggested by Asawalam et al. (2007). *C. frutescens* was found to be the most effective spice in protecting sorghum grains against *S. zeamais.* This agrees with the findings of Adedire and Ajayi (1996) who reported 0.00 WPI value when 1.0 cm^3 of *C. frutescens* extract was applied to 10 g of maize grains against *S. zeamais.*

The findings of this research have shown that the selected spices were effective in reducing sorghum grains damage caused by *S. zeamais* and had positive protectant ability against the weevil. In addition, the spices used are edible since they are used either as ingredients for soup or medicinal preparations.

Conflict of Interests

The author has not declared any conflict of interests.

REFERENCES

Abate T, Huis AV, Ampofo JKO (2000). Pest management strategies in traditional agriculture: An African prospective. Annual Rev. Entomol. 45:63-65.

Adedire CO, Ajayi TS (1996). Assessment of the insecticidal properties of some plant extracts as grain protectants against the maize weevil, *Sitophilus zeamais* Motschulsky. Nigerian J. Entomol. 13:93 - 101.

Adejumo BA, Raji AO (2007). Technical appraisal of grain storage systems in the Nigerian sudan savannah. Agricultural Engineering International: The International Commission on Agricultural Engineering (CIGR). J. Scientific Res. Develop. Invited Overview, IX(11):1- 12.

Al-Moajel NH (2004). Testing some various botanical powders for protection of wheat grainagainst Trogoderma granarium Evert. J. Biol. Sci. 4(5):592-597.

Arannilewa ST, Ekrakene T, Akinneye JO (2006). Laboratory evaluation of four medicinal plants as protectants against the maize weevil, *Sitophilus zeamais* (Mots.). African J. Biotechnol. 5(21): 2032- 2036.

Asawalam EF, Emosairue SO, Ekeleme F, Wokocha RC (2007). Insecticidal effects of powdered parts of eight Nigerian plant species against maize weevil, *Sitophilus zeamais* Motschulsky (Coleoptera: Curculionidae). Electronic J. Environ. Agric. Food Chem. 6(11):2526-2533.

Danjumma BJ, Majeed Q, Manga SB, Yahaya A, Dike MC, Bamaiyi L (2009). Effect of some plant powders in the control of *Sitophilus zeamais* Motsch (Coleoptera: Curculionidae) Infestation on maize grains. American-Eurasian J. Scientific Res. 4(4):313- 316.

Dawit KZ, Bekelle J (2010). Evaluation of orange peel *Citrus sinensis* (L.) as a source of repellent, toxicant and protectant against *Zabrotes*

subfasciatus (Coleoptera: Bruchidae). Mekelle University J. Sci. 2(1):61- 75.

Fatope MO, Mann A, Takeda Y (1995). Cowpea weevil bioassay: A simple pre-screen for plants with grain protectant effects. Int. J. Pest Manag. 41:84-86.

Govindan K, Nelson SJ, David PMM (2010). Fly ash – excellent filler for black pepper , *Piper nigrum* dust formulation against *Callosobruchus maculatus* F. J. Biopesticides, 3(1 Special Issue):320- 324.

Jayakumar M (2010). Oviposition deterrent and adult emergence activities of some plant aqueous extracts against *Callosobruchus maculatus* F. (Coleoptera: Bruchidae). J.Biopesticides, 3(1 Special Issue):325- 329.

Leder I (2004). Sorghum and millets, In: Cultivated Plants Primarily as Food Sources, (Ed. Gyorgy Fuleky), in Encyclopedia of Life Support Systems (EOLSS), developed under the auspices of the UNESCO, Eolss publishers, Oxford, UK (http://www.eolss.net 18 pp).

NAERLS (2002). Production of guinea corn in Nigeria. *Extension Bulletin* No. 1. Published by National Agricultural Extention and Research Liaison Services. Federal Ministry of Agriculture and rural Development, Ahmadu Bello University, Zaria National Agricultural Extension and Research Liaison Service, 31 pp.

Pugazhvendan SR, Elumalai K, Ross PR, Soundararajan M (2009). Repellent activity of chosenplant species against *Tribolium castaneum.* World J. Zoology, 4(3):188-190.

Rajapakse RHS, Ratnasekera D (2008). Pesticidal potential of some selected tropical plantextracts against *Callosobruchus maculatus* (F.) and *Callosobruchus chinensis* (L.) (Coleoptera: Bruchidae). Tropical Agric. Res. Extension, 11:69-71.

SAS (2000). Statistical analysis systems. *SAS/STAT User's guide version* 8 (2), Cary NC: SAS Institute Inc.

Suleiman M, Majeed Q, Abdulkarim B (2011). Toxicity of three plant powders as biopesticides against *Sitophilus zeamais* Motsch. On stored guinea corn grains.Biol. Environ. Sci. J. Tropics, 8(3):273-277.

Udo IO (2005). Evaluation of the potential of some local spices as protectants against the maize weevil *Sitophilus zeamais* Mots (Coleoptera: Curculionidae). J. Appl. Sci. Environ. Manag. 9(1):165-168.

Ukeh DA, Arong GA, Ogban E (2008). Toxicity and oviposition deterrence of *Piper guineense* (Piperaceae) and *Monodora myristica* (Annonaceae) against *Sitophilus zeamais* (Motsch.) on stored maize. J. Entomol. 5(4):295-299.

USDA (2010). Nigeria grain and feed annual. *Grain Report,* Number NI0007. United States Department of Agriculture, Foreign Agricultural Service, 11 pp.