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Full Length Research Paper

Control of maize weevil, *Sitophilus zeamais* (Motschulsky) using extracts of *Gnetum africanum* (Afang) leaves and *Curcuma longa* l. (Turmeric) rhizomes

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Maize (*Zea mays* [L.]) is a major staple food in many regions of the world. The maize weevil *Sitophilus zeamais* is a serious primary pest of maize in Nigeria. Laboratory investigations were carried out to compare the efficacy of the extracts of *Curcuma longa* rhizomes and *Gnetum africanum* leaves for the control of *S. zeamais* on stored maize grains. Three different solvents namely: petroleum ether, methanol and acetone were used to extract the essential oils from *C. longa* rhizomes and *G. africanum* leaves using a soxhlent extractor apparatus. The extracted oils were evaluated on *S. zeamais* for mortality effect. Weight loss of the maize grains was also assessed. The experiment was laid out in a completely randomized design (CRD) in four replications. The results obtained showed that the essential oil of C*. longa* extracted with petroleum ether evoked significantly ($P \leq 0.05$) higher mortality (90%) in the maize weevil at 42 days after treatment (DAT). It also recorded a significant reduction in percentage weight loss when compared with the control treatments. No mortality was recorded in the control of all solvents and untreated control. *C. longa* extracted with petroleum ether was very effective in controlling *S. zeamais* in stored maize grains and can be incorporated for the control of *S. zeamais* in stored maize grains.

Key words: *Curcuma longa, Gnetum africanum,* extracts, *Sitophilus zeamais,* maize grains.

INTRODUCTION

Maize weevil, *Sitophilus zeamais* (Motchulsky) (Coleoptera: Curculionidae) is one of the major pests of stored grains in Africa (Lajide et al., 1998; Zhou et al., 2012). Infestations not only cause significant losses due to consumption of grains; they also result in elevated temperature and moisture conditions that lead to accelerated growth of moulds including mycotoxins ((Tripathi et al., 2002). Control of this insect pest has mostly been by use of synthetic insecticides which has led to problems such as increasing cost of application, insect pest resurgence, insect resistance to insecticides and lethal effect on non-target organisms in addition to direct toxicity to applicators (Zhou et al., 2012). Recently, research interest has been focused on sustainable alternative to insecticides for stored product insect control (Bouda et al., 2001). Investigations confirm that some plant essential oils not only repel insects but possess contact and fumigant toxicity against stored product insects as well as exhibited feeding inhibition (Isman, 1989; Asawalam and Arukwe, 2004). Botanical pesticides have the advantage of providing novel modes of action against insects that can reduce the risk of cross-resistance as well as offering new leads for design of target specific molecules (Zhou et al., 2012).

Gnetum africanum is one of the most popular green leafy vegetable in Nigeria and is gaining popularity as a delicious vegetable in other African countries such as Cameroon, Gabon, Congo and Angola (Ekop, 2007). *G. africanum* leaves are widely consumed in the South Eastern Nigeria due to its palatability and taste. It is now eaten as vegetable salad when mixed with palm oil.

In East Asia, the rhizome from *Curcuma longa* L.

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belonging to the family Zingiberaceae, has long been considered to have natural medicinal properties such as an analgesic in the treatment of menstrual disorders, rheumatism, and traumatic diseases because it contains a number of monoterpenoids, sesquiterpenoids, and curcuminoids (Tang and Eisenbrand, 1992). The compounds responsible for the yellow pigments are the curcumin [1,7-bis(4-hydroxy-3-methoxyfenil)-1, 6-heptadiene-3,5-dione] and two curcuminoids [demethoxycurcumin (DMC) and bis(demethoxy)curcumin (BDMC)] (Taylor and McDowell, 1992).

Turmeric contains pungent, odoriferous oils and oleoresins; the rhizomes have been reported to possess many kinds of biological activities (Bhardwaj et al., 2011). Insecticidal properties of turmeric have been well documented in the literatures (Patro and Pati, 1997). The insect repellent components in turmeric are turmerones and arturmerone (Tripathi et al., 2002). Petroleum ether extract of *C. longa rhizome* has been reported as repellent to *Tribolium castaneum* (Jilani and Su, 1983). Hexane extract of rhizome of *C. longa* reduced progeny production in *T. castaneum* at 200 ppm concentration (Jilani et al., 1988). Aqueous extract of *C. longa* rhizome acted as repellent against *Callosobruchus chinensis* (Pati et al., 1996; Patro and Pati, 1997).

The objective of this study was to evaluate the efficacy of *G. africanum* leaves and *C. longa* rhizome extracts against *S. zeamais* using methanol, petroleum ether and acetone as extractants.

MATERIALS AND METHODS

The study was conducted at Crop Science Laboratory of the Department of Plant Health Management, Michael Okpara University of Agriculture Umudike, Nigeria. Maize weevils (*S. zeamais)* used for this study was obtained from the infested maize grains ("Bende white" a highly susceptible local variety) bought locally from the Umuahia main market. Two hundred grams of the infested maize grains were placed in a 5-L plastic bucket covered with muslin cloth and held tight with a rubber band to avoid escape of the insects, prevent entering of other insects and aid adequate aeration.

Clean uninfested maize grains (Bende white) were purchased from Umuahia main market. Leaves of *G. africanum* were obtained from Umuahia main market and the rhizomes of *C. longa* were collected from National Root Crops Research Institute, Umudike. The plant materials were air-dried in a well-ventilated area for seven days. The powders were prepared by milling the plant materials with Thomas (Model ED-5) milling machine. The milled plant materials of 1-mm particle size were put in separate brown envelopes and kept in refrigerator until ready for use. *G. africanum* was extracted using petroleum ether, acetone and methanol, after then it was taken to the shaker (Vortex 2 Genie model). A pipette with a filter paper underneath was used to get 1 g of silica gel to remove the excess petroleum ether, acetone and methanol. The extraction was done in Entomology Laboratory, Texas A&M University, USA. *C. longa* was extracted using petroleum ether, acetone and methanol as solvents at Food Technology Laboratory of Michael Okpara University of Agriculture Umudike using soxhlet extractor apparatus.

The essential oil extract of the plant materials were applied to the grains in separate plastic vials at the rate of 7 ml per 40 g of maize grains. The vials were covered with muslin cloth held with rubber bands, and shaken gently for proper admixture. Each treatment was replicated four times. The experiment was arranged in completely randomized design on the laboratory shelf.

Two blank controls were run periodically consisting of solvent treated grains and the untreated grains. Ten pairs of 5 to 7 day old *S. zeamais* adults were introduced into the vials containing the different treated and untreated maize grains.

Number of dead insects in each vial was counted after 7, 14, 21, 28, 35 and 42 days after treatment to estimate maize weevil mortality as:

100 (Number of dead insects) / (Total number of insect)

Data on percentage adult weevil mortality were corrected using Abbott's (1925) formula:

$$P_T = (P_o - P_c) / (100 - P_c)$$

Where P_T = Corrected mortality (%)
P_O = Observed mortality (%)
P_C = Control mortality (%).

Damage assessment was carried out on treated and untreated grains. Samples of 100 grains were taken from each jar and the number of undamaged and damaged (grains with characteristic holes) grains were counted and weighed. Percentage weight loss was calculated, using FAO (1985) method as follows:

$$\% \text{ Weight loss} = [UaN - (U+D)] / UaN \times 100$$

Where U = weight of undamaged fraction in the sample
N = total number of grains in the sample
Ua = average weight of one undamaged grain
D =weight of damaged fraction in the sample.

Statistical analysis

Data obtained were subjected to analysis of variance (ANOVA) using a general linear model procedure of SAS. Significant treatment mean were separated using Fishers' Protected Least Significant Difference (FLSD) test at 5%

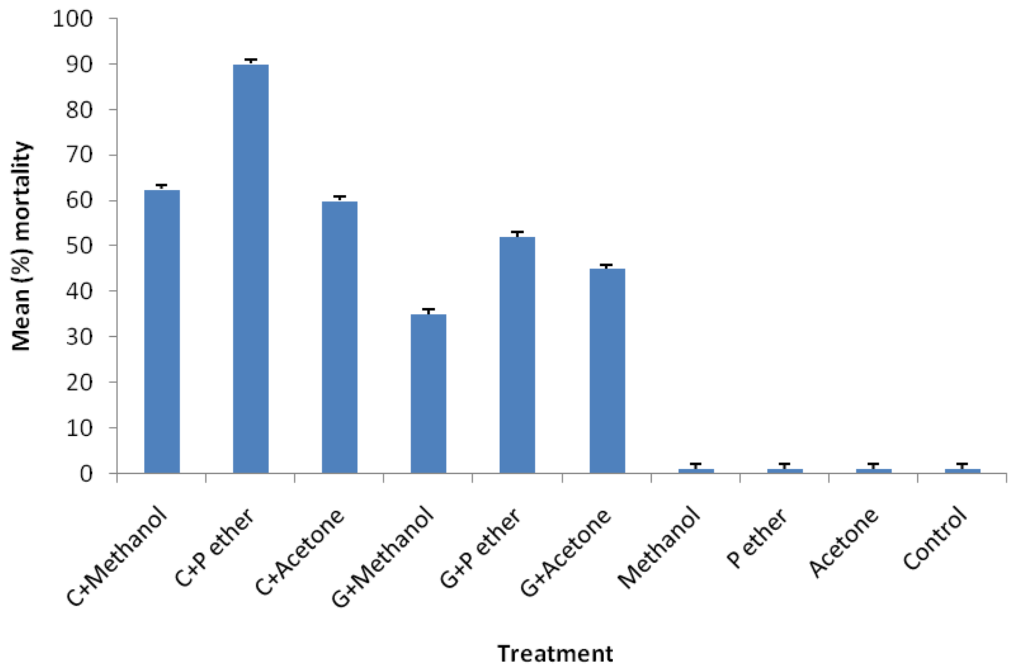

Figure 1. Cumulative mean percentage mortality of *S. zeamais* treated with *C. longa* rhizomes and *G. africanum* leaves at 42 days after treatment.

Table 1. Cumulative mean percentage weight loss of maize grains treated with *C. longa* and *G. africanum* at 7, 14, 21, 28, 35 and 42 days after treatment (DAT).

Treatment	Days after treatment					
	7	14	21	28	35	42
C + Methanol	1.31^{d}	2.06^{e}	3.38^{d}	5.13^{d}	6.81^{f}	9.56^{de}
C+ Petroleum ether	1.06^{d}	1.88^{e}	2.63^{e}	4.50^{d}	5.94^{g}	8.31^{f}
C + Acetone	1.81^{c}	2.88^{d}	3.50^{d}	4.94^{d}	7.63^{e}	9.00^{fe}
G + Methanol	1.94^{c}	4.31^{c}	6.00^{bc}	7.25^{c}	8.94^{d}	10.19^{cd}
G + Petroleum ether	1.81^{c}	4.38^{c}	5.69^{c}	7.0^{c}	7.94^{e}	9.69^{cde}
G + Acetone	1.13^{d}	3.94^{c}	5.63^{c}	7.31^{c}	8.88^{d}	10.38^{c}
Methanol	2.23^{c}	5.02^{b}	7.23^{a}	10.25^{a}	13.74^{b}	16.24^{a}
Petroleum ether	3.23^{a}	4.24^{c}	6.24^{bc}	9.51^{b}	12.01^{c}	13.24^{b}
Acetone	2.02^{c}	5.02^{b}	6.52^{b}	9.75^{ab}	11.75^{c}	13.51^{b}
Control	2.73^{b}	5.73^{a}	7.52^{a}	10.25^{a}	15.02^{a}	16.75^{a}
LSD (0.05)	0.44	0.50	0.64	0.69	0.67	0.76

‡ Means with different letter(s) within the same column are significantly different. M = Methanol; P.E = petroleum ether; A = acetone; C = *Curcuma longa*; G = *Gnetum africanum.*

level of probability.

RESULTS AND DISCUSSION

The mean cumulative percentage mortality of *S. zeamais* treated with G. *africanum* leaves and *C. longa* rhizome extracts is presented in Figure 1. The essential oil of C*. longa* rhizome extracted with petroleum ether evoked significantly ($P \leq 0.05$) high mortality (90%) in the maize weevil at 42 days after treatment. No mortality was recorded in the control of all solvents. The mean percentage weight loss of maize grains treated with G*. africanum* leaves and *C. longa* rhizome extracts is presented in Table 1. The result obtained indicated that the *C. longa* rhizome and G*. africanum* leaves extracted with the different solvents significantly ($P \leq 0.05$) reduced the weight loss in maize grains. The control recorded 16.75% mean percentage weight loss at 42 days after treatment while *C. longa* rhizomes extracted with petroleum ether recorded significantly lower mean percentage weight loss (8.31%). The insecticidal activity of these plant extracts against *S. zeamais* could be attributed to the presence of monoterpenoids, sesquiterpenoids, and curcuminoids (Tang and Eisenbrand, 1992).

The result agrees with the findings of Bhardwaj et al. (2011) who reported that *C. longa* rhizomes possess many kinds of biological activities against insects. Turmeric rhizome extract has been reported to show insecticidal activity against *Nilaparvala Iugens* females and *Plutella xylostella* larvae (Roh, 2000). The result obtained from these studies suggest good potential for the use of petroleum ether essential oil extract of *C. longa* for the control of *S. Zeamais* in stored maize grains

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