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Insecticidal Properties of Garlic (*Allium Sativum* L) and African Curry Plant (*Ocimum Gratissimum* L) Powders against Stored Maize Weevil (*Sitophilus Zeamais* L (Mots)

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Abstract
Powder of *Allium sativum* and *Ocimum gratissimum* leaf and admixture of the two were evaluated for comparative efficacy in controlling *Sitophilus zeamais* Mots infesting stored maize. The powders were tested at 5, 10 and 15/40g of the respective food materials. The parameters compared were adult mortality, the oviposition as well as number of perforations/holes. Results revealed that the plant materials tested showed significant adult mortality rate, oviposition hindrance and perforation deterrence compared to control; as with the admixture material tested, the results indicates high significant differences among the treatments on mortality rate, oviposition and perforation deterrence compared to control. The periodic trend of the results epitomized that the admixture of *A.sativum* and *O.gratissimum* leaf powder performed better in quelling *S.zeamais* infestation during the stored period research. These findings also suggest that botanical insecticides are promising but their effectiveness may vary with species as well as concentration of the botanic used and the period kept under storage.

Keywords: *Allium sativum, Ocimum gratissimum, Sitophilus zeamais,* Oviposition, Botanical

Introduction

Maize (*Zea mays L*) or corn is a major source of dietary carbohydrate as well as the most important cereal in Sub-saharan Africa, IITA (2009). While the maize weevil, (*Sitophilus zeamais* L Mots) is a major pest of stored maize grains in many regions of the world including Nigeria, Adedire (2001). The maize weevil, *Sitophilus zeamais mots* (coleopteran: curculionidae), is one of the most destructive stored products pest of grains, cereals and other processed and unprocessed stored products in sub-saharan Africa, *Ojo* and *Omoloye* (2012). *Sitophilus zeamais* causes qualitative and quantitative damage to stored products with grain loss ranging between 20% sometimes up to 90% for untreated stored maize, Nukenike *et al*. (2002) and the severity of the damage depends on factors which include storage structure, physical and chemical properties of the produce. Heavy infestation of adults and larvae of maize weevil which cause post-harvest losses have become important constraints to storage entomology, Mankham *et al*., (1994) and food insecurity in the tropics. These insect is notorious for attacking most crop food items pertaining to grain and while they usually bored with the grain, they can breed within other types of crops as well. Although the maize weevil cannot readily breed in finely processed grains, it can easily breed in product like macaroni and noodles and milled cereals that have been exposed to excessive moisture Alter, (2003). The direct and indirect damage made by weevil can cause kernel damage (consuming grain endosperm), contamination of the grain with their exuviae, faecal materials etc, grain powdering, grain heating and moisture migration in storage, lowering germination of seed grains, distribution of molds and other micro-organism through the grain mass and quality reduction caused by casted skin, faecal material, etc. which apparently reduce the future of the maize produce by farmers in Africa, Dhliwayo and Pixley (2003).

Apparently, there is urgent need to search for eco-friendly, cheap, sustainable, and safe plant that will protect as well as not to contaminate food products use as grain protection in storage systems that can be of used to small scale holder farmers. Moreover, because they are often viewed as mild on the environment, compounds of biogenic organic have more positive regards compared to substances partially or completely chemically synthesized in laboratories Slusarenko *et al.* (2008) and are therefore more likely to gain wider acceptance at the long run. Crop protection of natural origin also has the advantage of possessing dignified mode of actions against insects and thus has the potential to reduce the risk of cross-resistance while offering new leads for the design of target specific molecules Zhou *et a*l. (2012).

The powders and essential oils of garlic and African curry plants have been widely used for control of insect pests especially storage insect pests Oparaeke (2002). Research on the potential application of biologically active compounds from garlic abounds in literatures. For instance, steam-distilled garlic oil has been tested for toxicity against the adult of maize weevil *S. zeamais* Hot *et al.* (1997) while extracts from garlic have been vapourized and used in fumigation tests involving C.*maculatus* and *S.zeamais*, Isman (2000).

Although synthetic insecticides have long been widely used in the control of insect pests, the indiscriminate use or application of synthetic product has led to various problems including toxic residues in the treated products, environmental pollution and growing resistance against insecticide by insects and pest Hung *et al*. (1997). This study focus its attention on coming up with alternative measures, the use of plant materials that possess insignificant threat, environmentally friendly and require little or no skill to be used effectively.

Therefore, this study aim to evaluate the insecticidal property of *Allium sativum* and *Ocimum gratissimum* powders against stored maize weevil (*S. zeamais*) attack/infestation.

Materials and method

A laboratory research work was conducted at Federal college of Agricultural produce Technology, Hotoro, Tarauni Local Government Kano (11^0 39'N 8^0 27'E 427M above sea level) in the Sudan Savanna agro-ecological zone of Nigeria. The treatments were laid out in complete randomized designed and repeated three times.

Clean and certified maize free weevil was obtained from International Institute for Tropical Agriculture (IITA), Kano; while infested maize seed with *S. zemais* was reared in the entomology laboratory. Fresh *A. Sativum* was bought from Yan kaba market and O.gratissimum was collected from college farm and identified. The *O.gratissium* leaves were air-dried and pulverized and the garlic bulbs were cut into pieces and then placed on a tray and air-dried under ambient room temperature.

Garlic powder and African curly plant powder were applied into kliner jars at the rates of (5g, 10g and 15g respectively) and repeated three times excluding control. Forty grams (40g) of clean maize was placed into each glass jar and five adults (males and females) maize weevils were introduce into each sample except control. After then, an admixture of *A.sativum* and *O.gratissium* powder at a rate of (10g + 5g, 5g + 10g) ratio of 2:1and 1:2 were applied into Kliners jars and repeated three times. The following data were recorded at 10 days interval during the experimental period on mortality assessment, ovipositional assessment, perforation/ whole assessment. The data was subjected to the analysis of variance as described by Snedecor and Cochran (1967) using student Newman Test.

Results and discussion

Table 4.1 showed the treatment mean of insect mortality at different concentration of plant powders. The table indicated that $G_{10}AC_5$ had the highest mortality rate against *S.zeamais* which was followed by AC_{15}, G_{15} and AC_{10} respectively. G_{10} also exhibited moderate mortality efficacy when compared to Co (the control) which showed no effectiveness on the mortality rate of *S.zeamais*. The mean mortality rate with different letters showed significant difference ($p< 0.05$) using Student Newman test. The treatment $G_{10}AC_5$ appeared to be more effective at 20 and 30 days at the experiment period whereas G_{15} was having the same efficacy on the both 20 and 30 days. AC_{15} showed high efficacy at the 20 days in comparison with the remaining treatments (G_5AC_{10}, G_{10}, G_5, AC_5) at ($P>0.00$) and in contrast with the control (Co) which exhibited no mortality effectiveness throughout the whole experimental duration (50 days).

It was also observed that the efficacy of the treatment was directly proportional to the concentration of the treatments applied. Thus, $G_{10}AC_5$, AC_{15}, G_{15} (the highly concentrated treatments) exhibited the highest effect on the insect mortality and apparently AC_{10}, G_{10} (moderately concentrated) possessing moderate efficacy but G_5, AC_5 (the least concentrated) had a very little effect on the studied insects (*S.zeamais*).

Furthermore, the table also revealed that the admixture of the two plant materials use (*A.sativum* and *O.gratissium*) i.e $G_{10}AC_5$ exhibited the highest mortality effect than the use of the single plants. It was also noted that the plant admixture having the higher ratio of *A.sativum* appeared more effective than that with the higher ratio of *O.gratissium* (i.e $G_{10}AC_5>G_5AC_{10}$).

Table 4.2 depicts mean oviposition at different concentration of powders during the experimental trend. Results portrayed that the treatment $G_{10}AC_5$ has the best in inhibiting egg deposition by *S.zeamais* throughout the experimental period compared to the other treatments used. AC_{15} was the second most effective treatment which showed significant difference at ($P< 0.05$) by deterring the oviposition for the first 30 days and the final 10 days. This was followed by G_{15} in contrast with the remaining treatments (i.e G_{10}, AC_{10}, G_5, AC_5 and G_5AC_{10}) which shows no significant difference at ($P>0.05$) in comparison to the control (Co) which provided a convenient environment for the insect oviposition.

Table 4.2 also shows that that the admixtured of plant materials of *A.sativum* (i.e $G_{10}AC_5$) in particular, exhibited the highest insecticidal property in antiovipositioning. And also it was revealed that the effectiveness of the treatment was directly proportional to the concentration of the material used as vindicated by the concentration of *O.gratissium* ($AC_{15}>AC_{10}>AC_5>Co$) likewise that of *A.sativum* ($G_{15}>G_{10}>G_5>Co$). It is apparent to say that during the experiment, the more the concentration of the treatments, the more the efficacy noted.

Table 4.3 shows the mean number of perforation at different concentration of plant powders. The table revealed that $G_{10}AC_5$ significantly deterred the tunneling habit of the studied insect pests (*S.zeamais*) followed by G_{10} and AC_{15}, the two treatments were found to be significant at ($P< 0.05$)in inhibiting the oviposition throughout the period of experiment except on the first 10 days. The other treatments (AC_5, G_5, G_5AC_{10}, G_{15}) show no significant differences at ($P<0.05$) when compared with the control (Co) which was tunneled by *S.zeamais* for the whole experimental period.

Unlike in table 4.1 and 4.2, this result revealed that the efficacy of the treatment, in inhibiting the Oviposition was indirectly proportional to the concentration of the material used. This was observed that AC_{10} was more effective than AC_{15} so was G_{10} than G_{15}; this shows that higher concentration may not result in desired effect of control as shown in the mean number of holes.

It was also noted that admixturing the plant materials was not necessary because (admixtured treatment) exhibited equal effectiveness with G_{10} (single treatment). Thus, either *A.sativum* or *O.gratissium* powder could be used separately to deter seed perforation.

Conclusion

The present findings suggest that the admixture of powdered *A.sativum* and *O.gratissium* possess a vital insecticidal effect on *S.zeamais* when compared with the control. It also suggests the admixture of *A.sativum* and *O.gratissum* could be successfully used for the control of *S.zeamais* and may even be a replacement for the synthetic pesticides. Thus, powdered *A.sativum* and *O.gratissium* offers a significant promise for combating the threat posed by stored maize weevils to farmers in developing countries. Mwangangi and Mutsiya (2013) found out that *O.gratissium* powder caused up to 90% mortality of maize weevils within two weeks when applied at 2g powder per 100g of maize grains. It was reported by Booke *et al.*, (2004) that much greater effect of *O.gratissium* essential oils on closely related coleopteran, *C.maculatus* with a record of 49% mortality within 24 hours of exposure. Other factors such as suffocation and starvation might equally lead to mortality of maize weevil with grains treated with essential oil of *O.cimum gratissium*. Onu and Aliyu (1995) worked with African nutmeg, clove, garlic and Oparaeke (1997) worked with chilli pepper, black pepper and they both obtained positive result of their insecticidal effectiveness. The work also corroborated with the findings of Varma and Dubey (1998) who reported that powdered *A.sativum* and *A.indica* showed 90% mortality on stored rice weevil (*S.oryzae*). Similarly, Suleiman *et al.*, (2011) reported that 100% mortality of adult *S.zeamais* was observed when 0.5-2.0g *J.curcus* was applied to 20g of sorghum grains, this also agrees with the work of and findings of Adedire and Ajayi (1996). The findings in this research may also provide an easy solution to the problem of stored pest infestation in the tropics which will be important in food security and means of cash earning to poor resources farmers.

Table 4.1:. Effect of *A.sativum* and *O. gratissium* on *S.zeamais* mortality rate

Treatments Repetitions	Co	G_5	G_{10}	G_{15}	AC_5	AC_{10}	AC_{15}	G_5AC_{10}	$G_{10}AC_5$
10 Days	0.00 ± 0.00	0.33 ± 0.57	0.33 ± 0.57	2.00 ± 1.73	0.33 ± 0.57	0.33 ± 0.57	1.00 ± 1.00	0.00 ± 0.00	0.33 ± 0.57
20 Days	0.00 ± 0.00	1.66 ± 0.57	0.33 ± 0.57	2.33 ± 0.57	1.33 ± 0.57	2.00 ± 0.00	2.33 ± 0.57	1.33 ± 0.57	2.66 ± 0.57
30 Days	0.00 ± 0.00	1.00 ± 1.00	2.00 ± 1.00	2.33 ± 2.30	0.66 ± 0.57	2.33 ± 0.57	2.00 ± 1.00	1.66 ± 0.57	2.33 ± 0.57
40 Days	0.00 ± 0.00	0.00 ± 0.00	1.33 ± 0.15	1.00 ± 1.00	0.00 ± 0.00	1.33 ± 0.57	0.66 ± 1.15	0.33 ± 0.57	1.33 ± 0.57
50 Days	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.33 ± 0.57	0.66 ± 1.15	0.66 ± 1.15	0.66 ± 1.15	0.33 ± 0.57	0.00 ± 0.00

Table 4.2: Effect of *A.sativum* and *O. gratissium* on *S.zeamais* oviposition

Treatments Repetitions	Co	G_5	G_{10}	G_{15}	AC_5	AC_{10}	AC_{15}	G_5AC_{10}	$G_{10}AC_5$
10 Days	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
20 Days	1033.3 ± 1789.8	26.66 ± 26.02	10.66 ± 18.47	0.00 ± 0.00	6.003 ± 10.39	7.00 ± 12.12	0.00 ± 0.00	25.66 ± 10.570	0.00 ± 0.00
30 Days	1106.7 ± 1210.8	30.00 ± 28.61	36.33 ± 17.03	17.66 ± 10.01	15.33 ± 18.58	8.00 ± 13.85	0.00 ± 0.00	25.00 ± 22.60	0.00 ± 0.00
40 Days	716.67 ± 1198.3	35.00 ± 37.74	26.66 ± 34.03	15.33 ± 26.55	6.66 ± 11.54	0.00 ± 0.00	7.00 ± 12.12	13.66 ± 12.66	0.00 ± 0.00
50 Days	0.00 ± 0.00	0.00 ± 0.00	21.00 ± 21.51	0.00 ± 0.00	5.00 ± 8.66	06.66 ± 11.54	0.00 ± 0.00	14.00 ± 16.37	0.00 ± 0.00

Table 4.3: Effect of *A.sativum* and *O. gratissium* on *S.zeamais* perforation/no of holes

Treatments Repetitions	Co	G_5	G_{10}	G_{15}	AC_5	AC_{10}	OM_{15}	G_5AC_{10}	$G_{10}AC_5$
10 Days	2.667 ± 2.517	0.000 ± 0.000	0.333 ± 0.577	0.333 ± 0.577	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.333 ± 0.577	0.000 ± 0.000
20 Days	24.33 ± 2.517	2.000 ± 2.000	0.000 ± 0.000	0.000 ± 0.000	2.333 ± 0.577	0.000 ± 0.000	0.000 ± 0.000	0.00 ± 0.00	0.000 ± 0.000
30 Days	15.33 ±	5.00 ±	0.000 ±	2.00 ±	1.66 ±	0.000 ±	0.333 ±	5.33 ±	0.000 ±

	0.577	2.646	0.000	2.000	1.528	0.000	0.577	5.774	0.000
40 Days	1.000 ± 1.732	0.000 ± 0.000	0.000 ± 0.000	4.333 ± 1.155	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000
50 Days	1.000 ± 1.732	4.333 ± 1.155	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000

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