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# Bio-insecticidal potentials of testa powder of melon, *Citrullus vulgaris* Schrad for reducing infestation of maize grains by the maize weevil, *Sitophilus zeamais* Motsch

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**Abstract**
The bio-insecticidal potentials of testa powder of melon, *Citrullus vulgaris* for reducing infestation of maize grains by the maize weevil, *Sitophilus zeamais* was investigated. Maize mixed with testa powder of melon, *Citrullus vulgaris* at the dosage rates of 0.5g, 1.0g, 1.5g, 2.0g, 2.5g and 3.0g per 50g of maize was infested with five males and five females of *S. zeamais* for twenty-eight days. Melon testa powder significantly reduced the oviposition and natality of *S. zeamais* ($P < 0.05$), but did not significantly increase the mortality ($P > 0.05$). Testa powder of melon seed could therefore be used as a grain protectant in storage pest management systems.
**Keywords:** Bio-insecticidal potentials, *Citrullus vulgaris, Sitophilus zeamais,* maize grains

## 1. Introduction

Maize is the most important cereal crop in the world after wheat and rice. It has three main purposes; as a staple human food, as feed for livestock and as a raw material for many industrial products (Purseglove 1975). However, maize is not usually available throughout the year. For it to be available throughout the year, it has to be stored. In storing maize, the problem of pest infestation, especially that of *Sitophilus. zeamais* arises. In developing countries, maize production and consumption often falls below demand as a result of post-harvest losses due to storage pests and other spoilage agents (Udo 2005). This results in major economic losses and threatens food security (Ivbijaro *et al*. 1979). The problem is mostly severe in developing countries in the tropics due to unfavourable climatic conditions and poor storage structures (Bekele *et al*. 1997).

*Sitophilus zeamais* is an important pest that attack maize grains during storage, leading to a reduction in the quantity and quality of stored maize (Warui *et al.* 1990). It belongs to the order Coleoptera and family Curculionidae, and is a tiny weevil measuring 3 to 3.5 mm long with dull brown colour (Hill 1987). It can live up to 12 months, depending on environmental conditions (Longstaff 1981). Initial infestation of maize by the adult weevil occurs in the field and continues during storage (Adedire & Lajide 2003).

Various strategies aimed at checking the menace of pest infestation in stored grains have been employed. These strategies include physical, biological and chemical control among others. Under chemical control, pesticide usage has been employed. However, effective pest control is no longer a matter of heavy application of pesticides, partly because of rising cost of petroleum-derived products, but largely because excessive use of pesticides promotes faster evolution of resistant forms of pests, destroys natural enemies, turns formerly innocuous species into pests, harms other non-target species and contaminates food (Jones & Jones 1974; Marini-Bettolo 1977; Parmar & Devkunar, 1993; Obeng-ofori *et al*. 1997).

In view of these factors, peasant farmers in developing countries have resorted to using selected indigenous plants exhibiting insecticidal properties by mixing them with the stored grains. However, these farmers do not often know the rate and amount of botanical agents that will be toxic to storage pests resulting in poor control of these pests. This has led researchers to investigate the bio-pesticidal activities of botanical agents, the rate and also the amount at which they could be applied to stored grains in order to effectively control the pests. For example, Ivbijaro & Agbaje (1986) reported the toxicity of *Piper guineense*, a black pepper variety to *Callosobruchus maculatus*, the cowpea beetle. They found out that *P. guineense* was highly toxic to *C. maculatus* within forty-eight hours of application. In a related work, the toxicity of *P. guineense* to the nymphs and adults of the grasshopper, *Zonocercus variegates* was reported by Ogobegwu (1973). In another study by Ivbijaro (1983), the application of neem seed powder, *Azadirachta indica* to weevil-infested maize grains prevented oviposition at the high dose, reduced oviposition markedly at the low dose, and completely halted post-embryonic development at all doses. The mortality of adult weevils reached 100% within five days. Ivbijaro (1984) reported the toxic effects of groundnut oil on the rice weevil, *Sitophilus oryzae*. The study showed that at all doses, groundnut oil significantly reduced the natality and oviposition of *S. oryzae* while increasing the mortality of same. Rajapakse & Emden (1997) reported that corn oil, groundnut oil, sunflower oil and sesame oil significantly reduced the oviposition of *Callosobruchus maculatus*, *C. chinensis* and *C. rhodesianus*, and also significantly reduced the longevity of adults of *C. maculates* and *C. chinensis*. Effective treatment has been observed with leaves from *Eucalyptus globules*, *Schinese molle, Datura stramonium, Phytolacca dodecandra* and *Lycopersicum esculentum,* causing high adult weevil mortality for *S. zeamais* (Firdissa & Abraham 1999).

All these reports indicate that natural plant products can be used in controlling pest infestation of stored grains. In fact, Bekele *et al.* (1997) noted that botanical pesticides represent an important potential for integrated pest management programmes in developing countries as they are based on local materials. Plant materials with insecticidal properties provide small scale farmers with chemicals that are locally and readily available, affordable, relatively less poisonous and less detrimental to the environment for pest control (Niber 1994; Talukder & Howse, 1995). However, much still remains to be known about several other natural plant products that can be used in controlling pest infestation of stored products. Not much is known about the bio-insecticidal potentials of melon. Melon, *Citrullus vulgaris,* is used as condiment, garnisher, thickener in soups, flavourant and as a snack in most parts of the world (King & Onuora, 1983; El-Adaway & Taha, 2001). Little is known about the uses of the testa of melon. It is usually thrown away after it has been separated from the cotyledon.

Thus, this study was carried out to investigate and determine whether the testa powder of melon, *Citrullus vulgaris* has any bio-pesticidal potential on the maize weevil, *Sitophilus zeamais*.

## 2. Materials and Methods

*2.1 Collection and culturing of the maize weevil, Sitophilus zeamais*

20g of weevil-infested *Zea mays* was purchased from Uyo main market. Adult male and female weevils were culled out and introduced into jars containing un-infested maize grains. These jars were covered with thin netting held in place by rubber bands to prevent the weevils from getting out. After two weeks, the adult insects were removed. The emerging weevils (0-1 week old) were used for the experiment.

The sexes of *S. zeamais* were determined by examining the snout. The snouts of females are longer and thinner while that of males are shorter and fatter (Kranz *et al*. 1978). Also, the females have smooth textured bodies while that of the males are rough (Kranz *et al*. 1978).

*2.2 Collection and preparation of bio-pesticidal materials*

20g of unshelled seeds of melon, *Citrullus vulgaris* was purchased and hand-shelled. The testa was separated from the cotyledon. Thereafter, the testa was dried and ground into powder using an electric blender.

*2.3 Preparation of maize grains*

2.5kg of maize grains was used for the experiment. The maize grains were purchased and fumigated with half a tablet of phostoxin for forty-eight hours in an air-tight container. This was done to kill any weevils or eggs that might have been laid in the maize grains (Price & Mills 1988). After 48 hours, the phostoxin was removed. The maize grains were then aerated for five days to remove any toxic residue of phostoxin.

*2.4 Treatment of weevils-infested maize grains with testa powder of C. vitrullus: Effect on mortality of S. zeamais*

Dry ground testa of *C. vitrullus* was applied to different containers, each containing 50g of maize grains at the rate of 0.5g, 1.0g, 1.5g, 2.0g, 2.5g and 3.0g respectively. The containers were then shaken vigorously for optimum coverage of the grain surfaces. Dry ground testa of *C. vitrullus* was not applied to the control.

Five males and five females of *S. zeamais* (0-1 week old) were introduced into each 0.5g, 1.0g, 1.5g, 2.0g, 2.5g and 3.0g of ground melon testa and also to the control. Each treatment and control was replicated four times. The containers were then covered with thin white netting which was kept in place by rubber bands. The containers were labeled to avoid mixing them up.

After every forty-eight hours, the mortality of *S. zeamais* in treated and untreated maize grains was observed and recorded. This was done by gently touching the insects with a pair of forceps after they had been emptied unto a white surface. Insects that did not move when touched were considered dead. This continued for twenty-eight days when all survivors in the treated and untreated grains were removed to avoid mixing with the emerging $F_1$ generation.

*2.5 Treatment of weevils-infested maize grains with testa powder of C. vitrullus: Effect on oviposition of S. zeamais*

Twenty-eight days after initial infestation, the weevils were removed and thirty grains were taken at random from each jar, both the jars containing the testa powder of *C. vitrullus*, and also the control jars. The grains were stained in gentian violet (Goosens 1949) to reveal the egg plugs.

*2.6 Treatment of weevils-infested maize grains with testa powder of C. vitrullus: Effect on natality of S. zeamais*

Seven days after the removal of the adult *S. zeamais*, emergence of $F_1$ progeny was observed in both control and treated grains. The number of $F_1$ progeny was recorded.

*2.7 Data Analysis*

From the experiments conducted, data was collected and tabulated. The data was subjected to a one-way analysis of variance (ANOVA). This was to help in determining whether there were significant differences in the treatments or not. In order to establish the effectiveness of the treatments, the means of the different treatment dosages were compared using the least significant difference (LSD) test.

## 3 Results

*3.1 Treatment of weevils-infested maize grains with testa powder of C. vitrullus: Effect on mortality of S. zeamais*

Mortality of *S. zeamais* in maize grains treated with testa powder of melon was observed at all dosages. The highest mortality of eleven weevils was observed at 3.0g of melon testa powder treatment (Table 1). In the control, only one insect died per replicate. Only five insects died at the 0.5g, 1.5g and 2.0g treatment respectively. However, the analysis of variance test showed no significant difference ($P < 0.05$) for all the dosages.

*3.2 Treatment of weevils-infested maize grains with testa powder of C. vitrullus: Effect on natality of S. zeamais*

Natality of *S. zeamais* at the different treatment dosages was reduced when compared to the control (Table 2). The analysis of variance test done showed a significant difference ($P < 0.05$) in the natality of *S. zeamais*. The LSD showed a significant difference between treatment dosages of 1.0g and 1.5g. There was also a significant difference between the control and the treatment dosages.

*3.3 Treatment of weevils-infested maize grains with testa powder of C. vitrullus: Effect on oviposition of S. zeamais*

Oviposition of *S. zeamais* was reduced at all the treatment dosages when compared to the control (Table 3). The analysis of variance test indicated a significant difference ($P < 0.05$) in the total oviposition of *S. zeamais* in maize grains treated with melon testa powder. The least significant difference test indicated a significant difference between the different treatment dosages and the control.

## 4 Discussion

The study revealed that maize grains with testa powder of melon, *Citrullus vulgaris* at the dosage rates of 0.5g, 1.0g, 1.5g, 2.0g, 2.5g and 3.0g per 50g of maize gave promising levels of control of *Sitophilus zeamais* 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 this study could be attributable to colocynthin, a toxic poisonous substance known to be present in the white fleshy pulp of the melon fruit (Basalah *et al.* 1985).

The mortality of *S. zeamais* in the present study was not very high and not statistically significant ($P < 0.05$) (Table 1). This may have been due to the hard exoskeleton of the weevils which may have hindered the proper penetration of the testa powder. This exoskeleton is not found in the eggs, and is not properly developed in the young ones (Jones & Jones, 1974). Also, it is possible that the ground testa powder of melon settled at the bottom of the containers and the insects may have crawled to the top of the grains thereby reducing contact with the plant material. However, the highest mortality was observed at 3.0g treatment dosage (Table 1). This suggests that a much higher dose could exhibit greater potency.

When compared with the control (0.0g), there was a reduction in natality (Table 2) and oviposition (Table 3) of *S. zeamais.* This could be attributed to the presence of caryophyllene and germacrene. Adebayo & Gbolade (1994) reported that *Lantana camara* which contains caryophyllene and germacrene D in large quantities exhibited some ovipositional suppression on *Callosobruchus maculatus.* Also, absence of exoskeleton in the eggs and under-developed exoskeleton in the young ones (Jones & Jones, 1974) may have allowed proper penetration of the testa powder, which could have been toxic, leading to a reduction in the natality and oviposition of *S. zeamais* in the present study. Moreover, plants are known to possess secondary chemical compounds which are used as a part of the plant‘s defense against plant-feeding insects and other herbivores (Lupina & Chipps 1987). These secondary compounds give plant materials or their extracts, some insecticidal properties. Plant substances such as terpenoids, alkaloids, glycosides, phenols and tannins affect insects in several ways. They may affect nerve axons and synapses, muscles, respiration, hormonal balance, reproduction and behaviour (Bell *et al.* 1990).

The results observed in this study are similar to that of Ivbijaro (1983) who studied another botanical, the neem seed, *Azadirachta indica* and found out that the neem seed severely reduced egg-laying in female *Sitophilus oryzae*, while increasing the mortality of same. Ivbijaro (1984) also found out that groundnut oil reduced the oviposition and natality of *S. oryzae*, while increasing the mortality of same. The results also agree with that of Babarinde et al. (2008) who reported that *Xylopia aethopica* seed extract reduced natality of *S. zeamais.*

The findings of this work indicate that the testa powder of melon could be used in controlling the oviposition and natality of the maize weevil, *Sitophilus zeamais* in stored maize grains. This will reduce the high cost of pesticide usage, remove the risks of toxic residues in foods and ensure the continued availability of insect-free maize for food, planting, trading and storage. It is possible that other unexploited seeds could have a potential role in grain storage. Thus, further studies on the effects of different seeds on insect pests are recommended. Moreover, studies to determine and identify the specific active components of different plant materials should be carried out.

 

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Table 1: Mortality of *S. zeamais* in maize grains treated with melon testa powder after twenty-eight days

| Replicates | Dosages of melon testa powder per 50g of maize grains | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0.0 | 0.5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 |
| 2 | 1 | 1 | 2 | 1 | 2 | 3 | 5 |
| 3 | 1 | 2 | 3 | 1 | 1 | 2 | 1 |
| 4 | 1 | 1 | 2 | 2 | 1 | 2 | 3 |
| Total | 4 | 5 | 8 | 5 | 5 | 8 | 11 |
| Mean | 1.00 | 1.25 | 2.00 | 1.25 | 1.25 | 2.00 | 2.75 |

Table 1 shows that at all dosages, mortality of weevils was observed.

Table 2: Natality of S. zeamais in maize grains treated with testa powder seven of *C. vitrullus* seven days after removal of adult weevils

| Replicates | Dosages of melon testa powder per 50g of maize grains | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0.0 | 0.5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 |
| 1 | 20 | 6 | 7 | 13 | 10 | 12 | 22 |
| 2 | 32 | 15 | 5 | 21 | 15 | 7 | 7 |
| 3 | 34 | 20 | 11 | 24 | 10 | 15 | 20 |
| 4 | 32 | 7 | 10 | 18 | 8 | 16 | 9 |
| Total | 118 | 48 | 33 | 76 | 43 | 50 | 58 |
| Mean | 29.50 | 12.00 | 8.25 | 19.00 | 10.75 | 12.50 | 14.50 |

Table 2 above shows that the natality of *S. zeamais* at the different treatment dosages was reduced when compared to the control.

Table 3: Oviposition of *S. zeamais* in maize grains treated with melon testa powder after one month

| Replicates | Dosages of melon testa powder per 50g of maize grains | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0.0 | 0.5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 |
| 1 | 27 | 22 | 21 | 20 | 22 | 23 | 19 |
| 2 | 25 | 18 | 17 | 21 | 24 | 18 | 20 |
| 3 | 28 | 20 | 16 | 19 | 20 | 24 | 17 |
| 4 | 23 | 25 | 22 | 23 | 21 | 22 | 18 |
| Total | 103 | 85 | 76 | 83 | 87 | 87 | 74 |
| Mean | 25.75 | 21.25 | 19.00 | 20.75 | 21.75 | 21.75 | 18.50 |

Table 3 shows that the oviposition of *S. zeamais* was reduced at all the treatment dosages when compared to the control.