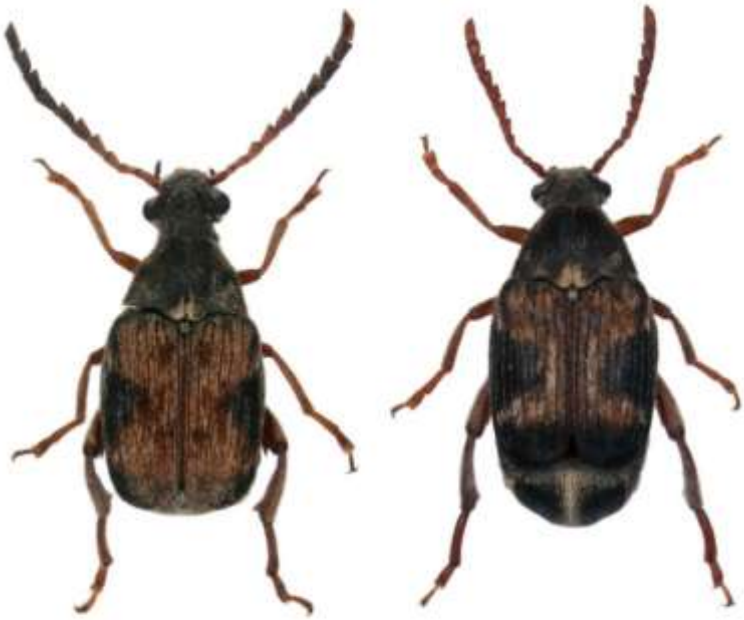
Bioactivity of *Allium sativum* (L) powder and oil extract against the cowpea beetle *Callosobruchus maculatus* (Fab.) (Coleoptera: Bruchidae)

النشاط الحيوي لمسحوق الثوم ومستخلصه الزيتي ضد خنفساء اللوبيا

***Callosobruchus maculatus* (f.) (Coleoptera: bruchidae)**



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زهراء جعفر و زهراء بشير

Submitted for the degree of Bachelor (BSc.)

June 2023

Contents

Abstract

The powder and oils extract of *Allium sativum* (L.) bulbs were tested as contact insecticides against the cowpea bruchid, *Callosobruchus maculatus* (Fab.) in cowpea seeds. The powder was incorporated at rates 1, 2.5 and 5/20g of cowpea seeds and acetone extract of the plant was also applied at 0.5, 1 and 1.5ml per 20g of cowpea seeds to assess contact mortality of adult insect, oviposition, adult emergence and damage assessment. The results obtained showed that at 72 hours; 1, 2.5 and 5/20g of cowpea seeds evoked 60.7, 73.3 and 100% adult mortality of the cowpea bruchid. All concentration of acetone extracts that were used evoked 100% mortality of *C. maculatus* after 72 hours of post treatment. Complete protection of seeds and complete inhibition of adult emergence in both powder and extract of *A. sativum* were achieved. The results obtained from this research revealed that powder and extract of *A. sativum* bulbs were effective in controlling cowpea bruchid, *C. maculatus* in stored cowpea seeds.

الخلاصة

اختبرت مساحيق وزيوت مستخلصات بصيلات الثوم *Allium sativum* (L.) كمبيدات حشرية تلامسية ضد خنفساء اللوبيا، *Callosobruchus maculatus* (Fab.) في بذور اللوبيا. تم دمج المساحيق بمعدلات 1 و 2.5 و 20/5 جرام من بذور اللوبيا ومستخلص الأسيتون للنبات أيضًا عند 0.5 و 1 و 1.5 مل لكل 20 جرام من بذور اللوبيا لتقييم معدل النفوق التلامسي للحشرات البالغة وعملية وضع البيض وظهور البالغين و تقييم الأضرار. أظهرت النتائج التي تم الحصول عليها أنه في غضون 72 ساعة ؛ 1 و 2.5 و 20/5 جرام من بذور اللوبيا أدى إلى موت 60.7 و 73.3 و 100٪ من البالغات لخنفساء اللوبيا. تسبب كل تركيز مستخلص الأسيتون المستخدم في موت 100٪ من *C. maculatus* بعد 72 ساعة من العلاج. تم تحقيق الحماية الكاملة للبذور والتثبيط الكامل لظهور الحشرات البالغة في كل من مسحوق ومستخلص *A. sativum* كما أظهرت النتائج التي تم الحصول عليها من هذا البحث أن مسحوق ومستخلص نبات الثوم *A. sativum* كانت فعالة في السيطرة على خنفساء اللوبيا *C. maculatus* في بذور اللوبيا المخزنة.

Introduction

Pulses are a major source of protein in Asia and West Africa (Pereira, 1983) and most developing countries. The cowpea, *Vigna unguiculata* (L.) Walps., is one of such important grain legumes in West Africa and a major source of protein (Stamton, 1966). Efforts to increase the production of cowpea are hampered by insect pests, encountered in the field and during the storage of the harvested produce.

The most important pest of stored cowpea is the cowpea beetle, *Callosobruchus maculatus* (F.), which has a worldwide distribution (Singh et al., 1978). Singh and Rachie (1985) reported that farm storage of cowpea for six months is often accompanied by about 30% loss in weight, with up to 70% of the seeds being damaged, rendering them virtually unfit for consumption. Grain damage could also reach 100% if the insects are not controlled (Owusu-Akyaw, 1991).

The serious damage caused to the grain by the pest has led to the extensive use of synthetic insecticides to control it. Tembo and Murfit (1995) also expressed concern about the development of resistant strains, toxic residues, workers' safety, erratic supply and the prohibitive cost of synthetic insecticides.

The effective measures in food pest control is the use of synthetic insecticides, which are very expensive, unavailable at critical period and they are sometimes constitute health hazards to consumers (Adedire, 2001; Ofuya, 2001; Oni and Ileke, 2008; Ileke and Oni, 2011; Oni, 2011). This led to continuous research towards substitution of synthetic insecticides with plant products as a cheaper and eco-friendly safer means of controlling insect pest's infestation of stored cowpea seeds (Adedire et al., 2011). Attention is being given to the use of edible plants materials as grains protectant (Ivbijaro and Agbaje, 1986; Adedire and Lajide, 2003; Akinkurolere et al., 2009; Ileke and Oni, 2011) and the tropical countries are well endowed with this plant species and some of which are also used for the medicinal purpose (Adedire and Lajide, 2003; Ileke and Oni, 2011)

These problems associated with the use of synthetic insecticides, have stimulated over the years, interest in finding alternatives to their use. Vegetable oils are reported as one of such viable alternatives to control some insect pests of stored products, including *C. maculatus* (Singh et al., 1978; Don-Pedro, 1987, 1989).

The potential of these oils for the control of this pest had prompted several trials to determine their efficacy as protectants of cowpea against pest damage (Mital, 1971; Singh et al., 1978; Golob and Webley, 1980).

Cowpea seeds are veritable source of minerals and vitamins such as calcium, thamine and riboflavin (Nelson, 1991). Cowpea have therefore been described as "poor man's meat".

The major problem facing grains storage is several insect pests including weevils, beetles and moths, leading to loss in weight and seeds quality (Adedire, 2001; Udo, 2005; Akinkurolere et al., 2006; 2009; Adedire et al., 2011). Bruchids especially those belonging to the genus *Callosobruchus* can infest stored cowpea seeds (Ofuya and Bamigbola, 1991). This insect pest has been recognized as a constraint to food security (Markham et al., 1994). Apart from contamination of food grains by dead insects, pupae and larval cocoons, their integument has been found to contain various carcinogenic compounds such as ethyl, methyl and methoxy quinines which can not be denatured by boiling or baking (Zehrer, 1980; Adedire et al., 2011).

Garlic, *Allium sativum*, is a cosmopolitan plant. It is an herbaceous biennial plant, characterized by its penetrating fragrance. It is a seasoning for soups and sauces and its oil is a flavoring agent. Medically, the bulb is used for reviving convulsive patients, as a cure for haemorrhoids and diuretics (Dike and Mbah, 1992). The pesticidal activities of garlic as a repellent, antifeedant, bactericide, fungicide and nematicide have been reported (Graigne et al., 1985; Oparaeke and Dike, 1996). The medicinal value of these plants has long been known. Therefore, the plants were believed to be safer as biopesticides for stored food protection (Arannilewa et al., 2006; Oparaeke and Bunmi, 2006; Adedire et al., 2011). However, the effectiveness of the oils for the control of the pest has varied from one worker to the other. There are also some contradictory reports on the effect of oils on seed viability, taste and flavor of oil-treated grains.

There was therefore the need to re-evaluate the efficacy of the powder and oils extract *of Allium sativum* (L.) bulbs for the protection of cowpea against pest infestation. It was against this background that this study was initiated with the following objectives:

1. Evaluation of the effectiveness of the powder and oils extract of *Allium sativum* (L.) bulbs.

2. determination of the optimum dosage level of the powder and oils extract that can give adequate protection of cowpea against pest infestation.

The cowpea beetle. *Callosobruchus maculatus* (F.) (Bruchidae)

Callosobruchus maculatus (F.) is a Coleopteran belonging to the family Bruchidae. The family contains many field and storage pests. The larvae of most species develop in the seeds of leguminous crops. The most valuable feature in the recognition of bruchid species is the arrangement of teeth and ridges on the hind femur (NRI, 1991).

C. maculatus, which does not attack Phaseolus spp (in the strict sense), is a small beetle, about 4-5 mm long. The body, which is clothed in short hairs, is compact. The elytra cover all but (unlike other similar insects) the last abdominal tergum (called the pygidium) and the antennae are relatively long.

It has a pair of distinct ridges (inner and outer) on the ventral side of each hind femur and each ridge bears a tooth near the apical end. The inner tooth is triangular, and equal to (or slightly longer than) the outer tooth. The antennae of both sexes are slightly serrated. Females often have strong markings on the elytra, consisting of two large lateral dark patches mid-way along the elytra and smaller patches at the anterior and posterior ends, leaving a pale brown cross-shaped area covering the rest. The males are much less distinctly marked.

The adult beetles, which do not feed on stored products, are short-lived (usually no more than 12 days under optimum conditions) and during this time the females lay many eggs (up to 115), although oviposition may be depressed in the presence of previously infested seeds (NRI, 1991). The optimum temperature for oviposition is 30-35°C. As the eggs are laid, they are firmly glued to the surface of the host seeds, smooth-seeded varieties being more suitable for oviposition than rough-seeded varieties with oval flat bases. When newly laid they are small, grey and inconspicuous. Upon hatching, the larva bites through the testa of the seed and into the cotyledons. The developing larva feeds entirely within a single seed, excavating a chamber within the cotyledons as it grows. The optimum development conditions are around 32°C and 90% r.h. and the minimum development period of *C. maculatus* breeding on cowpea seeds is about 36 days, pupation taking place within the seed 26 days after oviposition (NRI, 1991).

The infestation of cowpea by the insect may start from the field, where eggs are laid on pods. As the pods dry, the pest's ability to infest them decreases. Thus dry cowpeas stored in pods are less susceptible to attack than threshed cowpeas. The insects reduce the food value, cause loss of grain weight, loss of market value and loss of viability of the seeds when they attack the grain. Singh and Rachie (1985) reported that the insects often cause about 30% loss in weight of stored cowpea seed, with up to 70% of the seeds rendered virtually unfit for consumption after farm storage for six months.

Grain protection with plant oils

Plant products including oils have played an important part in traditional methods of protection against crops pests and disease vectors in Africa (Stoll, 1988; Poswal and Akpa, 1991). The precise strategy used by different communities varies from place to place and appears to depend partly on the type and efficacy of suitable plant materials available in different locations (Hassanali et al., 1983). The use of plant oils in the control of storage insect pests is an ancient practice (Yun-tai and Burkholder, 1981) and is particularly appropriate in small-scale storage systems. Pereira (1983) in support of this claim, added that mixing oils obtained from locally available plants with pulses has been an ancient Indian method of protection against bruchid attack. Treacy et al., (1991) observed that vegetable and petroleum oils are commonly used as diluent adjuvants for insecticides to enhance their activity. In recent years, attention has been given to the use of vegetable oils as stored grain protectants against insects (Golob and Webley, 1980; Qi and Burkholder, 1981; Pereira, 1983; Ivbijaro et al, 1984, Signamony et al., 1986, Don-Pedro, 1989; Hall and Harman, 1991; Stamopoulous, 1991). Several other workers have reported that vegetable oils provided sufficient protection to cowpea for varying durations, and Golob and Webley (1980) concluded that it is now well established that vegetable oils are very effective in controlling certain species of bruchids on pulses by their ovicidal effect. The widely used oils are palm oil, palm kernel oil, coconut oil, sunflower oil and soybean oil.

Materials and Methods

Collection of cowpea seeds

The cowpea variety (Black-eye) was used for this study because of its popularity in the country, and also its susceptibility to the cowpea beetle. Insecticide-free and undamaged seeds were obtained from markets in Hillah city, Iraq. They were stored in a room maintained at 25±2°C and 65-70% r.h.

Insect cultures

500 ml Kilner jars and cowpea grains were kept in the oven at 60°C for 2 hours for sterilization. These were used for the experiments. 750g of the sterilized cowpea grains were put in 10 separate previously cleaned 2-litre Kilner jars. One hundred adult cowpea beetles *C. maculatus* previously obtained from heavily infested cowpea from the market were introduced into each of the jars and covered with muslin held in place by the covers of the jars. This ensured that aeration was maintained in the jars and it also prevented the escape of introduced insects. The cultures were maintained in a laboratory at 25±2°C and 65-70% r.h. On the 20th day after the cultures were set up, the jars were emptied and all the insects (both dead and alive) were removed and the jars were refilled with the same grains. From the 30th day of each culture, the first adults began to emerge and these were used for the different experiments described below.

Collection of plant material

The plant material used in the present study was the garlic, *Allium sativum*. bulbs of Garlic were purchased fresh from the market of Hilla city, Babil, Iraq. The garlic bulbs were later dried in an open laboratory and ground into a very fine powder using an electric blender (Supermaster ®, Model SMB 2977, Japan). The powder was further sieved to pass through 1mm2 perforations (Ileke and Oni, 2011) before it was stored in separate plastic containers with tight lids and stored in a refrigerator at 4 ^{o}C prior to use.

Acetone extract of *A. sativum* bulbs was carried out using the cold extraction method. About 250g of *A. sativum* powder was soaked separately in an extraction bottle containing 70% acetone. The mixture was stirred occasionally with a glass rod and extraction was terminated after 72 hours. Filtration was carried out using a double layer of Whatman No. 1 filter papers and acetone was evaporated using a rotary evaporator at 30 to 40 ^{o}C with a rotary speed of 3 to 6 rpm for 8 hours (Udo, 2005). The resulting extract was air-dried in order to remove traces of solvent.

Toxicity of plant powder

Portions of 1, 2.5 and 5g of garlic powder corresponding to 5, 12.5 and 25% w/w concentration (Fatope et al., 1995) were weighed and added to a 20g of clean undamaged and uninfected cowpea seeds in 250ml plastic containers. The seeds in the controls contained no plant powder. The containers with their contents were gently shaken to ensure a thorough admixture of the cowpea seeds and treatment powders. Ten pairs of adults *C. maculatus* were introduced to each of the containers and covered. The insects were sexed based on the observation reported by Odeyemi and Daramola (2000). Three replicates of the treatments and untreated controls were laid out in Complete Randomized Design. The adult mortality was assessed after every 24 hours for 96 hours. On day 5, all insects, both dead and alive were removed from each container and ovipositon were noted before returned the seeds to their respective containers. Adult emergence (F1) was then recorded at 6 weeks. The percentage adult emergence was calculated thus:

$$\%\ \text{Adult emergence} = \frac{\text{No. of adults emerged}}{\text{No. of eggs laid}} \times \frac{100}{1}$$

At day 42, the cowpea seeds were re-weighed and the % loss in weight was determined and recorded. The percentage seed damaged were also evaluated as follows:

$$\%\ \text{seed damage} = \frac{\text{Number of seeds damaged}}{\text{Total number of seeds}} \times \frac{100}{1}$$

The Weevil Perforation Index (WPI) of the weevil to cowpea seeds were calculated using the methods of Fatope et al., (1995); Adedire and Ajayi (1996) respectively. The weevil perforation is defining as follows:

$$\text{WPI} = \frac{\%\ \text{treated cowpea seeds perforated}}{\%\ \text{control cowpea seeds perforated}} \times \frac{100}{1}$$

Toxicity of plants extract

The toxic effect of plant oils on adults of *C. maculatus* was accomplished using 250ml plastic containers containing 20g of cowpea seeds with concentrations of 0.5, 1 and 2% w/v plant extracts in acetone. The oil was thoroughly mixed with the aid of a glass rod and agitated for 5-10 minutes to ensure uniform coating. The containers were left open for 30 minutes so as to allow traces of acetone to evaporate off. Ten copulating pairs of *C. maculatus* were introduced into the containers and mortality was observed daily for 4 days. Cowpea seeds that were solvent treated served as the control experiment (Arannilewa et al., 2006). Three replicates of the treatments and untreated controls were laid out in Complete Randomized Design. Adult insects were considered dead when no response was observed after probing them with forceps.

The effect of the extract on adult emergence was recorded after 42 days. At the end of 42 days, the extent of weight loss as a result of weevil development, damage to seeds and weevil perforation index (WPI) was calculated as described under toxicity of plant powders.

Results

Toxicity of garlic powder to *Callosobruchus maculatus*

Table 1 shows the effectiveness of plant powder on the mortality of cowpea bruchid. The garlic powder at different concentrations had above 60% mortality when compared with untreated which had no mortality after 72 hours of post-treatment. Garlic bulb, *A. sativum*, caused 60.7%, 73.3% and 100% mortality of *C. maculatus* at rates of 1/20g, 2.5/20g and 5/20g of seeds at 72 hours of post-treatment. Garlic powder was able to produce 100% mortality of beetles at rates of 2.5/20g and 5/20g of cowpea seeds apart from cowpea seeds treated at the rate of 1g that evoked 83.3% mortality of beetles after 4 days of exposure.

Table 1. Effect of garlic powder on percentage mortality of *Callosobruchus maculatus* adults

Garlic powder	g/20g cowpea	Mean % mortality + S.E. at 24h to 96h Post treatment			
		24	48	72	96
A. sativum	1.0	13.3 + 0.0 b	46.7 + 0.3 b	60.7 + 0.0 b	83.3 + 0.0 b
	2.5	30.0 + 0.0 c	50.0 + 0.0 b	73.3 + 0.0 c	100.0 + 0.0 c
	5.0	50.0 + 0.0 d	70.0 + 0.0 c	100.0 + 0.0 d	100.0 + 0.0 c
Control	0.0	0.0 + 0.0 a	0.0 + 0.0 a	0.0 + 0.0 a	0.0 + 0.0 a

Each value is a mean of + standard error of three replicates. Means within the same column followed by the same letter(s) are not significantly different at (P>0.05) from each other

Effect of garlic powder on oviposition and adult emergence of *C. maculatus*

The garlic powder significantly reduced the number of eggs laid by *C. maculatus* **(Table 2)**. Compared with the control that recorded 90 adult emergences, seeds treated with *A. sativum* had no adult emergence apart from seeds treated at rate 1g that recorded 15 adult emergences.

Table 2. Effect of garlic powder on oviposition and adult emergence of *C. maculatus*

garlic powder	g/20g cowpea	No of Eggs	%Adults Emergence
A. sativum	1.0	26.7 + 0.3 b	14.8 + 0.1 b
	2.5	10.0 + 0.0 a	0.0 + 0.0 a
	5.0	10.3 + 0.0 a	0.0 + 0.0 a
Control	0.0	86.7 + 0.3 c	89.7 + 0.3 c

Each value is a mean of + standard error of three replicates. Means within the same column followed by the same letter(s) are not significantly different at (P>0.05) from each other.

Toxicity of garlic bulbs extract to *C. maculatus*

Table 3 shows that the extract of the garlic plant at different concentrations was able to evoke 100% mortality of adult beetles apart from the concentration at 0.5ml per 20g of cowpea seeds that produced 80% adult mortality of *C. maculatus* after 72 hours of post-treatment.

Table 3. Table 3. Effect of garlic bulbs extract on percentage mortality of *C.maculatus* adults

Garlic extract	Conc. ml/20g	Mean % mortality + S.E. at 24h to 96h Post treatment			
		24	48	72	96
A. sativum	0.5	30.0 + 0.0 b	66.7 + 0.3 b	80.0 + 0.0 b	100.0 + 0.0 b
	1.0	53.3 + 0.0 c	70.0 + 0.0 bc	100.0 + 0.0 b	100.0 + 0.0 b
	1.5	70.0 + 0.0 d	100.0 + 0.0 d	100.0 + 0.0 b	100.0 + 0.0 b
Control	0.0	0.0 + 0.0 a	0.0 + 0.0 a	0.0 + 0.0 a	0.0 + 0.0 a

Each value is a mean of + standard error of three replicates. Means within the same column followed by the same letter(s) are not significantly different at (P>0.05) from each other.

Effect of garlic bulbs extract on oviposition and adult emergence of *C. maculatus*

The garlic bulbs extract significantly reduced the number of eggs laid by cowpea beetles compared to untreated cowpea seeds that had 84 eggs **(Table 4)**. The percentage of adult emergence in the untreated was significantly different (P>0.05) from all the treated cowpea seeds that recorded no adult emergence. The extract completely inhibited the F1 development of *C. maculatus.*

Table 4. Effect of Garlic extract on oviposition and adult emergence of *Callosobruchus maculatus*

Garlic extract	Conc. ml/20g	No of Eggs	%Adults Emergence
A. sativum	0.5	20.0+ 0.0a	0.0+0.0a
	1.0	14.7+ 0.3a	0.0 +0.0a
	1.5	10.3+ 0.0a	0.0+ 0.0a
Control	0.0	83.3+ 0.0b	86.7+ 0.3b

Each value is a mean of + standard error of three replicates. Means within the same column followed by the same letter(s) are not significantly different at (P>0.05) from each other.

Damage assessment of cowpea seeds treated with A. sativum powder and extract

Cowpea seeds treated with plant powder showed no significant different (P.0.05) in the reduction of damage caused by *C. maculatus* **(Table 5)**. However, the weevil perforation index

(WPI) of 5.2 recorded on cowpea seeds treated with powder of *A. sativum* treated at rate 1g was significantly different (P>0.05) from weevil perforation index of the untreated cowpea seeds. In similar vein in **Table 6**, there was neither seed damage nor weight loss recorded in the treated cowpea seeds at all concentration. The weevil perforation index (WPI) was zero for the tested plant extract compared to untreated cowpea seeds.

Table 5. Protectantability of the garlic powder on cowpea seeds

Garlic powder	g/20g cowpea	Mean total no of seeds	Mean No of damaged seeds	Mean % seed damaged	% weight loss	Weevil Perforation Index (WPI)
A. sativum	1.0	94.3	4.0 + 0.0 a	4.2 + 0.4 a	0.7 + 0.3 a	5.2 + 0.1 a
	2.5	94.7	0.0 + 0.0 a	0.0 + 0.0 a	0.0 + 0.0 a	0.0 + 0.0 a
	5.0	93.3	0.0 + 0.0 a	0.0 + 0.0 a	0.0 + 0.0 a	0.0 + 0.0 a
Control	0.0	94.3	76.7 + 0.3 b	81.9 + 0.2 b	84.7 + 0.3 b	50.0 + 0.0 b

Each value is a mean of + standard error of three replicates. Means within the same column followed by the same letter(s) are not significantly different at (P>0.05) from each other.

**Weevil Perforation Index (WPI). Value lower than 50 is an index of positive protectant effect while WPI greater than 50 is an index of negative protectantability.*

Table 6. Protectantability of the garlic extract on cowpea seeds

Garlic extract	Conc. ml/20g	Mean total no of seeds	Mean No of damaged seeds	Mean % seed damaged	% weight loss	Weevil Perforation Index (WPI)
A. sativum	0.5	94.3	0.0 + 0.0 a	0.0 + 0.0 a	0.0 + 0.0 a	0.0 + 0.0 a
	1.0	93.3	0.0 + 0.0 a	0.0 + 0.0 a	0.0 + 0.0 a	0.0 + 0.0 a
	1.5	93.7	0.0 + 0.0 a	0.0 + 0.0 a	0.0 + 0.0 a	0.0 + 0.0 a
Control	0.0	93.7	72.3+0.0b	76.6+0.4b	82.7+0.3b	50.0+0.0b

Each value is a mean of + standard error of three replicates. Means within the same column followed by the same letter(s) are not significantly different at (P>0.05) from each other.

**Weevil Perforation Index (WPI). Value lower than 50 is an index of positive protectant effect while WPI greater than 50 is an index of negative protectantability.*

Discussion

Garlic powder and oil may have been very toxic to *C. maculatus* as a result of the strong choky odours it produces which may disrupt the normal respiratory activity of insects, thereby leading to asphyxiation and subsequent death (Adedire and Ajayi, 1996). This result agrees with the finding of Bhatnager-Thomas and Pal (1974) who reported the effectiveness of garlic oil against *Musca dominica* and *Trogoderma granarium*. Nasseh (1990) reported the insecticidal activities of *A. sativum* for the control of *Epilachna verivestis*. Arannilewa et al. (2006) reported 85% adult mortality of Sitophilus zeamais and 9 emerged adult maize weevil on treated maize grains with methanol extract of *A. sativum*.

The reduced oviposition and no adult emergence observed in the treated seeds with oils extract could be a result of the high adult mortality of *C. maculatus*. The oil inhibits locomotion which affects mating activities an effect that had been reported by many authors (Okonkwo and Okoye, 1996; Adedire, 2002, Akinkurolere et al., 2006, Oni and Ileke, 2008; Adedire et al., 2011; Ileke and Oni, 2011). The few eggs that were laid are unable to stick to the surface of the seeds as a result of oil presence also prevents progeny production. The lower F1 adult beetles in cowpea seeds treated with *A. sativum* powder at the rate of 1g may be due to the concentration used. The ovicidal and larvicidal of the plant powder and oil may be due to the presence of lipophilic compounds (Richards, 1978). Don-Pedro (1990) reported that eggs mortality may be a result of the physical properties of the oil resulting in blockage of respiratory pores (spiracle) while the larvicidal properties of the plant oil could be a result of both physical and chemical toxicity of oils (Ivbijaro, 1984).

The garlic plant powder and oil completely protected the seeds from being damaged by *C. maculatus*. The protectant ability of these plant powder and oil was highly remarkable. This may be a result of the ovicidal and larvicidal properties of the tested plant that completely killed a few eggs that were laid and also prevent the few ones that hatched into larvae from going into the pupa stage.

Conclusion

The result obtained from this study confirmed that powder and oil of garlic plant, *A. sativum*, can be used as a biopesticide against *C. maculatus* especially when the weevil perforation index is taken into consideration.

References

- Adedire, C.O & Ajayi, T.S. (1996). Assessment of the insecticidal properties of some plant extracts as grain protection against the maize weevil, *Sitophilus zeamais. Nigerian Journal of Entomology*, 13, 93-101.
- Adedire, C.O. (2001). Biology, ecology and control of insect pests of stored grains. Ofuya T.I. and Lale, N.E.S.(Eds). Pest of Stored Cereals and Pulses in Nigeria. Dave Collins publications, Nigeria. Pp. 59-94.
- Adedire, C.O. (2002). Use of nutmeg, *Myristica fragrans* (Houtt) powder and oil for the control of cowpea storage bruchid, *Callosobruchus maculatus*. *Journal of Plant Diseases and Protection*, 109. 193-199.
- Adedire, C.O., Obembe, O. O., Akinkurolele, R. O. & Oduleye, O. (2011). Response of *Callosobruchus maculatus* (Coleoptera: Chysomelidae: Bruchidae) to extracts of cashew kernels. *Journal of Plant Diseases and Protection*, 118(2), 75-79
- Akinkurolele, R. O., Adedire, C. O. & Odeyemi, O. O. (2006). Laboratory evaluation of the toxic properties of forest anchomanes, *Anhomanes difformis*, against pulse beetle, *Callosobruchus maculatus* (Coleoptera: Bruchidae). *Insect Science*, 13, 25-29.
- Akinkurolere, R. O., Boyer, S., Chen, H. & Zhang, H. (2009). Parasitism and host location preference in *Habrobracon hebetor* (Hymenoptera: Braconidae): Role of refuge, choice and host instar. *Journal Economics Entomology*, 102(2), 610-615.
- Arannilewa S. T., Ekrakene, T. & Akinneye, J. O. (2006). Laboratory evaluation of four medicinal plants as protection against the maize weevil, *Sitophilus zeamais. African Journal of Biotechnology*, 5(21), 2032-2036.
- Butterworth-Hememann, London. Hassanali, A., Singh, O. P. and Misra, U. S. (1983): Effectiveness of plant oil against pulse beetle, Callososbruchus chinensis (L.) Indian Journal of Entomology 45: 6-9.

- Dike, M. C. & Mbah, O. I. (1992). Evaluation of the lemon grass products in the control of *Callosobruchus maculatus* on stored cowpea. *Nigerian Journal of Crop Protection,* 14, 88-91.
- Don-Pedro, K. N. (1987): Insecticidal activity of plant oils against stored product pests. Ph.D. Thesis, University of London.
- Don-Pedro, K. N. (1989): Mechanisms of action of some vegetable oils against Sitoplilus zeamais Motch. (Celeoptera; Curculionidae) on wheat. Journal of Stored Products Research 25, 217-233.
- Don-Pedro, K. N. (1990). Insecticidal activity of fatty acid constituents of fixed vegetable oils against *Callosobruchus chinensis* on cowpea. *Pesticide Science,* 30, 295-305.
- Fatope, M. O., Mann, A. & Takeda, Y. (1995). Cowpea weevil bioassay: A simple prescreen for plants with grain protectant effects. *International Journal of Pest Management*, 41, 44-86.
- Golob, P. and Webley, D. J. (1980): The use of plants and minerals as traditional protectants of stored products. Rept. of Trop. Prods. Inst. G. 138 (iv): 32pp.
- Graingne, M; Ahmed, S, Mitchel, W. C. & Hylin, J. N. (1985). Plant species reportedly possessing pest control properties and EWC/UH data base- Resource Systems Institute, EWC. Honolulu, College of Tropical Agriculture and Human Resource, University of Hawaii.
- Hall, J. S. and Harman, G. E. (1991): Protection of stored legume seed against attack by storage fungi and weevils: mechanism of action of lipoidal and oil seed treatment. Crop Protection, Vol. 10, pp. 375-380.
- Ileke, K. D. & Oni, M. O. (2011). Toxicity of some plant powders to maize weevil, *Sitophilus zeamais* (Coleoptera: Curculionidae) on stored wheat grains. *African Journal of Agricultural Research*, 6(13), 3043-3048.
- Ivbijaro, M. F. (1984a): Groundnut oil as a protectant of maize from damage by the maize weevil Sitophilus zeamais Motsch. Protection Ecology 6, 267-270.
- Ivbijaro, M. F. (1984b): Toxic effects of groundnut oil on the rice weevil Sitophilus oryzae (L.): Insect Science and its Application 5, 251-252.

- Mital, H. C. (1971): Protection of cowpea from insect infestation with the aid of fixed oils. J. West Afr. Sci. Ass. 16: 45-48.
- Nasseh, M. O. (1990). Studies on insecticidal activities of *Allium sativum* for control of *Epilachna verivestis* (Coleoptera: Coccinelidae). *Zurich Angewandte Entomologie*, 92, 464-471.
- Nelson, S. N. (1991). Digestibility of Legume Protein. *Food Technology*, 45, 112-114.
- NRI, (1991): Insects and Arachnids of Tropical stored products: Their biology and identification. (A training manual). A Natural Resource Institute Production.
- Odeyemi, O. O., & Daramola, A. M. (2000). Storage practices in the tropics: Food storage and pest problems. Dave Collins Publication, Nigeria, 1, 235.
- Ofuya, T. I & Bamigbola, K. A. (1991). Damage Potential, growth and development of the seed beetle, *Callosobruchus maculatus* (Fab.) (Coleoptera: Bruchidae) on some tropical legumes. *Tropical Agriculture*, 68, 33-36.
- Ofuya, T.I. (2001). Biology, Ecology and control of insect pests of stored Food legumes. In: pp 59-94. Ofuya T.I.and Lale, N.E.S. (eds) pest of stored cereals and pulses in Nigeria. Dave Collins publications, Nigeria. Pp 25-58.
- Okonkwo, E. U. & Okoye, W. I. (1996). The efficacy of four seed powders and the essential oils as protestants of cowpea and maize grains against infestation by *Callosobruchus maculatus* and *Sitophilus zeamais Nigeria International Journal Pest Management*, 42(3), 143-146.
- Oni, M. O. (2011). Evaluation of seed and fruit powder of *Capsicum annum* and *C. frutescens* for control of *Callosobruchus maculatus* (Fab.) in stored cowpea and *Sitophilus zeamais* in stored maize. *International Journal of Biology*, 3(2), 185-188.
- Oni, M.O. & Ileke, K. D. (2008). Fumigant toxicity of four botanical plant oils on survival, egg laying and progeny development of the dried yam beetle, *Dinoderus porcellus* (Coleoptera: Bostrichidae). *Ibadan Journal of Agricultural Research*, 4(2), 31-36.
- Oparaeke, A. M. & Bunmi, O. J. (2006). Insecticidal potential of cashew, *Anacardium occidentale* for control of the beetle, *Callosobruchus subinnotatus* on bambara groundnut. *Archives of Phytopathology and Plant Protection*, 39(4), 247-251.

- Oparaeke, A. M. & Dike, M. C. (1996). Comparison of garlic and lemon grass products in the control of Callosobruchus maculatus on stored cowpea grains. Nigerian Journal of Entomology, 13, 73-80.
- Owusu-Akyaw, M. (1991): Evaluation of plant products for the control of cowpea and maize storage insect. Paper presented at the Joint Safgrud Research Networks' Workshop, Niamey, Niger, 8-14 March, 1991.
- Pereira, J. (1983): The effectiveness of six vegetable oils as protectants of cowpeas and bambara groundnuts against infestation by Callosobruchus maculatus (F.) (Coleoptera; Bruchidae) Journal of Stored Products Research 19, 57-62.
- Poswal, M. A. T. and Akpa, A. D. (1991): Current trends in the use of traditional and organic methods for the control of crop pests and diseases in Nigeria. Tropical Pest Management 37: 329-333.
- Qi, Y. and Burkholder, W. E. (1981): Protection of stored wheat from the granary weevil by vegetable oils. Journal of Economic Entomology 74: 502-505.
- Richards, A. G. (1978). The chemistry of insect cuticle. In: Biochemistry of insects, Academic Press, New York, U. S. A. pp. 205-232.
- Signamony, S., Anees, I., Chandrakala, T. and Osmani, Z. (1986): Efficacy of certain indigenous plant products as grain protectants against Sitophilus oryzae (L.) and Rhyzopertha dominica (F.). Journal of Stored Products Res. 22, 21-23.
- Singh, S R., Luse, R.A., Leuschuner, K. and Nangju, D. (1978): Groundnut oil treatment for the control of Callosobruchus maculatus (F.) during cowpea storage. Journal of Stored Products Research 14, 77-80.
- Singh, S.R. and Rachie, K O. (1985): Cowpea research, production and utilization. A Wiley - International Publication 460 pp.
- Stamton, W.R. (1966): Grain Legumes in Africa 183 pp FAO, Rome.
- Stoll, G. (1988): Natural Crop Protection Based on Local Farm Resources in the Tropics and Subtropics. 3rd ed. Josef. Margraf, Langen, Germany.
- Tembo, E. and Murfitt, R.F.A. (1995): Effect of combining vegetable oil with Pirimiphos - methyl for protection of stored wheat against Sitophilus granarius (L.) Journal of Stored Products Res. 31, 77-81.

- Treacy, M. F., Benedict, J. H, Schmidt, K. M. and Anderson, R. M. (1991): Mineral oil: Enhancement of field efficacy of a pyrethroid insecticide against the boll weevil (Coleoptera: Curculionidae) Journal of Economic Entomology 84 (2): 659-663.
- Udo, I. O. (2005). Evaluation of the potential of some local spices as stored grain protectants against maize weevil *Sitophilus zeamais. Journal of Applied Science and Environmental Management,* 9(1), 165-168
- Yun-tai, Q. I. And Burkholder, W. E. (1981): Protection of stored wheat from the granary weevil by vegetable oils. Journal of Economic Entomology 74: 502-505.
- Zehrer, W. (1980). Traditional methods of insect pest control in stored grain. In: Post harvest problems.