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# Studies on the Efficacy of *Vittallaria paradoxa* Seed Oil on the Oviposition, Hatchability of Eggs and Emergence of *Callasobruchus maculatus* (F.) (Coleoptera: Bruchidae) on Treated Cowpea Seed

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## ABSTRACT
The efficacy of *Vittallaria paradoxa* seed oil against *Callosobruchus maculatus* (Fabricius) on cowpea treated seed was evaluated under ambient conditions (32±0.64°C and 68±3% R.H) at the Biological Sciences Department of Bayero University Kano. *Callasobruchus maculatus* were obtained from IITA Store in Kano State of Nigeria. The insect were reared and bred in the laboratory. The cowpea seed used for the bioassay were kept in the freezer overnight to eliminate *maculatus* infestation coming from field and the Moisture content was determined. The oil was extracted locally by steaming of dry seeds of *Vittallaria paradoxa* in a large cooking pot after pounding into paste in a mortar. Four different concentrations of seed oil (0.5, 1.0, 1.5 and 2.0 mL) were separately mixed with 20 g of cowpea in separate petri dishes which correspond to (2.5, 5.0, 7.5 and 10.0% v/w), respectively. Ten pairs of one-day old *Callasobruchus maculatus* were introduced into each petri dish. Number of eggs laid, viability of the eggs and adult emergence from each treatment were compared with the control and were found to be significantly reduced in comparison with the control treatment. It is concluded that *Vittallaria paradoxa* has great potential for use as a plant-based biopesticide for controlling pulse beetle *Callasobruchus maculatus*.

**Key words:** Efficacy, *Vittallaria paradoxa,* seed oil, emergence, oviposition, eggs hatchability, *Callasobruchus maculatus*

## INTRODUCTION
Nigeria accounts for 70% of the world's Cowpea production (Blade *et al*., 1997). It is an extremely valuable crop both as a source of revenue and an important source of cheap dietary protein for the third world where meat is expensive (Alghali, 1991; Lale, 1991). As common to many leguminous crops, a wide spectrum of insects attack cowpea seed among them is the cowpea bruchid, *Callosobruchus maculatus* (F.) (Coleoptera, Bruchidae) (Deborah and Credland, 2003). The insect is a field to store pest as its infestation of cowpea often begins in the field as the mature pods dry (Haines, 1991). The insect multiplies very rapidly in storage where it causes very high losses. According to IITA (1989) *C. maculatus* consumes 50-90% of cowpea in storage annually throughout tropical Africa.

Several methods have been used over the years to protect cowpea grains in storage, but the use of synthetic insecticides has been very dominant (Adabie-Gomez *et al*., 2006; Mbata *et al*., 2005).

The pervasive use of these insecticides in granaries of small-scale farmers has led to a number of problems, such as killing of non-target species, user hazards, food residues, and evolution of resistance to the chemicals, high cost of the chemical and the destruction of the balance of the ecosystem. The search for alternative insect pest control methods and materials which are relatively cheaper and less harmful to the user and the environment has therefore become essential (Subramanyam and Hagstrum, 2000; Arthur and Phillip, 2002). Attention has been focused on the use of indigenous plants as sources of cheap and locally available pesticides. The use of plant oils against *Callasobruchus maculatus* (Boateng and Kusi, 2008) have been reported.

Similarly, The efficacy of *Jatropha* seed oil against cowpeabeetles (Adabie-Gomez *et al.*, 2006; Henning, 2007) has also been documented. Oil and powder obtainable from neem (*Azadirachta indica* A. Juss) seed have been reported to provide sustained protection of stored grains (Ketoh *et al.*, 2002; Ogunwolu and Idowu, 1994; Lale and Ajayi, 1996; Ogunwolu and Odunlami, 1996). The objective of the paper was to study the efficacy of *Vittallaria paradoxa* seed oil on the oviposition,hatchability and emergences of *Callasobruchus maculatus* (F.) (Coleoptera: Bruchidae) on treated cowpea seed.

## MATERIALS AND METHODS

**Study area:** The study was conducted in 2010 in Kano State of Nigeria at the Department of Biological Sciences Bayero University Kano under ambient conditions (32±0.64°C and 68±3% R.H)

**Test plant materials:** Seed of *Vittallaria paradoxa* was collected from some rural areas of Kano State (DanMadanho,Bela) during dry and rainy season. These were washed and air dried in the shade (Boateng and Kusi, 2008; Bamaiyi *et al.*, 2006).

**Test insect and maintainance:** The beetle, *Callasobruchus maculatus* (F.) was used for the experiment. A small population of *Callasobruchus maculatus* beetle was obtained from IITA store in Kano State of Nigeria, along with infested cowpea. These were identified as described by Utida (1972). The beetle *Callasobruchus maculatus* were reared and bred in the Biological Sciences laboratory and were differentiated into males and females based on their morphological characters (Southgate, 1979).

**Maintainance of Cowpea:** Cowpea (Danila) was collected from IITA, Kano. The seed were checked individually and damaged seed were excluded. Checked seeds were placed in plastic bags and kept in the freezer overnight to eliminate *maculatus* infestation coming from field (Marcileyne *et al.*, 2004). The seed were removed from the freezer and placed at room temperature and relative humidity for some hours to equilibrate and the moisture content of the seed were measured before the experiment (Jackai and Asante, 2001).

**Seed oil formulation:** Oil was extracted from the seed of *Vittallaria paradoxa* according to the method described by Bamaiyi *et al.* (2006). The fruit was collected from the plant and after pre-treatment of the fruit. The seed was grounded into paste using pestle and mortar. The paste were mixed with cold water and allowed to stand for 3 h. The mixture were sieved over cheese cloth to obtained the filtrate. The filtrate were then heated in a large cooking pot until evaporation was completed and the crude oil extract were collected at the bottom of the container (Bamaiyi *et al.*, 2006).

**Bioassay:** Bioassay were conducted based on the method described by Talukder and Howse (1994). Four different diluted concentration of oils from the seed of *Vittallaria paradoxa* (0.5, 1.0, 1.5 and 2.0 mL) was separately mixed with 20 g of Cowpea in separate petri dishes which correspond to 2.5, 5.0, 7.5 and 10.0% v/w, respectively. These seeds mixed with different plants oils were shaken properly to ensure proper coating of the seed with the oils. After shaking the seeds were taken out and air-dried for 1 h to evaporate the solvent (Talukder and Howse, 1994). Similar concentration of Dichorlovos (DVP) were set up as standard chemical insecticides. Control was also set along (which has neither oil nor dichorlovos). Ten pairs of the beetle *Callasobruchus maculatus* (1 day old) were released into each treatments. These were covered with a muslin cloth to facilitate proper aeration and prevent entry of other insects. Each treatment was replicated three times and arranged in a Completely Randomized Design (CRD) and left on the laboratory bench for daily observation (Opakaraeke, 1996). The number of eggs laid were counted separately for each treatment. All the eggs laid in different petri dishes were examined for hatching. The hatch or viable eggs were recognized by their morphological aspect (Marcileyne *et al.*, 2004) since they become opaque as a function of their residue discharged by the larvae during penetration. The number of hatch or viable eggs was calculated based on the hatching of eggs (Marcileyne *et al.*, 2004). The adult emergence was also monitored in each treatment

## RESULTS AND DISCUSSION

The higher doses of *Vittallaria paradoxa* seed oil used in the study significantly ($p<0.05$) inhibited the females *Callasobruchus maculatus* from laying eggs on treated cowpea seed (Table 1). The result was comparable with that of the chemical insecticide used in the study (Table1). This indicate the probable presence of a strong oviposition detterent in the oil. The finding in this study conform with the finding of Srivastava *et al.* (1988) who reported that eucalyptus oil effectively prevented the oviposition of insects and that of Mulatu and Gebremedhin (2000) who showed that the oils of *A. indica*, *Milletiaie ferruginea* and *Chrysanthemum cineraraefolium* were the most effective in partially or completely preventing egg laying, and pulse beetles emergence from the laid eggs. Lale and Mustapha (2000) found no significant difference in the efficacy of neem seed oil and pirimiphos-methyl in reducing oviposition of *C. maculatus*, adult emergence or seed damage rates in treated cowpeas which are also in agreement with the present study.

Table 1: Oviposition of female *Callasobruchus maculatus* and viability of eggs deposited (laid) on cowpea treated with *Vittalaria paradoxa* seed oils

| Plant seed oil used | Amount applied 20 g (conc in %) | Insect pairs used | Mean No. of eggs laid±SE | Mean No. of eggs hatched±SE | Mean viability of eggs (%) |
|---|---|---|---|---|---|
| *Vittallaria paradoxa* | 0.5 (2.5) | 10 | 123.67±11.62$^{b}$ | 58.33±13.69$^{b}$ | 47.16 |
| | 1.0 (5.0) | 10 | 0±0.00$^{a}$ | 0±0.00$^{a}$ | 0 |
| | 1.5 (7.5) | 10 | 0±0.00$^{a}$ | 0±0.00$^{a}$ | 0 |
| | 2.0 (10.0) | 10 | 0±0.00$^{a}$ | 0±0.00$^{a}$ | 0 |
| Control (untreated) | | 10 | 813.33±14.53$^{c}$ | 702 ±14.10$^{c}$ | 86.34 |
| Standard treated | 0.5 (2.5) | 10 | 0±0.00$^{a}$ | 0±0.00$^{a}$ | 0 |
| with diclorvos | 1.0 (5.0) | 10 | 0±0.00$^{a}$ | 0±0.00$^{a}$ | 0 |
| | 1.5 (7.5) | 10 | 0±0.00$^{a}$ | 0±0.00$^{a}$ | 0 |
| | 2.0 (10.0) | 10 | 0±0.00$^{a}$ | 0±0.00$^{a}$ | 0 |

Each observation is based on three replicates. Mean±SE bearing same letter(s) in a column are not significant different by LSD at 0.05

Table 2: Emergence of adult *Callasobruchus maculatus* from cowpea grains treated with varying concentration of *Vittallaria paradoxa* seed oil

| Plants seed oil used | Amount applied 20 g (conc in %) | Mean No. of eggs laid±SE | Mean No. of hatches eggs±SE | Mean No. of adult | Adult emergence (%) emerged±SE |
|---|---|---|---|---|---|
| *Vittalaria paradoxa* | 0.5 (2.5) | 123.67±11.62[b] | 58.33±13.69[b] | 15.66±3.17[b] | 26.85 |
| | 1.0 (5.0) | 0±0.00[a] | 0±0.00[a] | 0±0.00[a] | 0 |
| | 1.5 (7.5) | 0±0.00[a] | 0±0.00[a] | 0±0.00[a] | 0 |
| | 2.0 (10.0) | 0±0.00[a] | 0±0.00[a] | 0±0.00a | 0 |
| Control (untreated) | | 813.33±14.53[c] | 702 ±14.10[c] | 526.33±37.02[c] | 74.98 |
| Standard treated | 0.5 (2.5) | 0±0.00[a] | 0±0.00[a] | 0±0.00[a] | 0 |
| with diclorvos | 1.0 (5.0) | 0±0.00[a] | 0±0.00[a] | 0±0.00[a] | 0 |
| | 1.5 (7.5) | 0±0.00[a] | 0±0.00[a] | 0±0.00[a] | 0 |
| | 2.0 (10.0) | 0±0.00[a] | 0±0.00[a] | 0±0.00[a] | 0 |

Each observation is based on three replicate. Mean followed by same letter(s) are not significant different by LSD at 0.05

Furthermore the viability (%hatching of the eggs) in the lower dose of the oil was significantly reduced (47.16%) in comparison with untreated control (86.34%). The eggs mortality and failure to hatch on the seed treated with oil has been attributed to the toxic component of the oil and also to the physical properties which cause changes in surface tension and oxygen tension within the eggs (Singh, 1978).

Adult emergence was found to be inhibited at some dosage level of treatments (Table 2). Don-Pedro (1989) and Copping and Menn (2000) have reported that applications of oils occlude seed funnel leading to the death of the developing embryo of the insect by asphyxia which ultimately reduced the emergence of the insect from the treated seed.

The oil coating the seed may prevent *Callasobruchus maculatus* eggs to firmly attach to the seed coat which can inhibit larval penetration into the seed (Adebowale and Adedire, 2006) and this can prevent adult emergence. Oils coating on grains can also prevented penetration of oxygen to the developing stages (Adebowale and Adedire, 2006) which consequently affect the survival of the immature stages (Larvae and pupae) of *Callasobruchus maculatus*.

Several workers have reported growth and development inhibition properties of plant product on of the bettle *Callasobruchus maculatus*. Pandey *et al*. (1986), Akinkurolere (2007), Sathyaseelan *et al*. (2008) and Ramzan (1994) reported that cotton seed, sunflower, groundnut, soybean and mustard oils, when mixed with cowpea, completely suppressed the survival of immature stages as well as adult emergence of *C. maculates*. Similarly Shaaya *et al*. (1997) reported that edible oils are potential control agents against *C. maculatus* and can play an important role in stored-grain protection. Ahmed *et al*. (1999) found that the neem and sesame oils completely inhibited the survival of immature stages of the insect as well as adult emergence and appeared to be most promising as a seed protectant against *C. chinensis*. Yalamanchilli and Punukollu (2000) observed that the volatile oil from the leaves of *Curcuma domestica* could effectively protect the seeds against *C. chinensis*. The findings from these authors were similar to the finding in this study using *Vittallaria paradoxa* seed oil.

## CONCLUSION

The use of *Vittallaria paradoxa* oil has demonstrated a potent activity against *Callasobruchus maculatus* indicating that the plant oil may have some properties which can be useful in short listing the oil as an alternative source of botanical pesticide. It is recommended that further studies be conducted to identify and characterized the bioactive compound present in the plant oil which will benefit the low resource farmers as against the use of synthetic pesticide.

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