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**Laboratory Evaluation of Mahogany (*Khaya senegalensis* (Desv.)
Seed Oil and Seed Powder for the Control of *Callosobruchus maculatus*
(Fab.) (Coleoptera: Bruchidae) on Stored Cowpea**

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Abstract: The efficacy of *Khaya senegalensis* seed oil and powder was evaluated for the control of *Callosobruchus maculatus* on stored cowpea. The oil was extracted locally by steaming of the dry *K. senegalensis* seeds in a large cooking pot after pounding into a paste in a mortar. Similarly the seed shaft leftover from the extraction process was dried in the oven at 30°C and pounded in a mortar and further macerated in an electric moulinex kitchen blender into fine powder. This was compared with actellic Emulsifiable Concentrate (EC) and actellic dust as standards. Adult mortality of *C. maculatus* was highest within 24 h post treatment with seed oil concentrations at 1, 2 and 3 mL/100 g of cowpea. The seed oil significantly ($p < 0.05$) reduced the F_1 and F_2 progeny emergence but did not differ significantly ($p > 0.05$) when compared with the control. For all the parameters investigated, *K. senegalensis* seed oil did not differ significantly with Actellic EC in the Control of *C. maculatus*, during the study.

Key words: *Khaya senegalensis*, seed oil, seed powder, *Callosobruchus maculatus*, cowpea, fumigation

INTRODUCTION

The high cost of synthetic pesticides, the danger of pesticide misuses and toxic residues in food concerns, have resulted in the increase in the search for plant botanicals which can serve as good alternatives for the control of stored products pests (Shaaya *et al.*, 1997). In many storage systems, fumigation is the most effective method of protecting stored foods, feedstuffs and other agricultural commodities from insect infestations. Lately, however, the number of fumigants used for insect control has decreased drastically due to the development of resistance by the target insects and accordingly the mounting social pressures against the use of toxic chemicals have limited the introduction of new compounds (Snelson, 1987). Presently, in Nigeria, only two fumigants are being officially used namely Methyl bromide and Phosphine. Methyl bromide is reported as being responsible in the ozone layer depletion (WMO, 1995) and this cast doubts on its future use in insect control. Similarly, phosphine, although a widely used fumigant may become disused because of its resistance status to stored grain insects reported in more than 45 countries (Bell and Wilson, 1995; Chaudhry, 1995). Besides resistance, Phosphine has been reported to have mutagenic effects on occupational fumigators (Garry *et al.*, 1989).

Because of drawbacks in the use of conventional fumigants, efforts are geared towards the development of new non toxic compounds, preferably from plants origin, for control purposes (Lee *et al.*, 2001). The toxicity of essential oils extracted from plants against stored-product insects

offer special interests, because its major constituents are monoterpenoids which are secondary plant chemicals used in industrial processing due to their biological activities especially toxicity to insects (Kubo *et al.*, 1994; Shaaya *et al.*, 1997; Tunc *et al.*, 2000).

K. senegalensis leaves and barks are used for medicinal purposes for the treatment of stomach upset in both humans and livestock (Datziel, 1948). Its use in crop protection dates back to early 1900 where it was used for dressing seeds for the following year's planting (Thomson, 1910). *Khaya senegalensis* products are not toxic to humans than most conventional insecticides. Studies have reported that plant oils are readily biodegradable and less detrimental to non-target organisms than pesticides (Tunc *et al.*, 2000; Lale, 2002).

The use of oils as fumigants or contact insecticides to protect leguminous grains, against storage insect pests is a traditional practice in many countries in Asia and Africa. This method is considered convenient and inexpensive for households and small holder farms. Essential oils have low mammalian toxicity, high volatility, but toxic to stored-grain insect pests, thus have high potentials for use as alternative Control over chemical fumigants (Regnault-Roger *et al.*, 1993; Shaaya *et al.*, 1991).

This study reports on the efficacy of *Khaya senegalensis* seed oil and seed powder for the Control of *Callosobruchus maculatus* on cowpea.

MATERIALS AND METHODS

Laboratory Culture of *Callosobruchus maculatus*

Callosobruchus maculatus used in the investigation was obtained from a laboratory culture. The culture was raised by infesting 30 pairs of newly emerged *C. maculatus* adults into 500 g of cowpea in a large Kilner jar and kept in the laboratory condition in the Department of Crop Protection, Institute for Agricultural Research, Ahmadu Bello University Zaria, Nigeria. After 35 days, the newly emerged F₁ adults were collected and used to infest the cowpea samples tested during the investigation.

Source of *Khaya senegalensis* Seeds and Seed Oil Extraction

Dry seeds of *K. senegalensis* were collected from the pods obtained from the plants growing in the Institute for Agricultural Research farms. The seeds were removed from the pods and roasted in a wide source pan and pounded into a paste using pestle and mortar. The paste was mixed with cold water and allowed to stand for 3 h. The mixture was sieved over a cheese cloth to obtain the filtrate which is a brown liquid extract. The filtrate was heated again in a wide source pan until evaporation was completed and the pure oil was collected at the bottom of the pan. The seed residue obtained during filtration was dried and pounded and further macerated into fine powder by an electric blender. The seed oil and powder obtained were kept at room temperature until use.

Preparation Concentrations and Infestation of Cowpeas with *C. maculatus*

Freshly harvested and air dried cowpea were used for the experiment. Hundred gram of cowpea were weighed into Kilner jars according to seed oil, seed powder, actellic emulsion, actellic powder and control used as treatments during the investigation. The concentrations of *K. senegalensis* seed oil, seed powder, actellic emulsion and actellic powder used were 1, 2 and 3 mL/100 g of cowpea. Into each 100 g of cowpea in a labelled Kilner jar each concentration was measured and put into three replicates of the concentrations per treatment, the control was not treated with the seed oil, seed powder. All the kilner jars were shaken vigorously to ensure proper mixing after which they were infested with newly emerged adult bruchiids from the culture.

Five pairs of the newly emerged adult *C. maculatus* were infested into each Kilner jar according to treatments. The jars covered were arranged on the laboratory bench in a Completely Randomized Design (CRD) in triplicate per concentration per treatment at room temperature for 12 weeks.

Data Collection

Mortality counts were recorded after 24, 48, 72 h post exposure for all the treatments, during which dead insects were removed. Egg counts were carried out 14 days post treatment. This was done by random draw of 20 cowpeas from each jar in each concentration per treatment. The number of adults produced in each concentration in each treatment was counted from 28-35 days and from 56-63 days post infection for the F₁ and F₂ generations, respectively, during which newly emerged adults were sieved out and counted in each case.

Statistical Analysis

The data collected were summarized statistically to obtain means and standard errors which were used to draw histograms presented in Fig. 1, 2 and 3. Completely Randomized Design model of Analysis of Variance (ANOVA) was used to determine statistical difference (5% level) between treatments and the means were separated using Student Newman Keuls (SNK).

RESULTS

All the treatments caused significant ($p < 0.05$) mortality of adult *C. maculatus* than the Control and their effects were highest within 24 h post treatment. Seed oil and Actellic Emulsion showed significant mortality effects at all concentrations than seed powder which also showed significant effect over the control treatment during that period. Similarly, there was significant ($p < 0.05$) effects on the mortality of *C. maculatus* 48 and 72 h post treatment, except no significant ($p > 0.05$) mortalities of *C. maculatus* 72 h post treatment between seed powder and control treatments (Fig. 1).

Figure 2 shows the effects of different concentrations of the treatments on the reproductive biology of *C. maculatus* treated with the different concentrations of seed oil, seed powder, actellic emulsion and actellic powder. The result showed that different concentrations of the treatments significantly ($p < 0.05$) affected the number of *C. maculatus* produced 28 days after treatment (28 DAT) and 56 days after treatment (56 DAT) than the Control treatment (Fig. 2).

The result show that Seed Oil and Actellic E.C. significantly ($p < 0.05$) reduced germination at the concentrations. Similarly, the seed powder, actellic dust and the control did not differ significantly ($p > 0.05$) in their effects on the germination of cowpea during this investigation (Fig. 3).

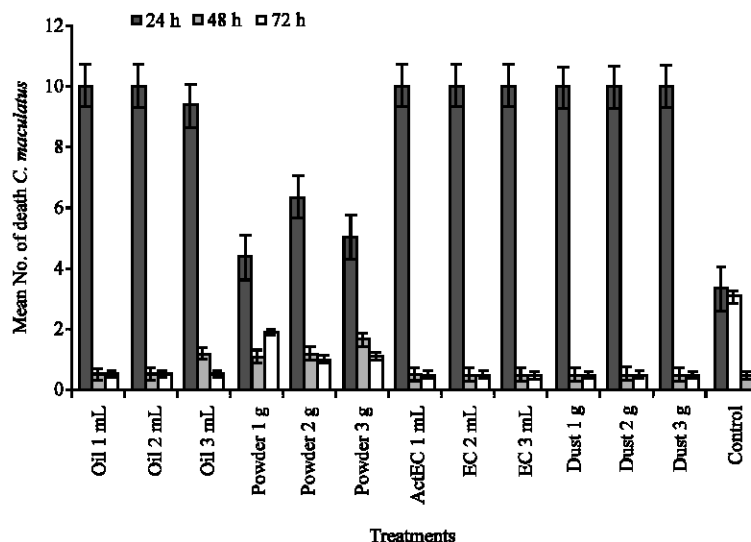


Fig. 1: Effect of *Khaya senegalensis* oil and powder on adult mortality of *C. maculatus*

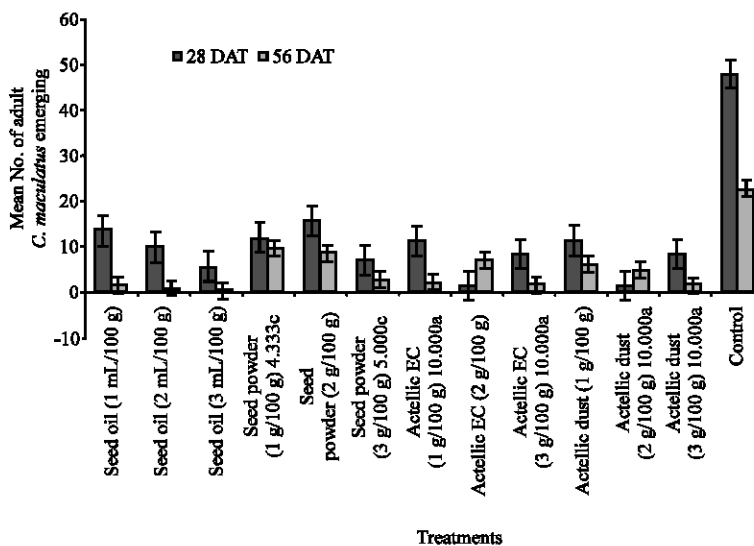


Fig. 2: Effect of *Khaya senegalensis* oil and powder on emergence of *C. maculatus*

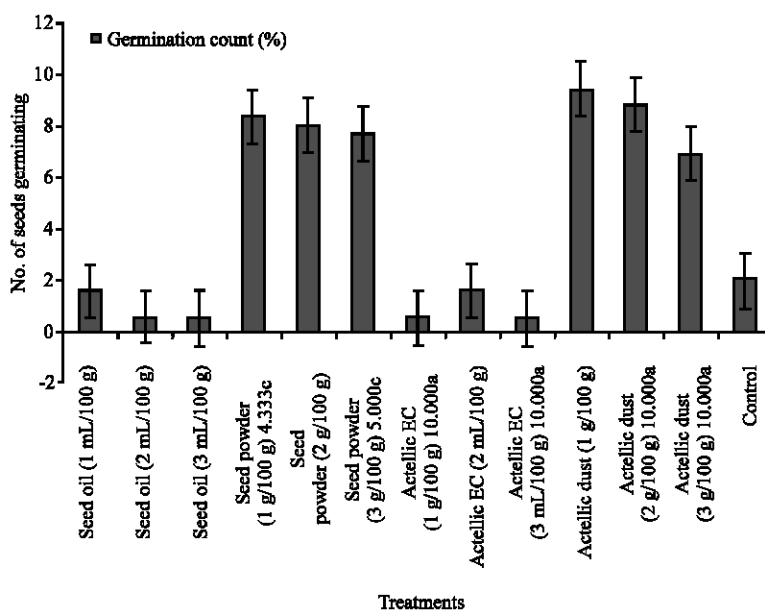


Fig. 3: Effect of *Khaya senegalensis* oil and powder on germination of cowpea grains

DISCUSSION

The evaluation of seed oil and seed powder as compared with Actellic EC and Actellic Dust as the standards, has demonstrated that the seed extracts caused significant mortalities similar to the chemical compound. This result suggest that *Khaya senegalensis* has properties that can be used as fumigants in the control of *C. maculatus* which supports Shaaya *et al.* (1997). The treatments of seed oils and seed powder did not differ in mortality effects with the standard fumigants suggest that the

seed extract possess properties similar to the chemical fumigants and therefore can be exploited for use on commercial and local levels. This plant is found in this part of the country where cowpea is grown in commercial quantity and therefore, its sustainable exploitation would enhance cowpea production and by reducing losses due to proper storage. Shaaya *et al.* (1997) have reported on the absorption of plant oils by the treated commodity and further suggested that higher concentrations and longer exposure periods were needed to achieve appreciative levels of mortality, which concurred with the results obtained in this study in which significant mortalities for 3 days at as low as 1 mL/100 g cowpea. In addition, the plant seed oil and seed powder showed ovicidal properties that suppressed the emergence of *C. maculatus*. The suppression of emergence due to egg mortality might have been caused physically by oil coating, blocking respiration, thus inhibiting immature stages survival and development of *C. maculatus* to their inability to firmly attach to the seed surface; suggesting that the seed oil treatments successfully inhibit larval penetration into the seed. Don-Pedro (1989) and Copping and Menn (2000) have reported that application of oils occluded seed funnels leading to the death of the developing insect by asphyxia,

Conclusively this study has revealed that treating cowpea with seed oil and seed powder extracts prevented the eggs from hatching, larval and pupal development cycle of *C. maculatus* infestation of cowpea. The sustainable use of the seed extracts may have impact in cowpea production in this part of the country.

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