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EVALUATION OF THE POTENTIAL OF *MORINGA* SEED OIL (*Moringa oleifera* LAM) TO CONTROL GROUNDNUT BRUCHID (*Caryedon serratus* OLIVIER) (Coleoptera: Bruchidae) IN YOLA, NIGERIA

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ABSTRACT

Laboratory study was carried out to evaluate the potency of moringa seed oil (MSO) to control the groundnut bruchid (*Caryedon serratus*). The bioassays were conducted at the rates of 0.5, 1.0, 1.5ml/100g and an untreated control laid out in Completely Randomized Design (CRD) in three replications. The ability of the MSO to protect both unshelled and shelled groundnut as assessed for mortality after1, 7 and 14 DAI. Eggs laid, adult emergence, progeny development and weight loss of unshelled and shelled groundnut was also determined. The result indicates that MSO at rate of 1.5ml showed significantly higher ($P<0.05$) mean mortality of 4.67 and 4.00 (80% and 60%) on unshelled and shelled groundnut, respectively at 1 day after treatment (DAT) compared to control. Mortality increases with increase in amount of MSO. Eggs laid and adult emergence were significantly different ($P<0.05$) among the treatments, with the highest egg laid and adult emergence in the control treatment of 360, 180 and 400, 225 in unshelled and shelled groundnut, respectively. However, these indicate that with increase in the amount of MSO, number of eggs and adult emergence reduces in both unshelled and shelled groundnut. Highest percent weight loss was recorded in the control with 54.67 and 64.63% for unshelled and shelled groundnut, respectively. Generally, different rates of treatments significantly protected both unshelled and shelled groundnut against *C. serratus* though, the effect increases with increase in the amount of MSO. It therefore suggests that MSO can be used as a good alternative to pesticides for the control of *C. serratus* in both unshelled and shelled groundnut.

Keywords: Moringa seed oil; *Moringa oleifera*; *Caryedon serratus*; Groundnut Bruchid

INTRODUCTION

Groundnut (*Arachis hypogaea* Linn.) originated from South America (Brazil) and was introduced into Nigeria by the Portuguese after the 16th century and its production spread to the Northern part of the country where it has become an important cash crop used as a foreign exchange earner prior to the petroleum boom in Nigeria (Oaya, 2012). Its production in Africa has been estimated at 4.6 million tons, with Senegal, Nigeria, Gambia, Democratic Republic of Congo (DRC) and Sudan being the major producers in Africa (Ashley, 1993; Oaya, 2012). Nyilra, (1988) reported that Nigerian's production of unshelled nut is about 2.6 million tons annually from a land area of approximately 2.5 million hectares. Groundnut is a good source of protein, fats and oil, vitamins and some essential amino acids (Aribisala, 1993). Shelled groundnuts are fried, roasted and salted, which is eaten as snacks and also serves as raw materials for some food industries and also as feed concentrates for livestock (David and Adamu, 1988).

Groundnut is vulnerable to insect pests attack in store, though the extent of damage caused by these insects varies from one agro-ecological zone to the other and also depends largely on damaged grains before being placed in store (Oaya, 2012). The groundnut bruchid (*Caryedon serratus*) also known as groundnut borer and groundnut seed beetle is synonymous with *Bruchus serratus* Oliver, *Bruchus gonagra* Fabricius (Wightman *et al*., 1990). In northern Nigeria alone, yield loss of groundnut due to *C. serratus* infestation is estimated at 150,000 - 250,000 tons annually, that is about 35% loss resulting to the lost of several millions of naira to the country (IITA, 2001). Infestation by this pest causes loss in dry mass of the kernel, increase levels of free fatty acid in the oil, thereby lowering the quantity and quality, respectively and if heavily damaged, germination potential is reduced (ICRISAT, 1987).

The destructive activities of insects and other storage pests have been adequately subdued by chemical control methods. These chemicals have been reported to be effective against stored products pests (Ogunwolu and Idowu, 1994; Adedire *et al*., 2011). Notwithstanding, the problems of these synthetic insecticides which include high persistence, poor knowledge of application, increasing costs of application, pest resurgence, genetic resistance by the insect and lethal effects on non-target organisms in addition to direct toxicity to users (Okonkwo and Okoye, 1996; Akinkurolere *et al*., 2006; Oni and Ileke, 2008) necessitated the idea of developing effective, cheap and easily biodegradable alternative products (Schmutterer, 1990). This led to the investigation and production of alternative pesticides which are cheap, readily available and are devoid of bio-accumulation in the system of animals. The use of biological materials especially, plant materials are highly favoured, since the materials can easily be applied without any technical knowledge.Though, the effectiveness of botanical pesticides have been demonstrated in many studies (Aslan, *et al*., 2005; Cetin and Yanikoglu, 2006; Negahban *et al*., 2007; Ayvaz *et al*., 2009; 2010; War *et al*., 2014).Therefore, botanicals used for grains preservation have been found to be with better insecticidal properties, low mammalian toxicity, safe to natural enemies and safe for human consumption.

M. oleifera also called the miracle tree is an abundant invasive plant found throughout Nigeria and many other African countries which have generated a lot of interest among scientists in African countries for its medicinal and other uses (Ozumba, 2005). Its potential as bio-pesticide has been evaluated by many researchers.Moringa seed oil and extract at 1.5 and 2.0 ml/20 g cowpea seeds, respectively resulted in significantly higher mortality, reduced damage and was effective in controlling many stored product insects (Adenekan *et al*., 2013; Ilesanmi and Gungula, 2013). However, information on the use of MSO for the control of *C. serratus* is scarce. Therefore, this study was carried out to evaluate the effect of MSO for the control of *C. serratus* on both unshelled and shelled groundnut and to determine the effect of different concentration levels.

MATERIALS AND METHODS

Study Area and Experimental Materials

The study was conducted in the Department of Crop Protection, Modibbo Adama University of Technology, Yola, Adamawa State. The shelled and unshelled groundnut were obtained locally from farmers in Girei village and then sorted out to remove damaged and infested ones and the clean uninfested ones, which were exposed to sunshine for two (2) hours to reduce moisture and remove harbored insects. *M. oleifera* seeds were collected from a local moringa farm in Girei village, Adamawa state. The dry mature fruits were dehulled and the seeds cracked using hand and the kernels milled using a hammer mill and the resultant powder was used for oil extraction. Moringa oil was extracted manually by kneading the moringa paste with hands with occasional addition of cool water until oil started coming out (Ilesanmi, 2009). The oil extracted was then filtered to remove impurities and then kept in a glass bottle until required. Parent weevils for the experiment were obtained from an infested groundnut seeds at Jimeta grain market.

Culturing of *Caryedon serratus*

The test bruchid (*C. serratus*) that was used to establish a laboratory colony was collected from infested groundnut seeds (*Arachis hypogea*) that were purchased. It was then brought to the laboratory and cultured on a groundnut variety at ambient room temperature and relative humidity of 35^{o}C and 55%, respectively. The stock culture of *C. serratus* was raised by placing about 50 unsexed adults into 500ml plastic container containing 500g of disinfected groundnut seeds. The jars were then covered with fine wire mesh held in place with rubber band to prevent contamination and escape of insects. The insects were allowed to mate for seven days and oviposit eggs after which they were removed. The groundnut seeds containing eggs were left undisturbed until the new adults emerged. F_1 progeny 0 - 2 days old from the culture was then used for the experiment.

Bioassay

The MSO was tested for toxicity against *C. serratus.* The treatments were applied at the rate of 0.5, 1.0 and 1.5ml/100g. The oil was thoroughly admixed manually and shaken for approximately 5 minutes to achieve equal and uniform distribution in the entire groundnut lot. Following this procedure, the admixture at different concentrations was obtained and each placed in a plastic bottle, 10 unsexed adults (0 – 2 weeks) of *C. serratus* from culture were placed into each bottle containing the treated grains and a control treatment. Each treatment including control was laid in a completely randomized design (CRD) with three replications. Data on mortality were taken at 1,7 and 14 DAI. Readings were taken on egg laid and adult emergence. Weight loss was taken at 120 days post experimental period (Ofuya and Lale, 2001).

Data Collection

Mean number of eggs laid: This was done by carefully removing the grains and taking the counts of the number of eggs laid on sampled grains for each replicate after 7 days of mating and oviposition with the aid of hand lens. The grains were then carefully placed back into the experimental jars.

Percentage insect mortality: Adult mortality was counted and recorded after 1, 7 and 14 DAI. Adults were considered dead when probed with sharp objects and made no movement.

Percentage adult emergence: Data on F_1 adult emergence were assessed; emerged adults from each replicate were removed and counted with an aspirator. The percentage adult emergence was then calculated as described by Odeyemi and Daramola (2000).

$$\% \, Progeny \; Development = \frac{No \; of \; adults \; emerged}{No \; of \; eggs \; laid} \; X \, 100$$

Percentage (%) weight loss: The percentage weight loss of groundnut was calculated using the formular of Zettler *et al*. (1997).

$$\% \, weight \; loss = \frac{initial \; weight - final \; weight}{initial \; weight} \; X \, 100$$

Data Analysis

Data obtained were subjected to Analysis of Variance (ANOVA) appropriate to completely randomized design and means were separated using Student-Newman –Keuls test (SNK) at P< 0.05 level of probability.

RESULTS

Effect of MSO on Mortality of *Caryedon serratus* on Unshelled and Shelled Groundnut

Evaluation of the effect of *Moringa* oil on groundnut bruchid *C. serratus* on unshelled and shelled groundnut is presented in Table 1.Unshelled groundnut treated with 1.5 ml of moringa seed oil gave significantly highest mean mortality (4.67) followed by shelled groundnut (4.00) within 1 DAT. It was observed that after 7 days of treatment unshelled groundnut treated with 1.0 ml of MSO gave the highest mean mortality (3.33). At 14 DAI unshelled groundnut gave the highest mortality (2.33) when treated with 1.0 ml MSO. The least mean mortality of *C. serrratus* was recorded in the control treatment on both unshelled groundnut. Similarly both unshelled and shelled groundnut in control gave the least mean mortality of *C. Serratus* within 7 and 14 DAI (Table 1).

Table 1: Mean mortality of *C. serratus* in groundnut

	Exposure period (days)		
Dose (ml)	1	7	14
Unshelled			
Control	0.00[d]	0.00[f]	1.00[d]
0.5	0.00[d]	3.00[b]	2.00[b]
1.0	1.67[c]	3.33[a]	2.33[a]
1.5	4.67[a]	2.33[c]	1.33[c]
Shelled			
Control	0.00[d]	0.00[f]	1.00[d]
0.5	0.00[d]	2.00[d]	0.00[e]
1.0	0.33[d]	2.33[c]	1.33[c]
1.5	4.00[b]	1.00[e]	1.00[d]
SE	0.69	0.45	0.25
CV (%)	29.93	28.73	29.33

Means followed by the same letter(s) in the same column are not significantly different (P <0.05)
SE = standard error; CV = coefficient of variability.

Mean Egg laid, Percentage Adult Mortality and Adult Emergence of *C. serratus* on Unshelled and Shelled Groundnut

The result of the study indicates that mean egg laid of *C. serratus* was lowest on unshelled groundnut treated with 1.5ml of MSO (82.00) followed by shelled groundnut treated with an equal amount of MSO (120.00). Significantly highest mean egg laid was recorded in the control treatments on both shelled and unshelled groundnut (Table 2). Shelled groundnut had the highest mean eggs laid as compared to unshelled groundnut of 400.00 and 360.00, respectively.

The highest percent mortality was recorded in unshelled groundnut treated with 1.5ml of MSO (80%) followed by treatment with 1.0ml MSO giving a percentage mortality of 70.33%. Shelled groundnut treated with 1.5ml MSO recorded significantly highest mortality of 60% as compared to treatment with 1.0 and 0.5 ml of 40 and 20%, respectively. The least percent mortality was recorded in the control for unshelled groundnut (10.33%), while in shelled no mortality was recorded.

Table 2 shows that mean adult emergence significantly differ from all treatment (p<0.05). The highest adult emergence was observed in the control treatment of both unshelled and shelled groundnut of 180 and 225, respectively. Mean adult emergence decreases as the amount of treatment increases.

Table 2 shows significant difference in percentage adult emergence. The highest adult emergence was observed in the control treatment of shelled groundnut (75%), while the least emergence was recorded in unshelled groundnut treated with 1.5 ml MSO. However, percent adult emergence decreases as the amount of treatment increases; viz; 0.5, 1.0 and 1.5 ml of 63.7, 55.37 and 18.0; 65.0, 57.67 and 22.1 of unshelled and shelled groundnut, respectively.

Table 2: Mean egg laid, mortality and percentage adult emergence of *C. serratus* treated with *Moringa* Oil

Dose (ml)	Mean Egg Laid	% Adult Mortality	% Adult Emergence
Unshelled			
Control	360.00[b]	10.33[g]	60.00[bc]
0.5	200.00[d]	50.00[d]	63.70[b]
1.0	143.00[e]	70.33[b]	55.37[d]
1.5	82.00[g]	80.00[a]	18.00[f]
Shelled			
Control	400.00[a]	00.00[h]	75.00[a]
0.5	240.00[c]	20.00[f]	65.00[b]
1.0	150.00[e]	40.00[e]	57.67[cd]
1.5	120.00[f]	60.00[c]	22.10[e]
SE	40.56	0.50	26.95
CV (%)	7.25	10.20	4.32

Means followed by the same letter(s) in the same column are not significantly different at P $\leq$0.05 using the Students Newman-Keuls
SE = standard error, CV= coefficient of variability.

Percent Weight Loss of Unshelled and Shelled Groundnut Treated with MSO

Result of weight loss of unshelled and shelled groundnut is presented in Figure 1. The result showed that mean percentage weight loss was highest on control treatments of 61.34 and 69.67% on unshelled and shelled groundnut, respectively. The difference in weight loss in the control treatments might be due to the presence of shelled in the unshelled groundnut which make it difficult or less susceptible to damage by *C. cerratus* than the unshelled groundnut. This also revealed that lowest weight loss of both unshelled and shelled groundnut were in descending order of 16.26, 12.18, 10.23% and 11.23,10.68, 8.42 at treatment rate of 0.5, 1.0 and 1.5 ml, respectively.

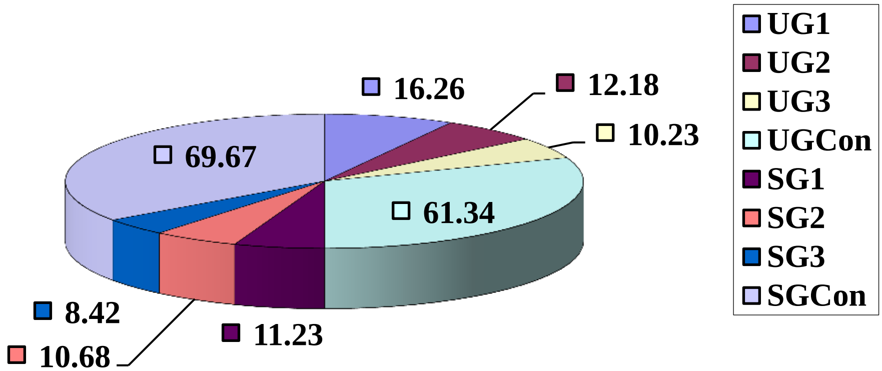

Figure 1: Percentage weight loss of unshelled and shelled groundnut caused by *C. serratus*

KEY:

UG - Unshelled Groundnut	SG – Shelled Groundnut
UG1- 0.5 ml	SG1 – 0.5 ml
UG2 – 1.0 ml	SG2 – 1.0 ml
UG3 – 1.5 ml	SG3 – 1.5 ml
UGCon–0.0ml (Control)	SGCon–0.0ml (Control)

DISCUSSION

The problems associated with storage of crops like groundnut and other legumes are not strange in Nigeria and Africa at large. It is evident that, the storage of these crops without the use of synthetic chemicals is usually not a success, however the toxic and negative effects of those chemicals to man, his livestock and residual damage done to the entire environment is of great concern (Zettler *et al.*, 1997). Therefore the need for identifying a safer, relatively non-toxic stored produce protectant has been necessary because groundnut in store in usually affected by insect pests, one of which is the groundnut bruchid *C. Serratus* which causes tremendous damage to stored groundnut.

MSO causes mortality of *C. serratus* in all the treatments, this could probably mean that MSO has toxic effect on this pest. This is in agreement with the findings of Oaya *et al.* (2012) who recorded the highest percentage mortality on unshelled groundnut of 46.27% and Illesanmi, (2009) recorded 90% mortality of cowpea bruchid treated with MSO. Thus indicating that apart from the other properties of moringa, it contains certain materials toxic to insect pests.

The effect of MSO showed that egg laid was highest on the control treatment, this is obvious because no bio-agent (plant extract) was introduced into the control treatment and therefore the insects reproduce under a conducive atmosphere without hindrance. Mean egg laid was lowest on unshelled groundnut mixed with MSO which conforms to Adenekan *et al*. (2013) that leaf, stem, root and flower of *Moringa oleifera* plant significantly reduced egg laying of bruchid on cowpea seeds. The reduction in egg laying ability on unshelled groundnut by the bruchid could also be probably due to the roughness and thickness of the outer covering (shell) of the groundnut.

Percentage adult emergence was least on unshelled groundnut treated with MSO. Though, there was highly significant difference between treatments at all levels, this agrees with Race *et al*. (2012) who reported that moringa root powder (MRP) significantly reduced adult emergence of cowpea bruchid on cowpea seeds while, MSO recorded the least adult emergence compare to MRP.

However, this study revealed that unshelled groundnut mixed with MSO recorded lowest weight loss. This agrees with the findings of Ilesanmi and Gungula, (2013) who reported that MSO to a great extent protected cowpea seeds from damage by *Callosobruchus maculatus*. Oaya *et al.* (2012) reported that there was significant difference between the effect of the bruchid on unshelled and shelled groundnut in store. Shelled groundnut is more susceptible to the bruchid attack, this could probably be due to the ease with which the bruchid penetrates the kernel since it has no outer covering (shell) and this agrees with the findings of Dick, (1987) that storing shelled groundnut soon after harvest increases their susceptibility to attack by number of pests. Therefore, storing shelled groundnuts makes it highly susceptible to attack by *C. serratus* in store. This means that this bruchid has the potential of destroying this stored product making it unfit for consumption. This is in agreement with Appert, (1987), who reported that infestation by *C. serratus* results in damp grain heating, reduction in glucose which reduces both quality and quantity of groundnut. Though, there is still hope with MSO showing some promise for the control of this bruchid.

CONCLUSION

The findings of the study revealed that bruchid *C. serratus* has the potential to cause damage to stored groundnut to an unacceptable state. On the other hand MSO showed insecticidal properties that exhibited good control properties against this pest. The study clearly showed that both unshelled and shelled groundnut was highly susceptible to attack by the bruchid this was seen on percentage weight loss in the control treatments. Nevertheless, it was found that stored groundnut mixed with MSO drastically reduced damage cause by *C. serratus* and also revealed that the use of MSO for the control of this bruchid is profitable and beneficial since the plant material used is harmless, cheap, effective and easily obtained and extracted with no special skills required. Finally, its use may be the way out as a shift from the use of synthetic pesticides.

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