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# Bioefficacy of Some Botanicals Against Gum Arabic Borer, *Bruchus baudni* Caill (Coleoptera: Bruchidae) on Stored *Senegalia senegal* Seeds

**B. S. Wudil,[1] Lucy, E.,[2] A. U. Yusuf,[1] H. Sule,[1] M. Abubakar[2]** and **Fakuta N. M.[2]**
[1]*Department of Crop Protection, Faculty of Agriculture, Bayero University, PMB 3011, BUK Kano*
[2]*Rubber Research Institute, Gum Arabic Sub-Station, Gashua, Yobe State, Nigeria*

## Abstract

The use of bio-pesticides has proven to be successful approach in controlling agricultural insect pests. Study was conducted in the Laboratory of the Department of Crop Protection, Faculty of Agriculture, Bayero University, Kano to study the Biology of *Bruchus baudni* on treated *Senegalia senegal* seeds. Seed oils and leaf powders of *K. senegalensis* and *M. oleifera* at three concentrations each, a chemical insecticide (Aluminum phosphide as standard check) and a control were laid out in a Completely Randomized Design (CRD) and replicated three times. Data collected were oviposition, egg hatchability and developmental stages. The results indicated significant reduction in the number of eggs laid (1% and 1.38%) and hatchability (0.00% and 0.57%) on both seed oil and leaf powder treatments, respectively; however, the control recorded the highest eggs laid (99.9%) and number of emerged *B. baudni* (99.2%). The present findings showed that seeds and leaves of mahogany and moringa were effective as protectant against some of the development stages of *B. baudni*. Therefore, based on the present results, mahogany and moringa seeds and leaves could be explored to replace the synthetic insecticides in the management of *B. baudni* especially as components of integrated pest management strategy.

**Keywords:** Efficacy, *Khaya senegalensis*, *Moringa oliefera*, Biology of *Bruchus baudni* and *Senegalia senegal* seeds.

## INTRODUCTION

Gum Arabic, *Senegalia senegal* (L) Britton, is a small, thorny, drought resistant, deciduous tree, native to North Africa (FDA, 2002). It is grown mainly for its gum production in arid and semi- arid zones of the African continent, notably Sudan, Chad and Nigeria (FDA, 2002). Apart from its gummy exudate, the seed and pods are used as fodder for goats, sheep and in Indian desert the seeds of the plant are consumed by local inhabitants in the form of a vegetable constituent known as "Puncttikutta" (Abdullahi, 2004; Nisha *et al*, 2008). The processed seeds of this plant are reported to have 37.2% protein, the highest among the

*Correspondence email:
bswudil.cpp@buk.edu.ng

seeds of 12 species of Acacia which is of medicinal value (Benerji *et al*., 1988).

*Bruchus baudni* (Coleoptera: Bruchidae) and the resulting damage could be as high as 100% (*Lucy et al*, 2016; Sibakwe Donga, 2015). *Bruchus baudni* attacks *S. senegal* seeds in almost all countries of North Africa (Appleby and Credland, 2001). In West Africa and specifically Northern Nigeria, 100% infestation occurs within 3-5 months of storage in traditional system (Parugrug and Roxas, 2008). The adults lay their eggs on the pod or seed surface, the larva burrows into the seed. During development the larva feeds on the endosperm before emerging subsequently as an adult (Haines 1991; Appleby and Credland, 2001). The egg to adult development of *B. baudni* lasts 45 to 56 days, depending on the temperature and relative humidity (Lale, 2002). *Bruchus baudni* causes significant qualitative and quantitative losses in stored seeds which ranged from 30-50% in Nigeria and Ghana (Haines, 1991; Golob *et al*., 1999).

Synthetic insecticides are often used for protecting stored *S. senegal* seeds. However, due to higher risk involved to the user, development of resistant pest strains, toxicity to non- target organisms and toxic residues left in the protected seeds (Obeng- Ofori and Dankwah, 2002; Oparaeke and Bunmi, 2006); desirable safe, cost effective and eco-friendly alternative are being sought. The promising botanical alternatives, such as mahogany and moringa (Korunic, 1998: Kabir *et al* 2011, 2013; Subramanyam and Roesli, 2000; Athanassiou, 2006) have however not been tested against the gum Arabic seed storage borer, *Bruchus baudni*. This study therefore evaluated the efficacy of moringa and mahogany seed oils and leaf powders against *B. baudni* on stored *S. senegal*.

## MATERIALS AND METHODS

The experiment was conducted in the Entomology laboratory of the Department of Crop Protection, Faculty of Agriculture, Bayero University, Kano ($11^0$ 58′ N, $8^0$ 25′ E). The treatments consisted of two forms of biopesticides obtained from *K. senegalensis* and *M. oleifera* at three dosage levels, a synthetic insecticide (Aluminum phosphide) as (standard check) and control (untreated) (Parugrug and Roxas, 2008; Musa, 2013). These were combined and laid out in a completely randomized design (CRD) and each replicated three times.

### Insect Preparations and Culture

The initial cultures of *B. baudni* were obtained from the established culture on *S. senegal* seeds at the Rubber Research Institute of Nigeria (RRIN), Gashua, Yobe State. This was reared in the laboratory at ambient temperature and relative humidity and test insects were sourced from the resulting laboratory culture.

### Preparation, Treatment and Maintenance of *S. senegal S*eeds

*S. senegal* seeds were obtained from matured pods of the Gum Arabic plantation of the Rubber Research Institute of Nigeria (RRIN), Gashua, Yobe state. The pods were harvested by shaking the tree branches, collected, seeds extracted by hand peeling and cleaned. *S*eeds with holes or egg debris on its testa were considered infested and removed. The clean seeds were packaged in a plastic containers and put in a freezer at temperature below $0^oC$ for 5 days in order to kill and prevent pest infestation and development. The seeds were subsequently removed from the freezer and allowed to equilibrate under screen cover on the laboratory bench for a period of three days

and then kept until needed as adopted by Ileke *et al*. (2013).

## PREPARATION OF BIO-PESTICIDES

### Seed Oil

Matured fruits of *K. senegalensis* and *M. oleifera* were collected by striking the pods gently with a stick on tarpaulin sheets spread under the tree, after dropping separately. Each one of the seeds for both moringa and mahogany were removed, dried under shade, weighed, grounded with a mortar and pestle and soaked in warm water separately (10ml/kg of seed powder), to form a paste. The paste was subsequently hand- kneaded for oil extraction following the method of Stoll (1988). The two oil type extracts (from *K. senegalensis* and *M. oleifera*) were filtered with a sieve individually (mesh size 5x 0.5m) to remove particles and transferred into respective plastic bottles labelled and stored temporarily in the laboratory before use.

### Leaf Powder

The leaves of *K. senegalensis* and *M. oleifera* were collected from the orchards of Audu Bako College of Agriculture, Danbatta, Kano State and Bayero University Kano Orchard, respectively. These were shade-dried individually to a crispy condition (Yusuf and Ahmed, 2005) and thoroughly pounded in mortar with pestle. The pounded plant parts were passed through 40µm sieve to give fine powder that were kept in plastic containers and labelled separately for future use.

## LABORATORY BIOASSAY

Each treatment line comprised 100g of clean and uninfested *S. senegal* seeds, were mixed with 2, 4 and 6g/100g of seeds leaf powder of each of the mahogany and moringa and 0.5, 0.75 1ml/100g of the oils respectively. The content of each container was thoroughly mixed. Thereafter, five (5) pairs of newly emerged adults of *S. senegal* seed borer were introduced, held in the container with muslin cloth tightly secured by rubber band and monitored for fecundity, egg hatchability and progeny emergence at a room temperature as described below:

### Fecundity of *B. baudni*

The adult insects were allowed to mate and oviposit for 10 days, after which seeds were examined individually (Arong *et al*., 2011), number of seeds with eggs and number of eggs deposited on the seeds were counted with the aid of hand lens and recorded in each of the treatment and replicates.

### Egg Hatchability and Progeny Development of *B. baudni*

At 10 days after oviposition, 30 seeds with eggs were randomly selected and the total number of eggs counted and placed into a plastic container containing the clean and un-infested *S. senegal* seeds. The number of adults that emerged was recorded at 30 days after exposure (Lucy, *et al*., 2016).

Percentage adult emergence was calculated from each of the treatments, using the formula:

$$\% \text{ Adult emergence} = \frac{\text{Number of adults emerged}}{\text{Total number of egg on 30 grains}} \times \frac{100}{1}$$

### Adult, Larval and Pupal Mortality (Residual Toxicity)

Data on residual toxicity was collected by counting the number of dead insects from the $F_2$ progeny produced by the parents that was introduced into the treated seeds. This data was recorded at 60 days after treatment as adopted by Abduljalal *et al* (2011). In a similar set up, was conducted to assess their larvicidal and pupicidal efficacy.

### Larval Mortality

Larval mortality was assessed by opening the seeds with a scalpel and a pair of forceps at the end of adult emergence. The dead larvae inside the seeds were counted and expressed as percentage of the seed examined (Arong *et al*., 2011).

### Pupal Mortality

Similarly, pupal mortality was assessed at the end of adult emergence and dead pupae within the seeds were counted and recorded. (Arong *et al*., 2011).

## DATA ANALYSIS

Data on adult mortality, larval mortality, and pupal mortality were expressed as percentages. These data were first corrected for mortality in the controls using the Abbott's formula (Abbott, 1925). All data in percentages were arc sine transformed while fecundity and egg hatchability were transformed using the square root $(\sqrt{n+1})$ method. These were then subjected to One-way analysis of variance (ANOVA) using Genstat 17th Edition computer Software. Where significant differences existed, treatment means were separated using Student-Newman-Keuls (SNK) test at $\alpha 5\%$.

## RESULTS

### Oviposition of *Bruchus baudn*i as affected by plant seed oils

The results of the oviposition counts are presented in Table 1. Both mahogany and moringa oils exerted statistically significant ($P \leq 0.05$) effects in reducing the number of eggs laid (1.00) by *B. baudn*i at all treatment levels. and these compared well with the synthetic insecticide (Aluminum phosphide). The control checks had significantly ($P \leq 0.05$) higher number of eggs laid than those treated with moringa (7.91-1.00) and mahogany (7.77-7.91) oils.

### Effect of plant seed oils on Progeny Emergence of *B. baudni*

The percentage progeny emergence of *B. baudni* on *S. senegal* seeds at 30 days after exposure is presented in Table 2. Although the moringa oil exerted higher effects on emergence of $F_1$ Progency, the differences were not significant (Table 2). The control checks significantly ($P<0.05$) recorded more eggs hatched than the rest of the treatments. Seed with moringa oil at 0.75ml recorded little higher (1.3) than the rest treatment, followed at 1ml/100g (0.45). However, an increase in mahogany oil dosage significantly ($P<0.05$) lowered the insect emergence. There was a significant variation in $F_1$ emergence with the treatments and more eggs hatched from untreated seeds than the other treatments. No progeny of *B. baudni* emerged in *S. senegal* seeds treated with mahogany oil at 1ml and Aluminum phosphide. The number of emerging progeny reduced significantly with increasing botanical concentrations.

### Effect of plant seed oils on the larval, pupal and adult mortality ($F_2$ generation) of *B. baudni.*

There were significant difference ($P<0.05$) among the oil concentrations of *M. oleifera*, *K. senegalensis* and the synthetic insecticide at all concentrations on the larval, pupal and adult mortality of *B. baudni* compared to the untreated control check (Table 3). All the concentrations of the two botanical oils were statistically similar with the Aluminum Phosphide across all developmental stages of the insect. The untreated control recorded the highest mortality of *B. baudni* throughout the developmental periods.

**Table 1:** Mean number of eggs laid by adult *B. baudni* on *S. senegal* seeds ten days after various treatments

| | Mean Number of Eggs Laid | | | | Concentration (ml/100g) |
|---|---|---|---|---|---|
| **Treatments** | **0.5** | **0.75** | **1.0** | **Al** | **Control** |
| Moringa – Oil | 1.24b | 1.0b | 1.00b | 1.00b | 7.91a |
| SE± | | 0.13 | | | |
| Mahogany – Oil | 1.14b | 1.0b | 1.00b | 1.00b | 7.77a |
| SE± | | 0.24 | | | |

Means followed by same letter(s) within same column are not significantly different (P>0.05) SNK test. Data was transformed using $\sqrt{n+1}$.

**Table 2:** Mean percentage of *B. baudni* eggs hatched on *S. senegal* seeds thirty days after various treatments

| | Mean Number of Eggs Laid | | | | |
|---|---|---|---|---|---|
| **Treatments** | **Concentration (ml/100g)** | | | | |
| | **0.5** | **0.75** | **1.0** | **Al** | **Control** |
| Moringa - Oil | 0.22 (0.71b) | 1.3(6.31b) | 0.45(3.85b) | 0.00(0.00b) | 93.2(74.97a) |
| SE± | | 3.493 | | | |
| Mahogany – Oil | 1.2 (6.20b) | 0.14 (2.18b) | 0.00(0.00b) | 0.00(0.00b) | 99.92(88.40a) |
| SE± | | 1.865 | | | |

Means followed by same letter(s) within same column are not significantly different (P>0.05) SNK test. Data was transformed using $\sqrt{n+1}$.

**Table 3:** Mean larval, pupal and adult ($F_2$ generation) *B. baudni* mortality sixty days after treatment

| **Treatments** | **0.5** | **0.75** | **1.00** | **AL** | **Control** |
|---|---|---|---|---|---|
| **Moringa Seed Oil** | 1.00b | 1.33b | 1.00b | | |
| Adult Mortality | 1.00b | 1.00b | 1.00b | 1.00b | 15.39a |
| SE± | 0.118 | 1.00b | 1.00b | 1.00b | |
| Pupa Mortality | 1.00b | 1.00b | 1.00b | 1.00b | 4.93a |
| SE± | 0.182 | 1.00b | 1.00b | 1.00b | |
| Larva Mortality | 1.00b | 1.00b | 1.00b | 1.00b | 3.10a |
| SE± | 0.064 | | | | |
| **Mahogany Seed Oil** | 1.00b | 1.00b | 1.00b | | |
| Adult Mortality | 1.00b | 1.00b | 1.00b | 1.00b | 16.06a |
| SE± 0.101 | 16.06a | 4.93a | 3.10a | | |
| Pupa Mortality | 1.33b | 1.00b | 1.00b | 1.00b | 4.93a |
| SE± | 0.235 | | | | |
| Larva Mortality | 1.00b | 1.00b | 1.00b | 1.00b | 3.10a |
| SE± 0.085 | 0.101 | 0.235 | 0.085 | | |

Means followed by same letter(s) within same column are not significantly different at P=0.05 according to SNK test. Data was transformed using $\sqrt{n+1}$

**Oviposition of *B. baudn*i as affected by plant leaf powders**

Table 4 shows the effect of plant leaf powders and aluminum phosphide on eggs laid by adult *B. baudni* at 2, 4 and 6g/100g seed concentration. There were significant differences ($P < 0.05$) between treatments in number of eggs laid for both oils. The moringa leaf powder treatment at 6g/100 seeds recorded the lowest eggs laid (1.38) and were statistically similar with the synthetic insecticide (1.00). Similarly, all the mahogany leaf powder concentrations (2g, 4g and 6g/100 seeds) including the synthetic insecticide had significantly ($P<0.05$) similar results in reducing the number of eggs laid by *B. baudni* (Table 4). However, the untreated control had significantly ($P<0.05$) higher number of eggs laid compared to other treatments.

**Effect of plant leaf powders on Progeny Emergence of *B. baudni***

The effects of various treatments and concentrations on egg hatchability of *B. baudni* at 30 days, after oviposition is presented in Table 5. All the concentrations of the moringa leaf powder were significantly ($P\leq0.05$) effective at reducing progency emergence and these compared well with the synthetic pesticide. The control check had the highest number of eggs hatched compared to all other concentrations. However, mahogany leaf powder at 4 and 6g/100g seeds were statistically. Similarly, the concentration at 2g/100g seeds had similar effects compared is with the synthetic insecticide and statistically better than the other treatments.

**Effect of plant leaf powders on the larval and pupal adult mortality of *B. baudni***

Table 6 shows that the pupal, larval and adult mortality ($F_2$ generation) mortality of *B. baudni* as affected by plant seed powders of *Moringa oleifera* and *Khaya senegalensis.* Among the moringa leaf powder (MLP) treatments; 6g/100g seeds (12.11) had the highest mortality, followed by 4g MLP (6.59%) while 2g/100g seeds of MLP (3.96%) recorded the lowest mortality.

Similarly, seeds coated with mahogany leaf powder recorded high $F_2$ mortality compared to Aluminum phosphide. The control recorded the highest $F_2$ mortality and was significantly different from the treated seeds. Pupal mortality was lower in seed coated at 4 percent but not significantly different from rest treated seeds. However, lower larval mortality was achieved on seed coated with MLP at all concentrations and these were not significantly different from aluminum phosphide.

**Table 4:** Effects of some leaf powders and control treatments on Eggs Laid by *B. baudni*

| | Number of Eggs Laid | | | | |
|---|---|---|---|---|---|
| **Treatments** | **2** | **4** | **6** | **Al** | **Control** |
| Moringa Leaf Powder | 2.34b | 2.40b | 1.38b | 1.00c | 4.75a |
| SE± | 0.253 | | | | |
| Mahogany Leaf Powder | 1.48b | 1.58b | 1.82b | 1.00b | 4.92a |
| SE± | 0.430 | | | | |

Means followed by same letter(s) within same column are not significantly different at P=0.05 according to SNK test. Data was transformed using $\sqrt{n+1}$.

**Table 5:** Mean Percentage of *B. baudni* eggs hatched on *S. Senegal* seeds thirty days after exposure to plant leaf powder

| Mean Percentage Progeny Emergence/30 Seeds | | | | | |
|---|---|---|---|---|---|
| Treatments | 2 | 4 | 6 | Al | **Control** |
| **Moringa Leaf Powder** | 2.1 (8.35b) | 3.2(10.37b) | 1.2(6.15b) | 0.00(0.00b) | 93.2(74.97a) |
| SE± | | | 3.132 | | |
| **Mahogany Leaf Powder** | 0.57(4.37bc) | 1.5 (7.20b) | 1.3 (6.34b) | 0.00 (0.00c) | 99.2 (84.89a) |
| SE± | | | 1.506 | | |

Means followed by same letter(s) within same column are not significantly different at P=0.05 according to SNK test. Data was transformed using $\sqrt{n+1}$.

**Table 6:** Mean mortality of larvae, pupa of *B. baudni* ($F_2$ generation) sixty days after treatment with plant leaf powders

| Mean Percentage Progeny Emergence/30 Seeds | | | | | |
|---|---|---|---|---|---|
| Treatments | 2 | 4 | 6 | Al | **Control** |
| **Moringa Leaf Powder** | | | | | |
| Adult Mortality | 3.96d | 6.59c | 12.11b | 1.00e | 15.39a |
| SE± | | | 0.525 | | |
| Pupal Mortality | 1.61b | 5.63a | 2.59b | 1.00b | 4.93a |
| SE± | | | 1.109 | | |
| Larval Mortality | 1.24b | 1.00b | 1.55b | 1.00b | 2.10a |
| SE± | | | 0.209 | | |
| **Mahogany Leaf Powder** | | | | | |
| Adult Mortality | 6.41b | 4.94b | 7.12b | 1.00c | 15.27a |
| SE± | | | 1.043 | | |
| Pupal Mortality | 8.35a | 4.11ab | 2.48b | 1.00b | 5.73ab |
| SE± | | | 1.335 | | |
| Larval Mortality | 1.73bc | 1.00c | 1.62bc | 2.44b | 3.54a |
| SE± | | | 0.292 | | |

Means followed by same letter(s) within same column are not significantly different at P=0.05 according to SNK test. Data was transformed using $\sqrt{n+1}$.

## DISCUSSION

The present study showed that treatments containing botanical products, regardless of their concentrations were better at reducing oviposition and progeny emergence of *B. baudni.* The effectiveness of botanicals used in the present study had earlier been reported by many workers (Stoll 2000; Makut *et al*, 2008). Mahogany wood ash (MWA) had been reported to be toxic to *Sitophilus zeamais* on stored maize. Yusuf (2009), had demonstrated the effectiveness of MWA, mahogany bark powder and citrus peel powder against *C. maculatus* on stored cowpea.

Several researchers have worked on plants and naturally derived pesticides that are non-toxic to humans and other animals ((Makut *et al*, 2008). This serves as useful tool for the development of a safer, effective,

sustainable and environmentally friendly bruchids control tactics. Promising results have been obtained in the study showed that moringa and mahogany against oviposition and egg hatchability of *B. baudni*.

The current findings indicated that the application of oils of moringa and mahogany on *S. senegal* seeds reduced eggs laid by adult *B. baudni*. The reduction in number of eggs laid which could be due to the pungent smell present in the oil, may have deterred the insect from laying eggs (Paul and Didia, 2012). Consequently, this may have been responsible for the inability of most of the adult insects to emerge as the application of oils were found to disrupt growth and reduced larval survival as well as disruption of life cycle of the pest. Similarly, Arannilewa *et al.* (2006) reported that the application of oil extract covered the outer layer (testa) of the seeds, which served as food poison to the adult insects; while some of the oil applied penetrated into the endosperm and germ layer thereby suppressing oviposition and larval develop-ment (Arannilewa *et al.*, 2006).

The fact that botanical oils reduced oviposition as demonstrated in this study revealed the superiority of plant oils. Tripath, *et al* (2007) have reported that maximum decrease in oviposition by *Callosobruchus chinensis* was recorded in seeds treated with Karany and mustard oils. Treatment with 0.5ml proved to be the least effective, more so both the oils were superior and able to check oviposition and adult emergence. These results confirmed those observed in earlier studies (Ivbijaro, 1983a; Lale and Abdulrahman, 1999; Lale and Mustapha, 2000). Similarly, other findings reported that neem oil treatment reduces oviposition, inhibits adult emergence and development of *C. maculatus, C. chinensis* and *C. analis* (Babu *et al*., 1989).

The effectiveness of these oils on fecundity of *B. baudni* is in agreement with several researchers (Kayode and Olaniyi, 2014; Ileke and Oni, 2011). The treatment with seed oil effectively suppressed progeny emergence for two generations. Although, number of eggs laid on *S. senegal* seeds with moringa seeds oil and mahogany seed oil was quite low as compared to the control. Yet the progeny raised from these eggs were negligible, indicating that these treatments were very effective. The marked differences observed on the emergence of adult *B. baudni* reared on treated and untreated *S. senegal* seeds indicated that oil extract from Moringa and mahogany seeds had marked effects on the developmental stages, which in turn affected emergence. All concentrations of oils extract reduced the emergence of progenies. In contrast, Aluminum phosphide considerably reduced the number of adult emergences; this could be due to the ability of the synthetic pesticide, Aluminum phosphide to impede the functioning of central nervous system thereby disrupting the growth and reduced larval survival. The effectiveness of these oils on fecundity of *B. baudni* is in agree-ment with several researchers (Kayode and Olaniyi, 2014; Ileke and Oni, 2011).

The present study revealed that the oviposition by *B. baudni* has been reduced when exposed to *S. senegal* seed treated with plant botanical powders. This indicated that most of the flora in the savanna composed of plant species that have insecticidal properties and this corroborates the work reported by Yusuf (2009). The moringa and mahogany leaf powders had affected and reduced number of hatchability of the *B. baudni.* The effectiveness of the plant leaf powder in reducing emergence of *B. baudni* especially when the crop is stored for a long period has direct relationship with number of progenies emerged and quantity of the plant leaf

powder applied. The inability of 2g and 4g moringa leaf powder to suppressed emergence could probably be due to low concentration of the leaf powder, in addition it could be due to atmospheric loss of plant's strong odour that might have conferred on them the slight effectiveness they had at the outset of the experiment (Athanassiou, 2006). Yusuf and Ahmed (2005) reported that neem and moringa powders applied at the rate of 8g/100g of grain reduced infestation at 42 and 63 DAT. This further supports the findings of Udo and Epidi, (2009) that plant extracts and powders were effective in reducing the population of $F_1$ generation of *C. maculatus* in treated grains. The *B. baudni* was observed to produce lower number of $F_1$ progeny probably because eggs of *C. maculatus* were laid on the seed coat thus exposing them to direct contact with toxic secondary plant metabolites.

It is evident from this study that despite reduced progeny production caused by these treatments, 100% suppression of progeny emergence was not achieved. This may be attributed to the ability of female's borers to lay their eggs within the seeds and thus the larvae may not be affected until reaching the adult stage. This agrees with the findings of Athanassiou, (2006), who reported that *Sitophilus oryzae* progenies emerged in stored wheat treated with beta cyfluthrin applied in combination with diatomaceous earth where 100% mortality of exposed adults were recorded. Adenekan *et al.* (2013) reported that *Moringa oleifera* powders from leaves, stem bark, roots and flowers had insecticidal effects on oviposition, eclosion and development of *C. maculatus* on cowpea seeds with flower powders having significantly higher effects compared with other plant parts. *Moringa oleifera* root powders caused reduction in seed damage on cowpea infested with *C. maculatus* (Ojiako *et al.*, 2013).

The present investigations also agreed with the report of Wongo, (1998) who stated that it would also appear that progeny inhibition of *C. maculatus* in treated grains could arise from the inability of young adult insects to chew through the seed coats of treated grains due to the presence of phenolic compounds. The significant reduction in $F_1$ progeny confirms the possible presence of ovicidal and larvicidal constituents in the plant extracts and powders (Tanzubil, 1991). Ovicidal action of some plants was also observed by Derkyi, *et al*., (2010) and they also reported a significant reduction in egg laying of *C. maculatus* on cowpeas mixed with neem seeds. The results of the study collaborated with these reports.

## CONCLUSION

Mahogany and Moringa seed oils performed better than the leaf powders irrespective of their concentrations and compared well with the chemical insecticide (Aluminum phosphide). However, among the leaf powder concentrations, better protection of the *S. senegal* seeds was achieved with Moringa and Mahogany at 6g/100g seed dosage rate. An appreciable level of protection was achieved using the different plant parts in the management of *B. baudni* on *S. senegal* seeds. Significant reduction in oviposition, inhibition of progeny emergence was achieved by using both the Moringa and Mahogany seeds oils and leaf powders in protecting the *S. senegal* seeds. Based on the present results, it can be recommended that the use of mahogany and moringa seed oils at 0.5ml/100g seeds and leaf powders at 6g/100g seeds could be employed for the management of *B. baudni* on stored *S. senegal* seeds by the resource poor farmers in the study area.

## REFERENCES

**Abbolt W.S. (1925).** A Method of Computing the Effectiveness of an Insecticide. *Journal of Economic Entomology*, 18: 265-267.

**Abdulkareem, R.C. Sexena, M.E.M. Boncodin, V. Krishnasamy, and D.V. Seshu (1989).** Neem as Seed Treatment for Rice Before Sowing: Effects on Two Homopterous Insects and Seedling Vigor. *Journal Economy Entomology*, 82: 1219-1223.

**Abdullahi, A. (2004).** Report on Survey of Selected Agricultural Raw Materials in Nigeria. Document Prepared for the Nigerian Raw Materials Research and Development Council (RMRDC), Abuja Nigeria.

**Adenekan M. O, Okpeze V. E, Ogundipe W. F, Oguntade M. I, (2013).** Evaluation of *Moringa oleifera* Powders for the Control of Bruchid Beetles during Storage. *International Journal Agriculture Policy Research*. 1(10): 305-310.

**Akinneye, J.O. and Ogungbite, O.C. (2013).** Insecticidal activities of some medicinal plants against *Sitophilus zeamais* (Motschulsky) (Coleoptera: Curculionidae) on stored maize. *Archives of Phytopathology and Plant Protection.* 46(10): 1206-1213.

**Ajayi, F.A. and Lale, N.E.S (2001).** Seed Coat Texture, Host Species and Time of Application Affect the Efficacy of Essential Oils Applied for the Control of *Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae) in Stored Pulses. *International Journal Pest Management*. 47 (3): 161-166

**Appleby, J.H. and Credland, P.F. (2001).** Botanical and Polymorphism in *Callosobruchus subinnotatus* (Coleoptera: Bruchidae). *Bulletin of Entomological Research*, 91: 235-244.

**Aqil F, Ahmad I, Mehmood Z. (2006).** Antioxidant and free radical scavenging properties of twelve traditionally used Indian medicinal plants. *Turkey Journal of Biology*, 30: 177-183.

**Arannilewa, S.T., Ekrakene, T. and Akinneye, O. (2006).** Laboratory Evaluation of Four Medicinal Plants as Protectants against the Maize Weevil, *Sitophillus zeamais* (Mots). *Africa Journal of Biotechnology* 5(21): 2032-2036.

**Arong, G.A., Imandeh, G.N., Utsu, A.A. and Shaa, K.K. (2011).** The Influence of Food Type on Larval Growth in *Musca domestica* and *Lucilia sericata* (Diptera) in Calabar, Nigeria. *World Journal of Science and Technol.*, 1: 73-77.

**Athanassiou, C. G., Kavallierators, N. G., and Tomanovic, Z. (2006).** Factors Affecting the Insecticidal Efficacy of the Diatomaceous Earth Formulation Silicosec against Adults of the Rice weevil, Sitrophilus oryzae (L.) (Coloeptera: Curculionidae). *Applied Entomology and Zoology*. 41: 201- 207.

**Babu T R, Reddy V S and Hussaini S H. (1989).** Effect of Edible and Non-Edible Oils on the Development of Pulse Beetle (*Callosobruchus chinensis* L.) and on Viability and Yield of Mungbean (*Vigna radiata* (L.) Wilzek). *Tropical Science*, 29(3): 215-220.

**Benerji, R. Chowdury, A.R; Misra, G. and Nigam, S.K. (1988).** Chemical Composition of *Acacia scleroxyla* Tuss. to Mycorrhizal Inoculation. *The International-Tree Crop Journals*. 65 (12): 1959-1960.

**Boeke SJ, Antonia AC, Rauls WM, Gilsang PJ, Dansai K. K, and Jrop J. A. (2003).** Side Effects of Cowpea Treatment with Botanical Insecticides on Two Parasitoids of *Callosobruchus maculatus*. *Entomologia Experimentalis at Applicata*, 108: 43-51.

**Das G P. (1986).** Effect of different concentrations of neem oil on the adult mortality and oviposition of *Callosobruchus chienesis* Linn. (Bruchidae: Coloeoptera). *Indian Journal of Agricultural Sciences*, 56(10): 743-744.

**Derkyi, N.S.A., Acquaah, S. O. and Owusu and M. Akwau (2010).** Bioctivity of Natural Products against the Cowpea Storage Weevil *Callosobruchus Maculatus*

L. Iternational *Journal of Biological and Chemical Sciences* 4(3): 616-623.

**FAO (1985).** Handling and storage of food grains. Food and Agriculture Organization of the United Nations, Rome. (www. faostat.org).

**FAO (1996).** Quality Control of Gum Arabic in Nigeria (Project TCP/ RAF/ 4557 Document). (www.faostat.org).

**FDA (2002).** Base Line Survey on Gum Arabic Production. Monograph by Federal Department of Agriculture in Collaboration with Rubber research Institute of Nigeria and Forestry Research Institute of Nigeria.

**Golob, P., Moss, C., Devereau, A., Goodland, A. D., Andan, F. H., Atarigya, J. and Tain B.M.D (1999).** Improvements in the Storage and marketing Quality of Grain Legumes: Final Technical report. NRI Report 2417. Project R 6503. Natural Resources Institute Chatham Maritime Kent. U.K. 246pp.

**Gupta, H.C., J.P. Verma, S. S. Bareth, and B.N. Mathur (1989).** Evaluation of Some Nonedible Oils as Grain Protectants in Wheat and Their Subsequent, Effect on Germination *Indian Journal Entomology* 50: 147-150.

**Haines, C.P. (1991).** Insects and Arachnids of TropicalStored Products: Their Biology and Identification (2nd edition). National Resources Institute, Chatha. UK. 246pp.

**Ileke, K.D. and Oni, M.O., (2011).** Toxicity of Some Plant Powders to Maize Weevil, *Sitophilus zeamais* (Motschulsky) [Coleoptera: Curculiondae] on Stored Wheat Grains (*Triticum aestivum). African Journal of Agricultural Research.* 6(13): 3043-3048.

**Ileke, K.D. Bulus, D.S. Aladegoroye, A.Y. (2013).** Effects of Three Medicinal Plants Products on Survival, Oviposition and Progeny Development of Cowpea Bruchids. *Callosobruchus maculatus* (Fab.) [Coloeptera: Chrysomelidae]. Infesting, Cowpea Seeds in Storage. *Jordan Journal Biology Sci*ence 6(1): 61-66.

**ISTA (2006).** International Rules for Seed Testing. International Seed Testing Association, Zurich. 33pp.

**Ivbijaro, M. F. (1983).** Preservation of Cowpea, *Vigna unguiculata* L. (Walp), with the Neem Seed, *Azadirachta indica* A. juss. *Protection Ecology*, 5 (2): 177-182.

**Kabir, B.G.J., Lawan M. and Jidda M. B. (2013).** Bioactivity of Raw Diatomaceous Earth against Rhyzopertha dominica Fab. (Coleoptera: Bostrichidae). Effect of Grain Type Dose Rate and Exposure Period. *Journal of Agriculture and Veterinary Science*. 4:44-59

**Karschon, R. (1975).** Seed Germination of Acacia Raddiana savi and A. tortilis Hayne as Related to Infestation by Bruchids, Leaflet No. 52, Div. Forestry, Agriculture Research Organization Ilanot, Isreal, 9pp.

**Kayode, D.I. and Olaniyi C.O., (2014).** Entomocidal Activity of Powders and Extracts of Four Medical Plants Against *Sitophilus oryzae* (L.) *Oryzaephilus mercator* (Faur) and *Rhyzopertha dominica* (Fabr). *Jordan journal of Biological Sciences* 7(1): 57-62.

**Khaire V M, Kachare B V and Mote U N. (1992).** Efficacy of Different Vegetable Oils as Grain Protectants Against Pulse Beetle, *Callosobruchus chinensis* L. in increasing Storability of Pigeon Pea. *Journal of Stored Products Research*, 28(3): 153-156.

**Korunic, Z. (1998).** Diatomaceous Earths, a Group of Natural Insecticides. *Journal of Stored Products Research,* 34 87-97.

**Lale N.E.S. and Abdulrahman H.T. (1999)**. Evaluation of Neem (*Azadirachta indica* A. Juss) Seed Oil Obtained by Different Methods and Neem Powder for the Management of*Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae) in Stored Cowpea. *Journal of Stored Products Research*, 35: 135-143.

**Lale N.E. S. and Mustapha A. (2000).** Potential of combining neem (*Azadirachta indica* A. Juss) seed oil with varietal resistance for the management of the cowpea bruchid,

*Callosobruchus maculatus* (F.). *Journal Stored Product Research*, 36: 215-222.

**Lale, N.E.S., (2002).** *Stored Product Entomology and Acarology in Tropical Africa*, First Edition. Mole Publications Maiduguri, Nigeria, 204p.

**Lucy, E., Aliyu, M. and Ojiekpon, I.F. (2016).** Effect of Neem Powders (*Azadirachta indica* A. Juss) on the Preservation of Gum Arabic (*Acacia senegal* L. Willd) Infested with *Bruchus baudni* (Caill) in Gashua, Yobe State Nigeria. *Journal of Agriculture and Food Environment* 3(2): 109-121.

**Makur, M. D., Gyar, S. D., Pennap, G. R. I. and Anthony, P. (2008).** Phytochemical Screening and Antimicrobial Activity of the Ethanolic and Methanolic Extracts of the Leaf and Bark of *Khaya senegalensis. African Journal of Biotechnology*, 17(9): 1216-1219.

**Mariappan, N., Srimathi, P., Sundaramoorthy, L. and Paramathma, M. (2013).** Effect of Organic Seed Pelleting on Seed Storability and Quality Seedling Production in Biofuel Tree Species. *African Journal of Crop Science*, 1: 024- 028.

**Mathur, S. B. and Kongsdal, O. (2003).** Common Laboratory Seed Health Testing Methods for Detecting Fungi. International Seed Testing, Association Basers Dorfch-Switzerland 425p.

**Musa, A.K. (2013).** Influence of Plant Powders on Infestation by Adults and Larvae of Khapra Beetle, *Trogoderma granaria* Everts (Coloeptera: Dermestidae) in Stored Groundnut. *Australian Journal of Basic and Applied Sciences*, 7(6): 427-432.

**Nisha, Patel, S.K., Singh, J.M. and Pancholy, A. (2008).** Bruchid Infesta-tion in Pod and Seed in Exotic Collections of *Acacia senegal* (L.) Willd. in the Thar Desert. *Annals of Arid Zone* (47) 1; 55-61.

**Obeng-ofori, D. and Dankwah, J. A., (2002).** Biological Effects of Four Protectants applied to Stored Bambara Groundnut against Infestation by *Callosobruchus maculatus* (Fab.) (Coleoptera: Bruchidae). *Journal of Ghana Science Association* 4(2): 41-51

**Obeng-Ofori D, Reichmuth CH, Bekele J, and Hassanali A. (1997).** Biological activity of 1,8 cineole, a major component of essential oil of *Ocimum kenyense* (Ayobangira) against stored product weevils. *Journal Applied Entomology*. 121: 237-243.

**Ohazurike N.C, Onuh MO, Emeribe EO. (2003).** The use of seed extracts of the physic nut (*Jatropha curcas* L.) in the control of maize weevil (*Sitophilus zeamais*) in stored maize grains (Zea mays L.). *Global J. Agric. Sci*., 2(2): 86-88.

**Ojiako, F.O., Agu, C.M., Ahuchaogu, C.E., (2013).** Potentiality of *Moringa oleifera* Lam. Extracts in the Control of Some Field Store Insect Pests of Cowpea. *International Journal of Agronomy and Plant Production*, 4: 3537-3543.

**Ojiekpon, I.F. and Aghughu, O. (2011).** Studies on the Production Pattern of Gum Arabic in Nigeria. Paper Presented at the Rubber Research Institute of Nigeria Seminar Series at RRIN Conference Hall Iyanomo 24th April, 1997.

**Omotoso, O.T. and Ogunleye R.F. (2006).** Insecticidal and antiovipositional properties of some aromatic medicinal plants of *Callosobruchus maculatus. J. Ultra Sci. Phys. Sci*., 18(2):181-186.

**Oparaeke, A. M. and Bunmi, O. J. (2006).** Insecticidal Potential of Cashew (*Anacardium occidentale* L.,) for Control of Beetle *Callosobruchus subinotatus* (Pic.) (Bruchidae) on Bambaragroudnut (*Voandzia subterranea*) (L.). Verdc. *Archives of Phytopathology and Plant Protection*. 39: 247- 251.

**Osekre, E.A. and Ayertey J.N. (2002).** Control of the cowpea weevil, *Callosobruchus maculatus* (F) on stored cowpea using Vegetable oils. *Ghana Journal Agricultural Science*., 35: 76-80.

**Otitodun, G.O., Opit, G.P., Nwaubani, S.I., Okonkwo, E.U. and Gautam, S.G. (2015)**. Efficacy of Nigerian- Derived Diatomaceous earth, Botanical and Riverbed Sand against *Sitophilus oryzae* and *Rhyzopertha domica*

on Wheat. *African Crop Science Journal* 23: 279-293

**Owusu-Akyaw M. (1994).** Evaluation of Plant Products for the control of Cowpea and maize Storage Insects. Ghana Grains Development Project C.R.I., Kumasi, Ghana.

**Owusu E.O, and Obeng-Ofori D. (2004).** Efficacy of Candlewood *Zanthoxylum xanthoxyloides* (Lam) for the Control of *Sitophilus zeamais* (Mots.) (Coleoptera: Curculionidae) and *Callosobruchus maculatus* F. (Coleoptera: Bruchidae). *Global Journal of Agricultural Sciences*, 3(1): 19-23.

**Papachristes, D.P. and Stamopoulos, D.C. (2002).** Toxicity of vapours of Three Essential Oils to the immature Stages of *Acanthoscelides obtectus* (Say) (Coleoptera: Bruchidae). *Journal of Stored Product Research* 38: 365-373.

**Parugrug, M.L. and Roxas, A.C. (2008).** Insecticidal Action of Five Plants against Maize Weevil, *Sitophilus zeamais* Motsch, (Coloeptera: Curculionidae). *KMITL Science. Technology Journal*, 8(1): 24-38.

**Paul, C.W and Didia B.C., (2012).** The Effect of Methanolic Extract of *Moringa oleifera* (Lam.) Roots on the History of Kidney and Liver of Pigs. *Asian of Medical Sciences* 4(1): 55-66.

**Plimmer J.R. (1993).** Regulatory Problems Associated with Natural Products and Biopesticides. *Pesticides Science.*, 39: 103-108.

**Ranasinghe, M.A.S.K. and Dharmasena, C.M.D. (1989).** Effect of Three Vegetable Oils on Oviposition and Egg Hatchability of Cowpea Bruchid, Procedure, International Workshop on the Use Botanical Pesticides. International Rice Research Institute., Manila, 1984. 15pp. (Mimeo).

**Schmutterer, H. (1990).** Properties and Potential of Natural Pesticides from Neem Tree, *Azadirachta indica*. *Annual Review Entomology*, 35: 271-297.

**Singh R and Sharma G. (2003).** Evaluation of Efficacy of Vegetable Oils as Grain Protectant Against *Callosobruchus chinensis* (L.) in Pea. *Journal of Applied Biology*, 12(1): 87-89

**Stoll, G. (1988).** *Natural Crop Protection Based on Local Farm Resource in the Tropics and Sub-Tropics*. 3rd Edition, Weikerssheim, Germany, Margraf Publishers, Scientific Books. 188p.

**Stoll, G. (2000).** Natural Crop Protection in the Tropics: Letting Information Come to Life. 2nd Enlarged Edition. Margraf Verlag.

**Tanzubil, P.B. (1991).** Control of Some Pests of Cowpea (*vigna unguiculata* L. Walp.) with Neem (*Azadirachta indica* A. Juss.) In Northern Ghana. *Tropical Pest Management*, 37(3): 216-217.

**Tripathi S, Avasthi S and Chandralekha A. (2007).** Management of *Callosobruchus chinensis* by Use of Oils in Stored Pigeon Pea. *Annals of Plant Protection Sciences*, 15(1): 250-251.

**Udo, I.O. and Epidi, T.T. (2009).** Biological Effect of Ethanolic Extract Fractions of *Ricinodendron heudelotii* (Baill) Pierre ex Pax against *Sitophilus zeamais* (Motschulsky) and *Callosobruchus maculatus* Fabricius on Stored Grains. *Africa. Journal. Agriculture. Research.*, 4: 1080-1085.

**Umoetok, S.A, and Gerard M.B. (2003).** Comparative Efficacy of *Acorus calamus* Powder and Two Synthetic Insecticides for Control of Three Major Insect Pests of Stored Cereal Grains. *Global Journal Agricultural. Science*., 2(2): 94-97.

**Vir, S. (1994).** Effectiveness of Some Natural Oils in Protection of Cowpea Seeds from Bean Weevil *Callosobruchus maculatus*. *Bulletin of Grain Technology*, 32: 68-91.

**Wongo LE. (1998).** Biological activity of sorghum tannin extracts on the stored grain pests *Sitophillus oryzae* (L.), *Sitotroga cerealella* (Olivier) and *Tribolium castaneum* (Herbst). *Insect Science and its Application*, 18: 17-23.

**Yakubu, A.I. (2005).** Potential of *Khaya senegalensis* on *Callosobruchus maculatus*. *Journal of Stored Product Research*. 13:19-23.

**Yang, N.W., Li, A.L., Wan, F.H., Liu, W.X and Johnson, D. (2010).** Diamaceous Earth

Enhances the Toxicity of Garlic Allium sativum. Essential Oils against Stored Product Pests. *Journal of Stored Products Research, 46: 118-123*.

**Yusuf, S.R., and Ahmed, B.I. (2005).** Potential of *Khaya Senegalensis* on *Callosobruchus maculatus. Journal of Stored Product Research* 13: 19-23.

**Yusuf, A.U. (2009).** Comparative Efficacy of Plant Materials and Pirimiphos-Methyl in the Suppression of *Callosobruchus maculatus* F. (Bruchidae; Coloeptera) Development and Damage in Cowpea Seeds. *Savannah Journal of Agriculture* 4: 45-53.

**Yusuf S. R., S. H. Lawan, B. S. Wudil and H. Sule (2017).** Detection of Dichlorvos Residue in Cowpea Grains, Six Months after Application Using High Performance Liquid Chromatography. *Asian Research Journal of Agriculture*. 7(4): 1-6

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