PRELIMINARY SCREENING OF SELECTED TROPICAL BOTANICALS AS COWPEA PROTECTANTS AGAINST COWPEA SEED BRUCHID, *CALLOSObRUCHUS MACULATUS* FABRICIUS (COLEOPTREA: CHRYSOMELIDAE: BRUCHINEAE)

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ABSTRACT: A preliminary screening was conducted to investigate the potentials of thirteen botanical powders as cowpea seed protectant against cowpea seed bruchid, *Callosobruchus maculatus*, Fabricius using seed damage parameters. The botanicals included *Azadirachta indica*, *Ekebergia senegalensis*, *Urginea altissima*, *Ancistrophyllum secundiflorum*, *Pseudocedrela kotschyi*, *Lannea welwitschii*, *Xylopia parviflora*, *Usteria guineensis* and *Antiaris toxicaria*. Others were *Indigofera arrecta*, *Hoslundia opposita*, *Cleome ciliata* and *Lagerra aurita*. All the botanicals, except *L. aurita*, showed potentials for cowpea protectant ability against the seed bruchid. Using Bruchid Perforation Index (BPI) values, the most effective powders were *A. indica* (2.95), *A. toxicaria* (2.07) and *H. opposita* (2.64) which BPI values were significantly (p<0.05) lower than that of *L. aurita* (26.46). Percentage Seed damage (PSD) varied with the studied botanicals (2.10-41.32%) and significantly (p<0.05) lower in the botanical-treated seeds compared to the untreated control (98.28%). The effective botanicals are, therefore, recommended for tropical resource-poor subsistent farmers for use in their small scale cowpea postharvest storage and for further studies to elucidate other effective formulations and their active ingredients.

KEY WORDS: Botanical powders, Bruchid Perforation Index, *Callosobruchus*, grain protectant, seed damage

Cowpea, *Vigna unguiculata* (L.) Walpers, is an important food legume and an essential component of cropping systems in many developing countries. Rich in protein and carbohydrate, it is the preferred pulse in large parts of Africa, where the seeds are processed into various products for human consumption or to appease to gods among the traditional worshippers. Seeds are medicinally used as a poultice to treat skin infections and boils. Despite its various uses, the post-harvest infestation by bruchids, especially the genus *Callosobruchus* (Coleoptera: Chrysomelidae: Bruchinae) poses a serious threat to its all-year round availability (Tuda et al., 2005).

The use of plant products to protect stored products from insect pest infestation is an age-long practice in developing world and is recently receiving a renewed attention as an important component of integrated pest control scheme. The reasons for this renewed interest include their abundance and cost effectiveness. Also, the use of botanicals reduces the ecological problems and health hazards of over-dependence on synthetic pesticides. Thirdly, some botanical formulations like powder and ash could be prepared by local resource-
poor farmers, because they require no skilled technicality. Although, a large array of plant species has been documented for their insecticidal properties against bruchids (Dales, 1996; Ileke & Bulus, 2012; Ashamo et al., 2013; Musa et al., 2015; Babarinde et al., 2016a,b; Chauhan et al., 2016; Vijayaraghavan & Zadda, 2016; Kosini & Nukenine, 2017; Usman et al., 2017), screening more botanicals for potential efficacies cannot be inappropriate in bio-rational innovations for bruchids control. This is because bioactivity of botanicals could be species-specific which necessitates the attempt to establish the spectrum of bioactivity of any chosen botanical species. Plants selected for the study were those known to possess medicinal, pesticidal or nutritional values.

In this study, powder formulation was used being a preliminary study which was designed to provide baseline information for further studies on the insecticidal properties of the selected botanical species. Interestingly, the selected species are naturally available in many tropical countries. Therefore, the aim of the study was to evaluate thirteen selected tropical botanicals for their protctant ability of cowpea seed against the seed bruchid, *Callosobruchus maculatus* using seed damage parameters due to the bruchid’s infestation.

**MATERIALS AND METHODS**

**Insect culture**

*C. maculatus* was reared on clean seeds of “Ife Brown”, a bruchid-susceptible cowpea cultivar, under ambient environmental temperature of 30±2°C and 70±5% using standard method earlier described by Babarinde and Ewete (2008).

**Botanical procurement and preparation**

Thirteen botanicals were collected from different towns in south western Nigeria, where they are found in abundance (Table 1). Identification of the botanicals was done with the help of local ethno-botanists and matching of the vernacular names with the scientific names contained in Gbile (2006). The root and stem bark of the woody species used for the study were exposed to sun drying for 2 days and subsequently air-dried, while the leaves were air-dried under shade until crisp to prevent destroying the thermo-labile compounds in them. Thereafter, the dried plant parts were pulverized with the aid of a hammer mill and sieved with the aid of 50 µm sieve. The plant powder were then stored in labelled plastic airtight jars until use.

**Botanical screening for insecticidal potentials**

The plant powders were screened according to Fatope et al. (1995) with some modifications. Cowpea seeds (30 g each) were put in a 1 L Kilner jar covered with muslin cloth into which 3 g plant powder corresponding to 10% (w/w) was added to the cowpea seeds. A Kilner jar containing 30 g cowpea seeds without botanical treatment served as control. Three pairs (sex ratio 1:1) 1- to 3-day old *C. maculatus* were introduced into each covered jar. Six replicates of the setup was maintained for seven days in order to infest the stock after which the insects were removed from the stock. At 3 months after infestation, data were collected on the number of damaged (NDS) and number of undamaged seeds (NUdS), weight of damaged and undamaged seeds from both treated and untreated grains.

Percentage seed damage (PSD) was calculated as

\[
PSD = \frac{NDS \times 100}{NDS + NUdS}
\]
Bruchid perforation index (BPI) was calculated to determine the seed damage level according to Fatope et al. (1995), using the formula:

\[
BPI = \frac{\text{%TP} \times 100}{\text{%TP} + \text{%CP}}, \quad \text{where}
\]

\[
\text{%TP} = \% \text{treated cowpea seeds perforated}
\]

\[
\text{%CP} = \% \text{control cowpea seeds perforated}
\]

\[
BPI > 50 = \text{negative protectant of plant material tested (i.e. enhancement of infestation of the bruchid)}
\]

\[
BPI < 50 = \text{positive protectant (i.e. prevention of infestation of the bruchid)}.
\]

**Experimental design and data analysis**

The experiments were laid out in completely randomized design. Data were subjected to analysis of variance and significant treatment means were separated using Tukey’s HSD at 5% probability level, with the aid of SPSS Software (SPSS, 2006).

**RESULTS AND DISCUSSION**

The highest BPI was observed in cowpea treated with *Lagerra aurita* (26.46), which was not significantly different from the BPI observed in cowpea treated with *Urighina altissima*, *Lannea welwitschii*, *Xylopia parviflora*, *Usteria guineensis*, *Indigofera arrecta* and *Cleome ciliata*. The BPI obtained from cowpea treated with *Azadirachta indica* (2.95), *Antiaris toxicoria* (2.07) and *Hoslundia opposita* (2.64), *Ancistophyllum secundiflorum* (6.88), *Ekebergia senegalensis* (5.57), *H. opposita* (2.64) were not significantly different from one another but were significantly lower than the BPI obtained from cowpea treated with *L. aurita* (26.46) (Table II). Based on the BPI, *A. indica*, *A. toxicoria* and *H. opposita* were ranked to possess very strong grain protectant effect; while *E. senegalensis*, *U. altissima*, *A. secundiflorum*, *P. kotschyi* *U. guineensis* and *I. arrecta* were ranked to possess strong grain protectant effect. Three of the studied botanicals, *L. welwitschii*, *X. parviflora* and *C. ciliata* were ranked to possess fairly strong grain protectant effect; while only one (*Laggera aurita*) was ranked to be weak in its grain protectant potential. Seed damage varied significantly with the botanicals used (2.10 - 41.20%), but generally lower in the botanical-treated seeds compared to the untreated control (98.28%). The most effective powders were *A. toxicaria* (2.10%), *H. opposita* (2.68%) *A. indica* (3.05%), *E. senegalensis* (5.94%) and *A. secundiflorum* (7.59%). The least effective botanical was *L. aurita* (with 41.32% PSD) (Fig. I).

According to Fatope et al. (1995), of the various screening procedures available, the cowpea bruchid bioassay is the most convenient for general use in the laboratory. A BPI value of 50 shows that equal amounts of botanical-treated and untreated cowpea seeds were perforated. This bioassay procedure thus allows plant materials with strong, weak or negative grain protectant effects to be identified, irrespective of their mode of action. In this study, all the tested botanicals showed varying levels of protection potentials of cowpea seeds against *C. maculatus*. BPI value of \( \leq 15 \) is good and considered to be a strong effect. The low BPI values obtained from the seed treated with *A. toxicaria*, *A. indica* and *H. opposita*, made them good candidates for further study towards establishment of their bioactivity against *C. maculatus*. Earlier studies on the insecticidal potentials of *A. indica* against *C. maculatus* were on its seeds (Lale & Mustapha, 2000; Tofel et al., 2016), known to possess azadirachtin. This work examines the
insecticidal potentials of the leaves. The study of Cepeda Palacios et al. (2014) reported the bioactivity of the neem leaves against insect. Based on their results, we included the leaf to investigate its bioactivity against the cowpea seed bruchid. Of the ten species assayed at 10-30% w/w by Fatope et al. (1995), *Hypitis suaveolens* (Labiateae) and *Spinocea zeylanica* (Sphenopleaceae) were the only ones with a BPI value of < 15 when the botanical powders were assayed at 10% w/w. The result from this study where the BPI of the majority of the tested materials was < 15 suggests that the majority of the plants have cowpea protectant potentials against the bruchid. The result of this study agrees with previous authors on the efficacy of botanical powders in controlling *C. maculatus* (Ileke & Bulus, 2012; Ojo & Ogunleye, 2013; Tefsu & Amana, 2013).

Plant species with lower PSD had lower BPI. *Xylopia parviflora* had a BPI of 15.76, despite the fact that some members of its family (Annonaceae) had been reported to be insecticidal against stored product pests (Babarinde et al., 2008; Babarinde & Adeyemo, 2010; Akinyemi et al., 2016; Babarinde et al., 2017). Similar report exists for another member of Annonaceae family (*Annona senegalensis*) included in Fatope et al. (1995), that was not effective in the protection of cowpea seeds against *C. maculatus*. The insecticidal properties of Meliaeaceae against *C. maculatus* has been reported by Babarinde and Ewete (2008). However, this is the first report of *A. toxicaria* (Family Moraceae), for its pesticidal potentials against stored product insect. The fact that the powders showed protectant ability justifies their recommendation for local farmers who may not have the technicality of essential oil extraction or production of inorganic extracts.

**CONCLUSION**

Majority of the screened species showed insecticidal potentials against bruchids. Since the formulation investigated in this study was powder, it is necessary to investigate other formulations like organic and inorganic extracts and essential oil. Also, their modes of action and bioactive ingredients should be well studied as prerequisites to the understanding of their mechanism of actions and the production of synthetic products from the species.

**LITERATURE CITED**


![Figure I](https://example.com/figure1.png)

**Figure I.** Percentage seed damage by *Callosobruchus maculatus* of cowpea seeds treated with selected plant powder {Number of replicates = 6; ANOVA Result: $F = 9.929; d f = 13, 70; p<0.0001$}.
Table 1. List of the thirteen plant species screened for insecticidal properties against *Callosobruchus maculatus*.

<table>
<thead>
<tr>
<th>Plant species</th>
<th>Common name</th>
<th>Family</th>
<th>Part used</th>
<th>Bioactivity information</th>
<th>Point of collection</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Azadirachta indica</em></td>
<td>Neem</td>
<td>Meliaceae</td>
<td>Leaf</td>
<td>Medicinal, insecticidal</td>
<td>Ogbomoso</td>
</tr>
<tr>
<td><em>Ekebergia senegalensis</em></td>
<td>Stavewood</td>
<td>Meliaceae</td>
<td>Leaf</td>
<td>Antibacterial</td>
<td>Ibadan</td>
</tr>
<tr>
<td><em>Uriginea altissima</em></td>
<td>Tall squill</td>
<td>Liliaceae</td>
<td>Leaf</td>
<td>Medicinal</td>
<td>Ibadan</td>
</tr>
<tr>
<td><em>Ancistrophyllum secundiflorum</em></td>
<td>Large Benin rattan</td>
<td>Arecaceae</td>
<td>stem bark</td>
<td>Chewing stick</td>
<td>Ogbomoso</td>
</tr>
<tr>
<td><em>Pseudegedrella kotschyi</em></td>
<td>Cedar mahogany</td>
<td>Meliaceae</td>
<td>root bark</td>
<td>Antibacterial, chewing stick,</td>
<td>Ogbomoso</td>
</tr>
<tr>
<td><em>Lannea welwichii</em></td>
<td>Kumbi</td>
<td>Anacardiaceae</td>
<td>Leaf</td>
<td>Antibacterial, medicinal, furniture</td>
<td>Ibadan</td>
</tr>
<tr>
<td><em>Antiaris toxicaria</em></td>
<td>False iroko</td>
<td>Moraceae</td>
<td>Stem bark</td>
<td>Insecticidal, medicinal</td>
<td>Ibadan</td>
</tr>
<tr>
<td><em>Xylopia parviflora</em></td>
<td>Bushveld bitterwood</td>
<td>Annonaceae</td>
<td>root bark</td>
<td>Medical, Chewing stick</td>
<td>Alapa-Ilorin</td>
</tr>
<tr>
<td><em>Usteria guineensis</em></td>
<td>Indigo</td>
<td>Loganiaceae</td>
<td>Aerial leaf</td>
<td>Medical</td>
<td>Akure</td>
</tr>
<tr>
<td><em>Indigofera arrecta</em></td>
<td>Indigo</td>
<td>Papilonaceae</td>
<td>Leaf</td>
<td>Dye production</td>
<td>Ogbomoso</td>
</tr>
<tr>
<td><em>Laggera aurita</em></td>
<td>Laggera</td>
<td>Asteraceae</td>
<td>leaf</td>
<td>Antibacterial, insecticidal</td>
<td>Ogbomoso</td>
</tr>
<tr>
<td><em>Cleome ciliata</em></td>
<td>Wild mustard</td>
<td>Capparaceae</td>
<td>seed</td>
<td>Green manure, vegetable</td>
<td>Ogbomoso</td>
</tr>
<tr>
<td><em>Hoslundia opposita</em></td>
<td>Hoslundia</td>
<td>Lamiaceae</td>
<td>Leaf</td>
<td>Medicinal, insecticidal</td>
<td>Ilorin</td>
</tr>
</tbody>
</table>

Table 2. Cowpea grain protectant potentials of the selected botanicals against *Callosobruchus maculatus* using Bruchid Perforation Index.

<table>
<thead>
<tr>
<th>Plant powder</th>
<th>Bruchid Perforation Index</th>
<th>Grain Protectant Potentials*</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Azadirachta indica</em></td>
<td>2.95±1.05a</td>
<td>Very strong</td>
</tr>
<tr>
<td><em>Ekebergia senegalensis</em></td>
<td>5.57±1.48ab</td>
<td>Strong</td>
</tr>
<tr>
<td><em>Uriginea altissima</em></td>
<td>13.25±3.78ab</td>
<td>Strong</td>
</tr>
<tr>
<td><em>Ancistrophyllum secundiflorum</em></td>
<td>6.88 ± 2.45ab</td>
<td>Strong</td>
</tr>
<tr>
<td><em>Pseudegedrella kotschyi</em></td>
<td>12.51 ± 7.71ab</td>
<td>Strong</td>
</tr>
<tr>
<td><em>Lannea welwichii</em></td>
<td>16.48 ± 10.04ab</td>
<td>Fairly strong</td>
</tr>
<tr>
<td><em>Antiaris toxicaria</em></td>
<td>2.07 ±0.76a</td>
<td>Very strong</td>
</tr>
<tr>
<td><em>Xylopia parviflora</em></td>
<td>15.76 ±3.97ab</td>
<td>Fairly strong</td>
</tr>
<tr>
<td><em>Usteria guineensis</em></td>
<td>7.76 ± 2.79ab</td>
<td>Strong</td>
</tr>
<tr>
<td><em>Indigofera arrecta</em></td>
<td>7.66 ± 3.67ab</td>
<td>Strong</td>
</tr>
<tr>
<td><em>Laggera aurita</em></td>
<td>26.46 ± 6.75b</td>
<td>Weak</td>
</tr>
<tr>
<td><em>Cleome ciliata</em></td>
<td>17.30 ± 3.16ab</td>
<td>Fairly strong</td>
</tr>
<tr>
<td><em>Hoslundia opposita</em></td>
<td>2.64 ± 0.37a</td>
<td>Very strong</td>
</tr>
</tbody>
</table>

ANOVA Results: F=2.586; df=12, 65; p=0.007

Means followed by same alphabet along a column are not significantly different from one another using Tukey’s HSD test (p<0.05).

*BPI of < 15 depicts a strong grain protectant effect {Adapted with modification from Fatope et al. (1995)}*