Efficacy of Jute Bags Impregnated with Plant Extracts in the Post-Harvest Protection of Cowpeas in Benin

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ABSTRACT

The biological efficacy of jute bags impregnated with Eucalyptus camaldulensis, Cymbopogon citratus essential oils, and vegetable oil of Azadirachta indica was evaluated on the adults of Callosobruchus maculatus of cowpea and the molds of the genus Aspergillus and Penicillium, in post-harvest conservation conditions. The results reveal that the jute bags tested have significant insecticidal and antimicrobial activity on Callosobruchus maculatus adults, when the dose and exposure time increase from 0 to 2% for 26 weeks.

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Introduction

Cowpea (Vigna unguiculata L., Walp) is the most important seed legume in tropical Africa (IITA 1982, Zannou 1995 and Diaw 1999). Africa provides more than half of world production with 3.36 million tonnes, 70% of which comes from the West African subregion (Ntare, 1987) with Nigeria, Niger and Burkina Faso as main producers (Jackai and Daoust 1986, Nwokolo and Ilechukwu 1996).

In Benin, despite favorable agro-climatic conditions for cowpea, yields are generally low in traditional cropping systems, between 500 kg and 650 kg / ha (INRAB, 1996). Under favorable conditions, the yield potential can reach 1200 to 1500 kg/ha (Aho, 1988). The losses caused by insects and molds are the most important, because of the tropical and inter-tropical climate very favorable to their development and the type of storage, not very conducive to the fight against insect pests of stocks (Visconti and De girolamo , 2002). In addition, there is a range of technologies available to reduce post-harvest losses, but several constraints persist in the storage or conservation and the processing of cowpea. These constraints are more and more accentuated in our markets where cowpea is kept in jute sacks, thus encouraging a very rapid multiplication of stock depredators. Thus, the present study aims to evaluate the efficacy of jute bags impregnated with plant extracts in the post-harvest protection of cowpea.

Material and methods

Equipment

Plant species

Three plant species were used in this study to evaluate their efficacy on cowpea pests in culture. These are Cymbopogon citratus, Eucalyptus camaldulensis and Azadirachta indica. The three plants are well known in African pharmacopoeia.

The cowpea

The cowpea seeds used in this study are of the variety "TOLA" and come from the market "Dantokpa" at Cotonou and the market "Ouando" at Porto-Novo, they are packaged in plastic bags, but the sorting of these seeds may be necessary to avoid the use of infected seeds.

Jute bag

Jute bags are purchased in the Dantokpa market. They are then made and dimensioned.

Animal material

The animal material used here is Callosobruchus maculatus, a very cosmopolitan species that is thought to be the most damaging to the cowpea stock (Giga and Smith, 1983). For this purpose, two forms are distinguished, namely the sowing or active form and the normal or non-sowing form.

Methods

Impregnation of jute bags

The experimental bags are impregnated with the "solvent-plant extract" mixture and with concentrations of plant extract of: 0%; 0.004%; 0.01%; 0.02%; 0.04%; 0.1%; 0.2%; 0.4%; 1%; and 2%. The 0% concentration solution represents solely of "solvent" and represents the control of the experiment. Once the bags are impregnated with the impregnating solution, they are dewatered and allowed to dry in the shade at room temperature for 48 hours. Twenty (20) bags are thus impregnated to each of concentration.

Method of preparation and screening of cowpea samples

For the preparation and screening of cowpea samples, 500 g of cowpea are introduced into each bag. Infestation of the storage systems is carried out by introducing into each bag 20 pairs of C. maculatus. The selection is random. Twenty (20) replicates are made for each concentration. A negative control (free from any treatment) is made, infested

Keywords

Jute Bag,
Essential Oils,
Azadirachta Indica,
Mold,
Callosobruchus Maculatus,
Post-Harvest.
and replicated in twenty (20) copies. The bags are then stored in areas protected from water. In the warehouse, the bags are labeled and grouped according to treatments.

**Population parameters of the insects studied**

Stripping is performed every 15 days of storage. During stripping, the following parameters are observed on each bag:
- The number of *C. maculatus* still living;
- The number of dead *C. maculatus*.

The values of these different parameters are collected on sheets previously designed for this purpose.

**Microbiological characterization of cowpea during storage**

During storage we investigated whether treated cowpea samples are contaminated with the previously identified mold types. It consists in sowing the seeds of treated cowpea on Sabouraud medium in petri dishes and then incubated at 25° C. for 5 days. The first reading is made from the third day. At the end of the five days of culture, the various mold strains are isolated one by one on culture medium such as MEA, DRBC, Sabouraud and PDA for further identification tests.

**Determination of the conservation date**

The shelf life is determined by the duration of the insecticidal/repellent effect of the plant extracts studied. Indeed we have determined the duration of each plant extract to lose its insecticidal power.

**Results and discussions**

**Results**

**Making and impregnation of jute bags**

The made jute bags are then soaked with the plant extract, drained and allowed to dry in the shade at room temperature for 48 hours as shown in Figure 1 below.

![Figure 1: Jute bags impregnated with plant extracts](image)

**Cowpea conservation**

![Figure 2: Cowpea conservation.](image)

**Variation of the number of live insects as a function of time**

<table>
<thead>
<tr>
<th>Sources of variation</th>
<th>Chi²</th>
<th>Pr (&gt;Chi²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant extracts</td>
<td>70658</td>
<td>0.000</td>
</tr>
<tr>
<td>Doses</td>
<td>1701</td>
<td>0.000</td>
</tr>
<tr>
<td>Time</td>
<td>2864</td>
<td>0.000</td>
</tr>
<tr>
<td>Plant extracts × Doses</td>
<td>657</td>
<td>0.000</td>
</tr>
<tr>
<td>Plant extracts × Time</td>
<td>2953</td>
<td>0.000</td>
</tr>
<tr>
<td>Doses × Time</td>
<td>5295</td>
<td>0.000</td>
</tr>
<tr>
<td>Plant extracts × Doses × Time</td>
<td>639</td>
<td>0.000</td>
</tr>
</tbody>
</table>

In Table I were presented the results of the generalized linear regression, family of fish carried out on the shelf life of bags of cowpea impregnated with the different plant extracts and according to the doses applied. It appears that the main factors as well as their interactions induced significant differences (P <0.05) in the maximum shelf life of cowpea bags, which reflects a variation in the shelf life according to the extract of plant used, but also of the dose and time (and vice versa).

Table II shows the number of living insects in the cowpea stocks according to the doses of the various plant extracts used. Overall, regardless of the plant extract considered, an increase in the dose of plant extracts induced a decrease in the number of insects.

<table>
<thead>
<tr>
<th>Doses (µl)</th>
<th><em>A. indica</em> Moy ±SD</th>
<th><em>C. citratus</em> Moy ± SD</th>
<th><em>E. camaldulensis</em> Moy ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.4</td>
<td>316 ± 323</td>
<td>12 ± 15</td>
<td>5 ± 11</td>
</tr>
<tr>
<td>1</td>
<td>311 ± 321</td>
<td>9 ± 13</td>
<td>4 ± 11</td>
</tr>
<tr>
<td>2</td>
<td>308 ± 321</td>
<td>7 ± 13</td>
<td>4 ± 11</td>
</tr>
<tr>
<td>4</td>
<td>303 ± 322</td>
<td>4 ± 11</td>
<td>3 ± 11</td>
</tr>
<tr>
<td>10</td>
<td>295 ± 318</td>
<td>3 ± 11</td>
<td>3 ± 11</td>
</tr>
<tr>
<td>20</td>
<td>288 ± 315</td>
<td>3 ± 11</td>
<td>3 ± 11</td>
</tr>
<tr>
<td>40</td>
<td>250 ± 282</td>
<td>3 ± 11</td>
<td>3 ± 11</td>
</tr>
<tr>
<td>100</td>
<td>367 ± 316</td>
<td>3 ± 11</td>
<td>3 ± 11</td>
</tr>
<tr>
<td>200</td>
<td>144 ± 257</td>
<td>3 ± 11</td>
<td>3 ± 11</td>
</tr>
</tbody>
</table>

The variation in the number of insects in time according to the plant extracts used has been presented in Figure 3. It emerges that for both the control (Figure 3.a) and for the extract of *A. indica* (Figure 3.b), the number of insects increased exponentially until reaching the peak at the tenth week (950 insects for the control and 750 for *A. indica*). From the eleventh week onwards, this number decreased considerably to zero for the control and stabilized at 50 insects for *A. indica*. In addition, with cowpea treated with the essential oil of *C. citratus* (Figure 3.c) and *E. camaldulensis* (Figure 3.d), the number of insects in the stocks was zero from the eighth week for *C. citratus* and the twelfth week for *E. camaldulensis*. 

![Figure 3: Cowpea conservation.](image)
important to indicate that the highest concentration (2%)...
structure of mitochondria (Adjou and Soumanou, 2013). The retention period is 14 weeks (3 months) at 2% for A. indica, 26 weeks (more than 6 months) for C. citratus and E. camaldulensis, whatever the dose applied.

Conclusion

In general, the number of live insects and the rate of microbial contamination are proportional to the concentration of A. indica essential oil or vegetable oil in jute bags. These results also show that the plant extracts used have a good insecticidal and antimicrobial action against cowpea pests according to the biological parameter targeted. It is therefore very interesting to continue this work in a dimension of industrializing the results of its work which will not only guarantee the food security of the populations by a better conservation of the cowpea, but it will also open a track for the valorization of aromatic plants from which the essential oils can be extracted for commercial purposes thus increasing farmers' incomes.

Bibliographical references