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Deterrent Susceptibility of Ethanolic and Methanolic Leaf Extracts of *Strychnos spinosa* (*Loganiaceae*) Plant Against Cowpea Weevil (*Callosobruchus maculatus*)

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ABSTRACT

This study tested the cowpea-repelling potential of Strychnos spinosa. To achieve this aim, an experiment was conducted by infesting the cowpea seeds with the adults of Callosobruchus maculatus with different dosages of the plant extracts (0. 2g, 0.4g, and 0.6g) in order to assess their effect on the rate of mortality and eggs laid by insects. The experiment was done in order to determine the effectiveness of methanolic and ethanolic extracts from the plant's leaves to manage Callosobruchus maculatus. According to the study, both ethanolic and methanolic extracts had an impact on adult insects after 72 hours when compared to the positive control. Furthermore, it was discovered that when compared to methanolic leaf extract of the plant, ethanolic leaf extract of the plant creates a substantial influence on the mortality of Callosobruchus maculatus following exposure to the environment for 72 hours. However, as the dosage for either of the two extracts is increased, the subject insect's egg production drops. The results show that 0.4g of the plant's ethanolic extract could be utilized as a control material to produce a significant level of protection on stored cowpea seed against cowpea-related damage.

Keywords: Strychnos spinosa, Cowpea, mortality, weevil, Callosobruchus maculatus

1.0 INTRODUCTION

Callosobruchus maculatus is the main pest of cowpea (Timothy T. Epidi, 2008). It is a major insect pest of many grains, especially Soyabean, Lentil, Chickpea, and Cowpea (*Callosobruchus maculatus*), ((Mahfuz, 2008). Methyl bromide or Phosphine fumigation is the primary method used to control pests in stored goods (Sankarganesh E., 2020). The application of Methyl bromide is restricted as it depletes the ozone layer (Shaw, 2014). The use of this fumigants have been restricted due to insect resistance to phosphine, which has been documented in many different countries (Patrick J. Collins G. J., 2002; Patrick J. Collins G. J., 2005). Essential oils with components that are biodegradable and have low toxicity for mammals have been utilized as substitutes for conventional fumigants ((E. Shaaya, 1997; J. Wang, 2006). In most countries that produce cowpeas, insect damage is the greatest hurdle to its production. The most prevalent insects that can result in financial losses are cowpea aphids *(Aphis craccivora)*, leafhoppers *(Empoasca spp)*, blister beetles (*Hycleuslugens*), green stink bugs (*Nezaraviridula*), and cowpea weevil *(Callosobruchus maculatus)* (Oyewale R. O., 2013). The primary post-harvest pest of cowpea in the tropics is the Callosobruchus maculatus, a global field-to-store pest (Z. Masoumi, 2021). It leads to significant quantitative and qualitative losses, as seen by the perforation of seeds and reductions in their weight, market value, and ability to germinate (Bamphitlhi Tiroesele, 2015). Various techniques and management mechanisms have been established, and more are consistently being created, to help reduce major losses caused during storage (Tesfaye Walle Mekonnen, 2022). Chemical pesticides are heavily used to control cowpea seed storage bugs (Kalpnaa, 2022). However, for various technical and financial reasons, most small-scale farmers have not welcomed these new practices. The environment, people, and non-target creatures are all adversely affected by insecticides.

Thus, solutions for affordable, secure, and simple cowpea weevil protection against the storage of cowpeas are required. African farmers with little resources use a multitude of conventional methods, including ash, sand, dry pepper, and herbal extracts (Niranjana R F, 2019). In various parts of the world, naturally occurring plant products have been used for a long time to protect agricultural crops against pests (Kalpnaa, 2022). The plant (Strychnos spinosa) products used for this study produce odors believed to repel weevils, thereby preventing them from attacking cowpea seeds. Information on using this plant as a supplementary measure to prevent weevil infestations in storage is minimal. The usage of the plant as mentioned above may provide an environmental sustainability, safe, and effective alternative to synthetic insecticidal compounds. The value of plant products as a cowpea weevil management strategy in small-scale farmers' storage facilities will also be made known as a result of this research.

2. EXPERIMENT

2.1 Experiment Site

The Experiment was conducted at the physiology laboratory of the international institute of tropical agriculture (IITA) in Kano state, Nigeria.

2.2 Sample Collection and Identification

The leaves of the Strychnos spinosa plant were collected from Gadama Kumbotso and was identified and authenticated at department of biology, Bayero University Kano (BUK), with herbarium accession number BUKHAN 124. The leaves were washed and dried for sixty days under laboratory temperature in chemistry laboratory KUST wudil. And the sample was ground into powder using a pestle and mortar in the food science and technology laboratory, KUST Wudil.

2.3 Extraction Procedure

The Soxhlet method of extraction using methanol and ethanol as a solvent was utilized. 30g of the plant powdered sample was used in each 400ml for both the solvents i.e. methanol and ethanol (Reza Dehghani Bidgoli, 2014).

2.4 Insecticidal Analysis

2.4.1 Study Area

The study was conducted at the physiology lab, international institute of tropical agriculture (IITA) Kano state, Nigeria.

2.4.2 Collection of Cowpea Seed (Vigna unguiculata)

The clean and healthy cowpea seed was obtained from the international institute of tropical agriculture (IITA) in Kano, Nigeria, and mechanically damaged seeds were excluded.

2.4.1 Processing of Cowpea Seed

The checked seeds were placed in plastic bags and kept in a freezer overnight to eliminate any possible beetle infestation coming from the field, *Marcileyne et al (2004)*. The seeds are then removed from the freezer and kept at room temperature and relative humidity for some hours to equilibrate the moisture content and also measured before the experiment (*Jackai and Asante, 2001).*

2.5 Collection of Test Insects

The Cowpea seeds with infested insects were purchased from the local market (i.e Hotoro Dan-market), Tarauni local government, and the insect was identified and authenticated at the crop protection department, international institute of tropical agriculture (IITA) Kano state, Nigeria.

2.5.2 Rearing of Cowpea Beetle (C. maculatus)

The insects were raised and developed in a laboratory setting using cowpea (*Vigna unguiculata*) seeds,that had a relative humidity of 75± 5% and an ambient temperature of 28± 2°C. Initially, a plastic bucket holding 6 kg of cowpea seeds and 60 pairs of 1-2 day old adults was used to allow mating and oviposition for approximately 7 days. In order to ensure appropriate aeration and prevent contamination and beetle egress, the parent stocks were then removed, and cowpea seeds bearing eggs were covered with fabric connected with rubber bands. The experiments were conducted using the beetles' progeny (Mobolade-Adesina, 2020).

2.6 The Test Experiment

The experiment was conducted according to the procedure (Howse, 1994). Three different dosages of both the two extracts from the leaf of *S. spinosa* (0.2g, 0.4g, and 0.6g) were prepared and then separately mixed with ten (10) cowpeas seeds in separate plastic containers with a diameter of 1.7cm by a depth of 1.7cm. To ensure that the ten cowpea seeds were fully coated with the extract, the mixture of the seeds and the various dosages of the extract were thoroughly shaken. A positive control using cypermethrin dust was prepared as a standard chemical pesticide. Additionally, a control treatment was also prepared, i.e. a negative control, that contained neither extract nor cypermethrin dust. Five pairs of the beetle *C.maculatus* which freshly emerged from the culture were released into each treatment (three female and two male). These were covered with a muslin cloth to facilitate proper aeration and prevent the entry and exit of insects. Each treatment was replicated three times, arranged in a completely randomized design (CRD), and left on the laboratory bench for daily observation (Dike, 1996). Mortality of the insect was observed 72 hours after treatment. The numbers of eggs laid were counted separately for each treatment. On the third day after the introduction of beetles to seeds all the eggs laid in different Plastic containers were examined and the viable eggs were identified. Viable eggs were recognized by their morphological aspect, the adult emergence was also determined on 21days after the introduction of beetles to the seeds (Abdullahi, 2011).

3.RESULTS/DISCUSSION

EXTRACTION RESULT

The weight of the extracts recovered from the methanolic and ethanolic extraction, with their respective physical properties are given in the table below:

Table 3.1: Showing the results of the extraction:

S/N	Extract	Colour	Texture	Weight
1	Methanolic	Green	Powder	7.20g
2	Ethanolic	Dark-green	Powder	8.86g

INSECTICIDAL ANALYSIS RESULT

Table three below shows the effect of the leaf methanolic and ethanolic extracts of *Strychnos spinosa* on the mortality of adult cowpea beetle (*C. maculatus)* on treated cowpea seed *(Vigna unguiculata)* and observe the number of the eggs laid for each 10 seed in 72 hours.

Table 3.2: Showing the mean number of the rate of mortality.

S/N	PRODUCTION AND DOSAGE IN GRAM	MORTALITY OF ADULT INSECTS	MORTALITY OF FEMALE INSECTS	MORTALITY OF MALE INSECTS	NUMBER OF EGGS ON THE SEEDS
1	P1D1	2.33	2.00	0.33	4.00
2	P1D2	4.00	2.00	2.00	14.00
3	P1D3	2.00	1.33	0.66	16.33
4	P2D1	0.66	0.33	0.33	4.00
5	P2D2	1.00	0.00	1.00	35.66
6	P2D3	1.33	0.33	1.00	36.33
7	CR1	0.33	0.00	0.33	54.00
8	CR2	5.00	3.00	2.00	0.00

KEYS: *P_1 = ethanolic extract, P_2= methanolic extract, D_1= 0.2g, D_2= 0.4g, D_3= 0.6g, CR1 = negative control, and CR2 = positive control.*

DISCUSSION

From the Soxhlet extraction only 7.2g was recovered for the methanolic extract while for ethanolic extract 8.86g was recovered. The result of this study has shown that ethanolic and methanolic leaf extracts from strychnos spinosa plants have the potential to manage cowpea beetles, and *C. maculatus*. Both the two extracts cause mortality and suppress eggs laying by *C. maculatus*. This mortality caused by leaf extracts may be attributed to the insecticidal properties of extracts. According to Idoko and Adesina (2012), plant extracts may contain insecticide/or repellent compounds including fatty acids. The result of this study agrees with the findings of previous workers who have reported the effectiveness of various plant extracts used as grain protectants against various insect pests of stored products (Niranjana R F, 2019). It is clear from the study that ethanolic extract was potent in managing *C. maculatus* as the extract causes high mortality, reducing oviposition of eggs laid by the weevils compared to that of methanolic extract. On the effect of dosage, this study shows insecticidal's activity of plant extract depends on the dosage of the extracts as witnessed in the number of eggs laid and mortality rate as earlier reported using different plants (A. M. Oparaeke, 2006; N., 2011). Furthermore, separate studies report that the efficacy of various plant products tested against storage insect pest increase with increasing dose of the plant products (J. A. Chudasama, 2015). In this study, methanolic extract dosages (i.e. 0.2g, 0.4g, and 0.6g) of the extract, the effect of the rate of mortality increased with the increase of dosage compared with the positive control, where all the five insects died, as described in the chat below.

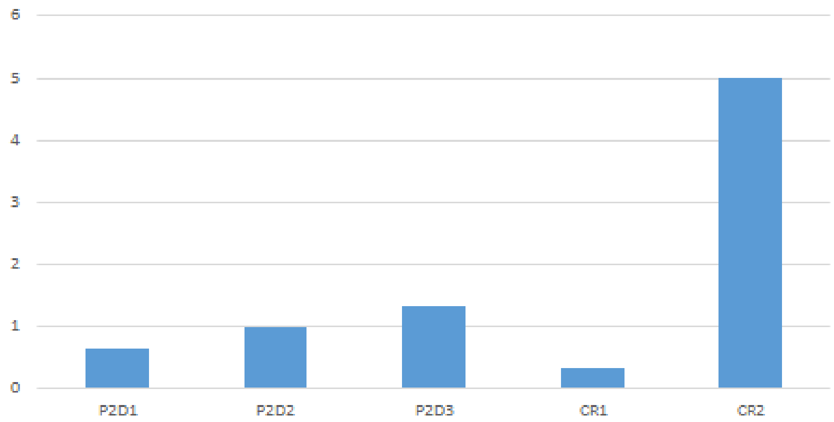

fig 3.1: Bar chart showing the rate of mortality of the adult in 72 hours using the dosage of the methanolic extract

The number of eggs laid also decreases with increases in dosage, however compared with negative control which has the highest number of eggs because the insects are kept with seeds for 3 days without any insecticides or extract, they did not die until the end of their life cycles (i.e. 8 to 11 days) only one dies. While the ethanolic extract is more effective for the *C. maculatus.* The effect of dosage is more effective at the medium dosage on the rate of mortality of the bruchids (i.e. 0.4g), as in figure 3.2, but the number of eggs laid also increase with the increase of the dosage as in the bar chart figure 3.3

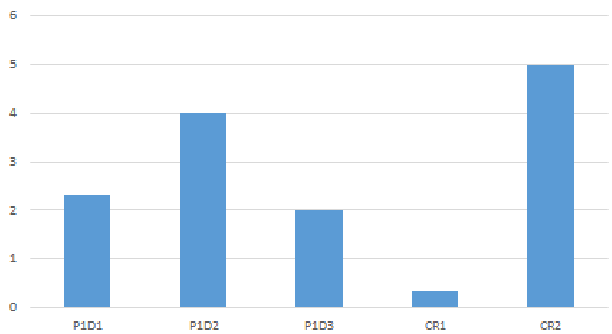

Figure 3.2: Showing rate of mortality of the adults in ethanolic extract

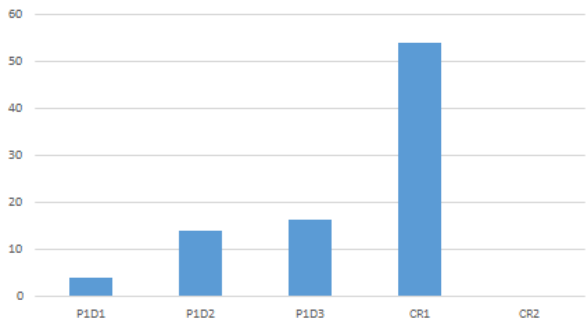

Figure 3.3: Number of eggs laid by the adults in ethanolic extract

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CONFLICT OF INTEREST

The authors declared no competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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