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Research Article
Insecticidal Comparison of Botanicals and Synthetic Insecticide on Cowpea Bruchid, *Callosobruchus maculatus* (Fab.) [Coleoptera: Chrysomelidae] Development on *Vigna unguiculata* (L.) Walp

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Abstract
Background and Objectives: Cowpea seed bruchid, a cosmopolitan field-to-insect pest of stored cowpea. Efficient and effective control were achieved using synthetic chemicals but with consequences on human and the environment. The study was conducted to compare the effect of botanicals and a synthetic insecticide on Cowpea Seed Bruchid (CSB) development and also to identify chemical constituents in catmint that are pesticidal. **Materials and Methods:** About 30 g of uninfested Sampea 13 cowpea seeds were place in plastic containers measuring 8.80 (outside lid diameter) and 3.80 cm (depth). Five grams of each treatment were separately measured into the plastic containers and shaken. Five pairs of approximately one day old CSB were artificially introduced in to the each cup. The cups were covered with a muslin cloth and fastened with a rubber band to disallow CSB escape, but cut opened to allow aeration. The experiment was arranged in a completely randomized design and replicated four times. Parameters measured were on mortality, oviposition and number of progeny emergence. The data was subjected to analysis of variance and means were separate using LSD at 5% probability level. **Results:** The results obtained showed a significant difference ($p \leq 0.05$) on mortality between the treatments and the control. Highest mortality counts were recorded in pestox (6.00) 24 h after infestation. Significantly ($p \leq 0.05$) higher number of eggs were laid in the control compared to botanicals which were statistically similar. There was no significant difference ($p \geq 0.05$) among the botanicals and pestox on mean number of progeny emergence. However, high mean adult emergence was recorded in the control (18.50). Phytochemical analysis of catmint revealed the presence of insecticidal secondary metabolites such as flavonoids, tannins, saponins and alkaloids. **Conclusion:** Based on this findings, botanicals can be used in preserving cowpeas instead of using synthetic insecticides that are highly toxic and their use has some negative consequences on human, animals and the environment.

Key words: Botanicals, synthetic insecticide, cowpea, *Callosobruchus maculatus*, chemical constituents, anthraquinone

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Cowpea, *Vigna unguiculata* (L.) Walp belongs to the family of crops Fabaceae, genus *Vigna*. It is otherwise called black eye pea or southern pea and constituted one of the most important food legumes in the tropics and sub-tropical countries[1]. It is an annual legume and believed to have originated from Africa[2]. According to African Agricultural Technology Foundation[3], cowpea was categorized as a grain legume which can be cultivated in tropical Africa. It is the most important indigenous legume in the dry savanna of the tropics cultivated on about 12.5 million ha with annual production[4] of about 3 m t. Nigeria is one of the world's largest producer of cowpea with an average production of 2.92 m t. followed by Niger Republic[5] with 1.10 m t. Cowpea constituted an important source of protein for poor resourced rural and urban people with about 22-26% protein[6]. The crop is commonly consumed in different forms[7, 8].

The primary insect pest causing loss to stored cowpeas in West Africa is the cowpea weevil, *Callosobruchus maculatus* (Coleoptera: Chrysomelidae). It was ranked as the most notorious post-harvest pest. Damage to stored cowpea due to *C. maculatus* infestation is a very serious problem to farmers and traders[9]. Infestation begins in the field and insect population continued to build up until cowpea is completely damaged and great loses suffered[10,11]. Cowpeas weights lose up to 30% were also observed[12]. Infestation culminates in substantial reduction in the quantity and quality of seeds. Damaged cowpea grains are unfit for household and commercial uses[13]. Farmers generally resort to application of synthetic insecticide otherwise they will lose the entire stored product[14]. Bruchids control using plant products proved most promising alternative. For several decades, the use of plant materials as grain protectant and particularly control of cowpea bruchids in cowpea is regarded as next alternative strategy. Plants repel insects with their volatile chemicals and thus stop further infestation. Plants were endowed with some chemicals capable of affecting the insect metamorphosis. Studies were carried out on the effect of black pepper powder on cowpea beetle[15] with outcomes significantly suppressing seed bruchids survival, less damage and fewer exit holes were observed by Reuben *et al.*[16]. The similar experiment of Emeasor *et al.*[17] evaluated the efficacy of mixed seed powders of *Piper guineense* (Schum and Thonn) and *Thevetia peruviana* (Persoon) Schum against CSB and observed that the mixture of seed powders of *P. guineense* and *T. peruviana* caused mortality of the weevil. Botanicals such as; *Azadirachta indica*, *Acorus calamus*, *Lantana camara*, *Melia azadarach*, *P. nigrum and Adhatoda zeylanica* were biodegradable, non-residual, equally effective and easily available. Synthetic insecticides have played a historic role in agricultural development and particularly in the post-harvest grain storage. According to Ekeh *et al.*[18], the use of chemical insecticides gives the best result in controlling CSB. Insecticides were reported to have a quick knock-action and were persistent, efficient and effective means of control. Their use by farmers has however been criticized worldwide[19]. In spite of chemical effectiveness, they possessed some negative effects. Adebiyi and Tedela[20], Suleiman and Yusuf[21] and Sharah and Ali[22] reported that chemicals were unavailable, expensive, hazardous to man and livestock, low biodegradability and development of resistance. Recent revelations have shown that synthetic insecticides were found to penetrate grains and become toxic[20]. All these had called for, an alternative to these synthetic products[14].

The common name catmint locally referred to as "Bunsurun fadama in Hausa Language, Nigeria" is cultivated as an ornamental plant for use in gardens. The drought resistant plant is grown for its attractants qualities to house cats and butterflies. According to Ghannadi *et al.*[23], *Nepeta cataria* has been widely used in traditional medicine in many countries. The decoction of leaves and aerial parts are used against kidney disorders, rheumatism and inflammations[24]. *Nepeta cataria* showed many biological activities, viz; anti-inflammatory, antimicrobial, antioxidant as well as antifungal[25]. It can be a repellant for certain insects including aphids and squash bugs[26]. Catmint possessed an ingredient called Nepetalactones that were now known to act as insect repellant. It can be harnessed as component of integrated pest management of harmful insect pests species opined by Sharma *et al.*[27]. Oil isolated from the plant by steam distillation act as a repellant against insects, in particular mosquitoes, cockroaches and termites. Some related compounds (iridoids) identified were mainly responsible for different biological activities of the plant, viz; cat attractant, insect heromone, insecticidal and insect repellent[27]. Local farmers in northern Nigeria use catmint as protectant against insect pests in their local storage structures. Extensive researches were carried out on its medicinal values. However, no research was conducted on its agricultural pest control benefit. This research was aimed at evaluating the efficacy of the powders of neem, *Azadirachta indica* A. Juss, ginger, *Zingiber officinale* Roscoe and catmint, *Nepeta cataria* (L.) against *C. maculatus* in stored cowpea and to identify the chemical constituents in catmint that are pesticidal.

MATERIALS AND METHODS

Site description: The experiment was conducted in Microbiology Laboratory, Federal University Dutsin-ma, Latitude 12°27'14.11"N and Longitude 7°29;50.03"E, Katsina state, Nigeria from June-September, 2019.

Sources of plant materials: Ginger rhizome was purchased from a market in Dutsin-ma town and the neem kernel seeds were collected from a nearby neem tree plantation while catmint was obtained from a Fadama area. They were shade dried for 7 days before grounded into small particles size and then sieved with 2 mm mesh according to Muhammad *et al.*[28]. Pestox as synthetic insecticide was used. It is a contact poison chemical consisting of cypermethrin (2.0%), talc (97.8%) and fragrance (0.2%). It was purchased from chemical store in Dutsin-ma town.

Data collection

Mortality: The mortality of adult bruchids were recorded at 24, 48 and 72 h after infestation. Insects that failed to respond to 3 probing using feather were assumed dead and were included in the counts as in the work of Udo *et al.*[29].

Oviposition: Ten cowpea seeds were randomly sampled and the number of egg laid were counted and recorded under a hand lens 2 weeks after artificial infestation.

Progeny emergence: Insect culture as well as the total numbers of F_1 progeny emerged at the end of the experiment were also counted according to Adenakan *et al.*[8].

Phytochemical analysis of catmint powder: Qualitative and quantitative chemical test analysis of the powder were carried out at National Research Institute for Chemical Technology in Zaria, Nigeria. Insecticidal plant components as secondary metabolites consisting of terpenoid, alkaloid, flavonoids, tannins, saponins and phenols etc., were determined using the procedure described by Khan *et al.*[30].

Data analysis: The data obtained were subjected to one way analysis of variance (ANOVA) using SAS system version 9 and means were separated using LSD at 5% level of significance.

RESULTS

Cowpea seed bruchid mortality: Statistically similar results were obtained among T1 (0.00), T3 (1.05) and T5 (0.00). Statistically similar result was obtained at both 48 and 72 h with, T4 having the highest mortality (3.075) and T2 recorded the lowest (1.00) at 48 h while T1 recorded the highest (2.00) and T4 recorded the lowest (0.25) at 72 h (Table 1).

Table 1: Effect of botanicals and synthetic insecticide on cowpea seed bruchid (*Callosobruchus maculatus*) mortality at different time after infestation in Dutsin-ma

Treatments	24 (h)	48 (h)	72 (h)
T1	0.000^{b}	3.025^{a}	2.000
T2	4.075^{a}	1.000^{b}	0.075
T3	1.050^{b}	1.075^{ab}	0.075
T4	6.000^{a}	3.075^{a}	0.025
T5	0.000^{b}	1.075^{ab}	1.050
LSD	2.447	1.842	1.477

Means followed by same letters within the same column are not significantly different ($p \leq 0.05$) using Least significant difference (LSD), T1: Ginger, T2: Neem kernel seed, T3: Catmint, T4: Pestox , T5: Control

Table 2: Effect of botanicals and synthetic insecticide on number of eggs and progeny emergence on cowpea seed bruchid

Treatments	Mean No. of eggs laid	Mean No. of progeny emerged
T1	4.050^{ab}	05.00^{bc}
T2	5.000^{a}	06.25^{bc}
T3	4.025^{ab}	09.00^{b}
T4	2.025^{b}	03.25^{c}
T5	6.000^{a}	18.50^{a}
LSD	2.020	03.752

Means followed by same letters within the same column are not significantly different ($p \leq 0.05$) using Least Significant Difference (LSD), T1: Ginger, T2: Neem kernel seed, T3: Catmint, T4: Pestox, T5: Control

Table 3: Result of qualitative and quantitative phytochemical test of catmint powder

Secondary metabolites	Qualitative test	Quantitative test
Terpenoid	+	02.29
Alkaloid	+	08.88
Flavonoids	++	04.83
Tannins	++	01.56
Saponnins	+	11.06
Phenol	+	06.09
Anthraquinones	-	00.41

Phytochemical analysis carried out at National Research Institute for Chemical Technology, Zaria, Kaduna state, Nigeria, +: Present, -: Absent, +: Little, ++: Moderate

Effect on oviposition and progeny emergence: Statistically similar results were obtained among the treatments on mean number of eggs. The control recorded the highest means oviposition (6.00) compared with the other treatments (botanicals). Synthetic insecticide treatment recorded the lowest (2.25) mean number of eggs laid (Table 2). No significance difference ($p \geq 0.05$) was obtained among the botanicals and the synthetic insecticide on mean number of progeny emergence. Lower means were however recorded in synthetic insecticide (3.25). The control significantly ($p \leq 0.05$) recorded highest number of progeny (18.50) compared with the other treatments (Table 2).

Phytochemical analysis of catmint powder: The result of qualitative and quantitative phytochemical test of catmint powder revealed the presence of secondary metabolites that were pesticidal in the plant material (Table 3).

DISCUSSION

The result of this study indicates that pestox and neem kernel seed powder showed similar effect on Cowpea Seed Bruchid (CSB) at 24 h as they have highest insecticidal activity. This was presumed due to the presence of azadirachtin, an active ingredient in neem kernel seeds. This implied that neem kernel seed and pestox had high insecticidal activity on CSB than ginger and catmint. Ginger and pestox showed high insecticidal activity on CSB after 48 h as compared to other treatments. This finding disagreed with the work of Yusuf *et al.*[1], who observed that there was no significant difference on effect of CSB on ginger powder and pirimiphos methyl (synthetic insecticides). While significant effects were observed among the treatments and control at 72 h. This is in disagreement with the findings of Adenakan *et al.*[8], who observed that all bruchid beetles treated with pirimiphos methyl (synthetic insecticide) died within 10 h. It can therefore be concluded that ginger and neem kernel seed can cause bruchid mortality. This finding is in agreement to the works of Brisibe *et al.*[31] who evaluated different plant materials and observed significant insecticidal properties that are relevant in pest control. The family Zingiberaceae contains a variety of compounds which have shown insecticidal, oviposition, antifeedant, growth regulating, reducing fecundity, development modifying properties and repellent activity against many tested insects[32]. There was reduction in number of egg laid on cowpeas treated with plant materials as compared to the control. Control recorded higher number of progeny than other treatments and this result also support the earlier observations by Adenakan *et al.*[8], who reported pesticidal effect of moringa plant parts for the control of bruchid beetles on cowpea. The powders of *Azadirachta indica*, *Zingiber officinale* and *Nepeta cataria* from this study proved to have efficacy on CSB compared with the control. The pesticidal properties of plant material can be ascertained due to the presence of active ingredients referred to as secondary metabolites. These secondary metabolites include terpenoid, alkaloid, flavonoids, tannins and saponins etc. This findings agreed with the work that reported, *N. cataria* as rich sources of nepetalactones and related compounds such as; tannins, phenols and saponins etc., which have been mainly responsible for different biological activities that included cat attractant, insect pheromone, insecticidal and insect repellency[24,33,34]. This research now opened up for further investigation of the role of these secondary metabolites present in catmint in agricultural pest control. More research need to be undertaken to determine the part of the plant having high concentration of these metabolites. Similar trial can be carried out to validate these finding on the effect of catmint on CSB.

CONCLUSION

Based on the results obtained in this study, management of cowpea seed bruchid using botanical powders of neem, ginger and catmint could be achieved. However, their effectiveness were not as that of synthetic insecticide. Therefore, cowpeas intended for storage can be admixed with any of these botanicals in order to extend its storage period without necessarily resulting to the use of synthetic insecticide.

SIGNIFICANCE STATEMENT

This study discovers that catmint contained some important pesticidal compounds that could be used in agricultural pest control. The plant was valued much in ethnomedicinal control of many sicknesses. This pioneer research now indicated that it can as well be used in the management of storage insect pests.

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