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INSECTICIDAL EFFICACY OF *Balanite aegyptiaca* (L.) SEED OIL IN THE MANAGEMENT OF *Callosobruchus maculatus* (F.) (COLEOPTERA: BRUCHIDAE) ON FRESHLY INFESTED COWPEA GRAINS

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ABSTRACT

Protection of grains against infestation and damage by diverse storage insect pests is an age-long practice that ensures agricultural produce and guarantees food security. This paper reports the insecticidal efficacy of Balanite aegyptiaca (L.) seed oil in reducing and/or inhibiting damage and loss in cowpea grains infested with freshly laid eggs. The experiment involved weighing ten grams (10 g) of cowpea grains from four different varieties into a 200 ml bottle in four replicates for both untreated and four levels of Balanite

Introduction

Cowpea (*Vigna unguiculata* [L.] Walp.) is one of the most important food legumes cultivated in tropical and subtropical regions, valued for its high protein content, adaptability to diverse agro-ecological zones, and role in food security (Singh *et al.*, 2020). Nigeria is the largest producer of cowpea globally, contributing more than 70% of total world production (FAO, 2021). Despite its importance, cowpea production and storage

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aegyptiaca treatments (0, 0.2, 0.4, 0.6 ml). The number of grains from each replicate was counted and recorded. Three pairs of 0-48 hrs old male and female C. maculatus were used to infest the grains of each replicate for both untreated and the four treatment levels. After seven days, the bruchids were removed and the number of eggs laid was counted. The four levels of B. aegyptiaca treatments were then applied to the eggs laid on the cowpea grains. The number of adults that emerged from the grains in each replicate was counted daily throughout the first filial generation (F1). All data were subjected to analysis of variance at a 5% level of probability, and significantly different means were determined using the least significant difference. The results indicated statistical significance ($P<0.05$) between treated and untreated grains of each variety. This demonstrated the bio-efficacy of BSO in salvaging freshly infested grains by C. maculatus. Success was mainly due to the oil's larvicidal/suppressive or inhibitory effect on early larval instars, thereby reducing and/or inhibiting the damaging effect of C. maculatus.

Keywords: Cowpea grains, Balanite aegyptiaca, Callosobruchus maculatus, Insecticidal Efficacy, Management

are severely constrained by insect pests, particularly the cowpea weevil, *Callosobruchus maculatus* (F.) (Coleoptera: *Bruchidae*). This beetle is recognized as the most destructive storage pest of cowpea, responsible for up to 90% of post-harvest seed damage if uncontrolled (Amatobi, 2007; Aliyu *et al.*, 2020). Infestation often begins in the field but escalates rapidly during storage, leading to seed perforation, weight loss, reduced germination capacity, and complete loss of market value (Ojo and Omoloye, 2019).

For decades, synthetic insecticides and fumigants such as phosphine have been the predominant tools for managing storage insect pests due to their rapid knockdown effect and relatively low cost (Baoua *et al.*, 2021). However, indiscriminate use of these chemicals poses significant challenges including health risks to consumers, contamination of the environment, harm to non-target organisms, and the development of resistant pest populations (Opit *et al.*, 2020). These limitations have necessitated the search for eco-friendly, safe, and sustainable alternatives.

Botanical pesticides, particularly essential oils and plant-derived extracts, have shown promising insecticidal, repellent, and oviposition-deterrent effects against C. maculatus (Kedia *et al.*, 2015; Ahmed *et al.*, 2021). In recent years, studies have highlighted the protective effects of plant seed oils such as neem (*Azadirachta indica*), castor (*Ricinus communis*) and *Balanite aegyptiaca* against bruchid infestation (Oladejo *et al.*, 2019;

Adeyemo *et al.*, 2022). While much research has focused on the preventive role of these botanicals in protecting clean grains, there is limited information on their curative efficacy—that is, their potential to salvage already infested grains. This gap is critical because in most rural storage systems, farmers often discover infestations only after they have already begun.

Therefore, this study evaluates the insecticidal efficacy of *Balanite aegyptiaca* (L.) seed oil in the management of *C. maculatus* on freshly infested cowpea grains. Specifically, it evaluates its effects on oviposition, adult emergence, percentage seed damage, and severity of infestation. By doing so, the study aims to provide scientific evidence supporting the use of *B. aegyptiaca* seed oil as a sustainable alternative to synthetic insecticides in smallholder storage systems.

AIM AND OBJECTIVES OF THE STUDY

Aim

The aim of this research is to determine the insecticidal efficacy of *Balanite aegyptiaca* seed oil in the management of *Callosobruchus maculatus* (F.) in freshly infested cowpea grain.

The objectives of the study were to:

I. Evaluate the effect of *Balanite aegyptiaca* seed oil on the oviposition of *Callosobruchus maculatus* (F.) infecting cowpea.
II. Determine the effect of *Balanite aegyptiaca* seed oil on adult emergence of *C. maculatus*
III. Evaluate the efficacy of *Balanite aegyptiaca* seed oil on percentage seed damage of cowpea.
IV. Determine the severity of damage to freshly infested cowpea.

MATERIALS AND METHOD

Experimental site

The experiment was conducted at the Agronomy laboratory, Department Agricultural Technology, Federal Polytechnic, Bauchi, Bauchi state, Nigeria. The experiment lasted from January to April 2025 under a prevailing temperature of 25-30°C and 27-56% relative humidity.

Cowpea Variety Used

Grains of local varieties of cowpea, *Vigna unguiculata* (Borno Brown, Banjara, Gwadam and Kanannado) used for the experiment were obtained from a local farmer in Biu,

Borno State, Nigeria. The cowpea grains were sorted out, cleaned, and stored in a refrigerator until required for use.

Collection of *Balanite aegyptiaca* seeds and extraction of the oil

B. aegyptiaca seeds were collected from around Central market, Bauchi, Bauchi State, Nigeria, and were air-dried in the shade. The crude *B. aegyptiaca* seed oil was extracted using the traditional method for extraction of vegetable oils. The dried seeds were shelled to obtain the kernel and grilled with intermittent stirring for five minutes. The kernels were allowed to cool and pounded to a paste using mortar and pestle. Some little amount of boiling water was added and stirred until the oil separates from the cake. The crude oil was decanted and heated to reduce the moisture.

Insect Culture

Adult Callosobruchus maculatus was raised on Banjara Cowpea grain obtained in a local market in Bauchi. The culture was reared under ambient fluctuating temperature ranging from 25-30°C and 27-56% Relative humidity. Adult *C. maculatus* 0-48 hrs old that emerged from the culture were used to infest grains of experimental replicates.

Experimental Procedure

Experiment was conducted in the Agronomy laboratory, Department Agricultural Technology, Federal Polytechnic Bauchi under the same conditions that *C. maculatus* was raised. Ten grams (10g) Cowpea grains of the four varieties were each weighed into a 200ml bottle in four replicates for untreated and four levels of *Balanite aegyptiaca* treatments (0, 0.2, 0.4, 0.6ml). Number of grains from each replicate was also counted and records taken. Three pairs male and female of (0-48hrs) old *C. maculatus* were used to infest grains of each replicate for untreated and four levels of *Balanite aegyptiaca* treatments, The bruchids were removed after seven days and the number of eggs laid was counted. Four levels of *B. aegyptiaca* (0, 0.2, 0.4, 0.6 ml) treatments were applied on eggs laid on the cowpea grains. Number of adults that emerged from grains in each replicate was counted daily throughout the first filial generation (F1). Data obtained on number of eggs laid and adults that emerged from grains of each replicate for the levels of *B. aegyptiaca* treatments were sum up. Percentage seed damage was calculated using the formula; Number of damaged seeds/Total number of seeds x 100, while severity of seed damage to cowpea grains of each cultivar was calculated using the formula: Number of adults that emerged/number of seeds x 100.

Data Analysis

Data obtained on number of eggs laid and adults that emerged, percentage and severity of seed damage were subjected to analysis of variance (ANOVA). Significantly different means were determined using the least significant difference (LSD) at 5% level of probability.

RESULTS AND DISCUSSION

Mean number of eggs laid by *C. maculatus*

There was no significant (P>0.05) differences in the mean number of eggs laid on cowpea grains of all the varieties of cowpea (Table 1). The lack of significant differences recorded in the mean number of eggs laid by *C. maculatus* on each variety showed that the cowpea grains are liable to infestation by the cowpea bruchid, despite the fact that female *C. maculatus* laid more eggs on the smooth coated than a rough-coated seeds. For instance, studies by Messina and Renwick (1985) that evaluated the resistance of selected cowpea lines to infestation by *C. maculatus* found that a rough seed coat was less preferred for oviposition by the bruchid beetle. Nwanze *et al.* (1975) showed that rough seeds were less acceptable to *C. maculatus* than smooth ones.

Table 1: Mean number of eggs laid by *C. maculatus* on 10 g Cowpea grains

	Borno Brown	Banjara	Gwalam	Kanannado
	7.67	18.33	34.00	7.33
	10.67	33.33	42.67	4.67
	9.33	14.00	23.67	21.67
	9.67	13.67	35.00	17.33
SE±	3.01	8.37	7.05	6.20
LSD	6.94	19.29	22.99	14.29

Values are means of three replicates

Mean number of Adults emerged from treated Cowpea grains

There was a high significant (P<0.05) difference in the mean number of adult that emerged from infested untreated grains of Borno brown, Banjara and Kanannado relative to treated grains with each dose of Balanite seed oil (BSO), there was however no statistical significance among grains treated with different dose of the oil. There was also no significant difference in the mean numbers of adult that emerged from untreated grains of Gwalam relative to treated grains at 0.2 ml. There was a high significant (P<0.05) difference in number of adult that emerged from the check compared to grains

treated with higher dose of 0.4 and 0.6 ml (Table 2). This result showed the bio-efficacy of *B. aegyptiaca* seed oil in not only reducing but completely inhibiting adult emergence as a result of damage and loss by the cowpea bruchid. All Balanite seed oil (BSO) doses were effective in reducing or completely inhibiting damage. This tallies with the findings of Dauda *et al.*, (2013) who reported that early larval instars are more amenable to the effect of sesame seed oil than late larval instars. They further showed that cowpea grains infested with 8 days old eggs/larvae could still be saved from damage and loss by *C. maculatus*. In addition, the effect of sesame seed oil could also be protective against re-infestation by *C. maculatus*. Ravindra (2010) also reported *Jatropha* seed oil to be highly toxic to the eggs of *C. maculatus* compared to other pre-adult stages. Water melon seed was similarly reported to prevent adult emergence from the eggs laid on cowpea seeds (Okunola, 2003).

Table 2: Mean number of Adults emerged from treated Cowpea grains

Balanite Seed Oil ml/10gram	Borno Brown	Banjara	Gwalam	Kanannado
0.0	15.00	13.00	21.67	6.00
0.2	0.00	0.00	6.00	0.00
0.4	0.00	0.00	0.00	0.00
0.6	0.00	0.00	0.00	0.00
SE±	1.22	4.71	7.67	1.41
LSD	2.82	10.86	17.69	3.26

Values are means of three replicates

Mean percentage damage by *C. maculatus* in infested treated grains

There was a high significant ($P<0.05$) difference in mean percentage damage of untreated grains compared to treated grains with each dose in each of the cowpea cultivar (Borno brown, Banjara and Kanannado and Gwalam). The effect of the oil is dose dependent, with reduction of adult emergence as the dose increased, resulting to zero adult emergence at 0.4 and 0.6 ml dose each of the variety (Table 3). The result showed that the oil is effective in reducing or inhibiting damage by *C. maculatus* on cowpea grains. The result presents the promising effect of *aegyptiaca* seed oil in mitigating damage by the beetle.

Table 3: Mean percentage damage by *C. maculatus* in infested treated grains

Balanite Seed Oil ml/10gram	Borno Brown	Banjara	Gwalam	Kanannado
0.0	46.04	21.33	39.67	7.67
0.2	0.00	0.00	8.67	0.00

0.4	0.00	0.00	0.00	0.00
0.6	0.00	0.00	0.00	0.00
SE±	6.97	7.58	15.65	1.89
LSD	16.09	17.47	36.08	4.35

Values are means of three replicates

Mean severity of damage to freshly infested Cowpea grains by *C. maculatus*

Results from Table 4 showed a high significant ($P<0.05$) between untreated and treated grains. It was also dose dependent as severity of damage reduced with increase in **BSO** dose. This also showed the efficacy of the oil in inhibiting or reducing damage potential. Plant oils are generally reported to exert ovicidal action against insect pest of stored product (Don-Pedro, 1989).

Balanites aegyptiaca seed oil (BSO) was effective in reducing and inhibiting damage and loss in cowpea grains infested with freshly laid eggs by the beetle *C. maculatus*. The oil had a **larvicidal/suppressive or inhibitory effect** on the egg/larval instars, preventing adult emergence.

The study showed the **bio-efficacy of BSO** in salvaging freshly infested grains. While consumers generally prefer uninfested grains, the researchers suggest that in developing regions where food scarcity is an issue, salvaging grains from complete damage and loss would be a welcome idea for poor resource farmers.

Table 4: Mean severity of damage to freshly infested Cowpea grains by *C. maculatus*

Balanite Seed Oil ml/10gram	Borno Brown	Banjara	Gwalam	Kanannado
0.0	43.16	31.33	47.67	16.00
0.2	0.00	0.00	22.33	0.00
0.4	0.00	0.00	0.00	0.00
0.6	0.00	0.00	0.00	0.00
SE±	5.07	10.63	20.09	3.53
LSD	11.68	24.50	46.31	8.15

Values are means of three replicates

SUMMARY, CONCLUSION AND RECOMMENDATIONS

Summary

Callosobruchus maculatus is a major field to storage pest of cowpea with initial infestation starting in the field and expanding rapidly during seed storage. *C. maculatus* appeared to be responsible for over 90% of the damage done to cowpea seeds by insects

(Amatobi, 2007). Outside Africa in India cowpea is grown on an area of 3.9 million hectares with a production of 2.21 million tonnes with the national productivity of 683 kg/ha (Singh *et al.*, 2012). Cowpea is a major source of dietary protein that nutritionally complements staple low-protein cereal and tuber crops, and is a valuable and dependable commodity that produces income for farmers and traders (Singh, 2002).
Dauda *et al.*, (2014) showed the promising effects of Moringa seed oil as a protectant against the cowpea bruchid infestation. However, the curative effect of plant essential oils with a view to salvaging freshly infested grains has not been sufficiently reported in literature. This study aims at evaluating the efficacy of *Balanites aegyptiaca* (L.) seed oil in mitigating *C. maculatus* damage and loss to freshly infested cowpea grains in storage.

Conclusion

From this study, it was observed that *B. aegyptiaca* seed oil was effective in reducing and/or inhibiting damage and loss in cowpea grains infested with freshly laid eggs, in grains of all the varieties of cowpea treated with the various doses of Balanite seed oil (BSO). The oil appeared to have had adverse effect on egg/larval instars of the beetle as no adult emergence was recorded in all grains treated with all doses in Borno brown, Banjara, and Kanannado varieties and high doses of 0.4 and 0.6 ml in Gwalam variety with the exception of grains treated with 0.2 ml. This showed the bio-efficacy of BSO in salvaging freshly infested grains by *C. maculatus*. Success was achieved mainly due to its larvicidal/suppressive or inhibitory effect. Although consumers would prefer clean uninfested grains for consumption, but availability, deprivation, educational or social status may play a role in the acceptance of freshly and lightly infested cowpea grains. In under developed regions (countries) where malnutrition and lack of enough food is common, salvaging such grains from complete damage and loss will be a welcome idea to the poor resource farmers.

Recommendations

I. Adoption of BSO as Grain Protectant: Farmers, especially in resource-poor communities, should be encouraged to adopt *Balanite aegyptiaca* seed oil (BSO) as a cost-effective, eco-friendly, and locally available method of protecting cowpea grains against *Callosobruchus maculatus* infestation.
II. Extension and Awareness Programs: Agricultural extension services should create awareness among farmers about the efficacy, preparation, dosage, and safe application of BSO for grain protection.
III. Dosage Optimization: Since the study revealed that higher doses (0.4 ml and 0.6 ml) were more effective in preventing adult emergence, farmers should be

guided on the appropriate concentrations to ensure maximum protection of grains with minimal wastage of oil.

IV. Integration into Storage Practices: BSO treatment can be integrated with other indigenous and modern storage practices (e.g., airtight containers, PICS bags) to enhance grain preservation and reduce post-harvest losses.

V. Nutrition and Food Security Consideration: In regions where food scarcity is common, the use of BSO to salvage lightly infested grains should be encouraged to reduce hunger, malnutrition, and economic losses.

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