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ORIGINAL RESEARCH ARTICLE

Botanical Control of Cowpea Weevil (*Callosobruchus maculatus*) in Stored Cowpea Using *Ocimum gratissimum* and *Allium sativum* Powders in Lafia, Nasarawa State

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ABSTRACT
An infestation of storage cowpeas caused by *Callosobruchus maculatus* poses a significant risk, which can lead to food shortages and economic losses especially where cowpeas are a main crop. This study investigated the insecticidal potential of *Allium sativum* and *Ocimum gratissimum* leaf powders in managing *Callosobruchus maculatus* infestation in stored cowpea seeds. Different amounts (5g, 10g, 15g, 20g, and 25g) of these botanical powders were mixed into batches of 100 seeds. Each batch was introduced to 20 cowpea weevils, all set up inside containers covered with muslin cloth. The experiment consisted of four treatments: the first treatment, labelled A contained *O. gratissimum* powder; the second B contained *A. sativum* ; the third C comprised the mixture of O. gratissimum and *A. sativum* powders in the ratios of 1:1, 2:3, 3:2, 4:1 and 1:4; and the last treatment D, served as the control, contained no powder. Data collected were subject to analysis of variance (ANOVA), and the treatment means were compared using the Duncan Multiple Range Test (DMRT) at a 5% probability level ($P<0.05$). Weevil mortality was found to be significantly influenced by both concentration level and exposure duration. At a 25g dosage, the highest death rate was 9.17, followed by 4.86 at a 20g dosage and 1.89 at a 5g dosage. Of all the powders, *A. sativum* had the highest death rate (5.20), followed by the powder combination (4.73) and *O. gratissimum* (3.38). The death rates for each therapy showed significant differences ($P \leq 0.05$). The results suggest that these botanical powders can act as sustainable botanical pesticides to control post-harvest cowpea infestation and enhance food security by substituting chemical pesticides with more ecologically friendly alternatives.

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INTRODUCTION
Cowpea (*Vigna unguiculata*), a leguminous annual crop that belongs to the genus Vigna, is a crucial crop for the economic and nutritional stability of communities in Sub-Saharan Africa (SSA) and other semi-arid nations due to its resistance to sandy soils and little rainfall (Dangi *et al.*, 2020). Nigeria produces over 2.4 million tones of cowpeas a year, making it the world's leading producer and consumer (Boukar *et al.*, 2018; Huynh *et al.*, 2016). Cowpea offers an inexpensive source of protein, especially for farmers with limited resources whose diets mainly consist of starchy staples like cassava and millet (Bolarinwa *et al.*, 2021; Ddungu *et al.*, 2016). However, cowpea weevil (*Callosobruchus maculatus*) post-harvest infestation drastically lowers yield, which results in up to 60% seed damage while being stored (Ileke, 2015, 2019; Ileke *et al.*, 2021).

Synthetic pesticides are frequently employed to eradicate *Callosobruchus maculatus* infestation, but they are costly for smallholder farmers, provide health and environmental hazards, and contribute to pesticide resistance (Sharma *et al.*, 2020; Belhamel *et al.*, 2020). Consequently, botanical insecticides are becoming more and more well-liked as safer and less expensive alternatives. Several plant-based powders and extracts, including *Ocimum gratissimum* (scent leaf) and *Allium sativum* (garlic), showed pesticidal properties in previous studies (Abdalla, 2017; Isinkaye and Oke, 2018; Obembe *et al.*, 2020; Shitu *et al.*, 2020; Remesh and Babu, 2025).

However, gaps still exist in the literature. Many of the published works have examined these plants' insecticidal efficacy, whether alone or in conjunction with irrelevant plant species like neem (Isinkaye and Okeke, 2018). Moreover, the volatility, high expense, and storage needs of extracts and essential oils sometimes constrain their practical application in spite of their efficiency (Ileke *et al.*, 2019; Shitu *et al.*, 2020; Remesh and Babu, 2025). Leaf powders have not been carefully examined, especially

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concerning different botanical mixtures and concentration gradients.

In several important respects, this work is different from previous research. As far as we are aware, this is the first study to assess the combined insecticidal effects of *A. sativum* and *O. gratissimum* leaf powders employing synergistic ratios (1:1,2:3, 3:2, etc.) throughout a five-tier dose gradient (5g-25g/100seed) in a cowpea storage setting in Nigeria. Compared to earlier research that generally concentrated on extracts or oils (Keita *et al.*, 2001; Abdalla *et al.*, 2017; Shitu *et al.*, 2020), the utilization of leaf-powdered materials in this study provides a more steady, cost-effective, and farmer-friendly option. In order to aid in elucidating the best treatment approaches, it also contrasts the respective potency of distinct botanicals (garlic and scent leaf) with their combinations. Lastly, the present finding clarifies how exposure duration correlates with efficacy by investigating temporal mortality dynamics, which was not adequately documented in past investigations (e.g., Ileke, 2015).

This study aims to evaluate the insecticidal effectiveness of powdered *Ocimum gratissimum* and *Allium sativum* as environmentally friendly substitutes for synthetic insecticides in the management of *Callosobruchus maculatus* infestations in stored cowpea. In particular, the study looks into how these powders work against cowpea weevils both separately and in combination.

The results will further our understanding of botanical pest management and give smallholder farmers a more environmentally friendly option for post-harvest storage. In order to investigate this, the following theory was developed: Garlic (*Allium sativum*) and scent leaf (*Ocimum gratissimum*) powders, both separately and in combination, do not significantly inhibit weevils in beans that have been preserved.

MATERIALS AND METHODS

Experimental Site

The experiment was performed at the Plant Science Laboratory, Department of Plant Science and Biotechnology, Federal University of Lafia, located along Makurdi Road Lafia, the capital of Nasarawa state.

Study Area

The research was carried out in Lafia, Nasarawa state. Based on the results of the 2006 census, Lafia has 330,712 residents. Lafia is located at latitude 8º29' 32' N, longitude 8º30' 55'E, and its' total land area is 27,117km2 (10,470 sqm). Farming is the major source of income in Lafia.

Collection of Plant Materials

Fresh scent leaves (*Ocimum gratissimum*), garlic bulbs (*Allium sativum*), and healthy Cowpea seeds were purchased from Lafia's modern market in the city. Weevils (*Callosobruchus maculatus*) used for infection were obtained from infected cowpeas from cowpea sellers in Lafia Modern Market and identified in the Zoology Department, Federal University of Lafia.

Processing of Plant Materials

The plant materials were processed using the methods of Isinkaye and Oke (2018). The purchased scent leaves and garlic bulbs were dried in the shade, pounded separately using pestle and mortar, and stored separately in an air-tight container.

Rearing of Cowpea Weevil

The insects were cultured using the technique outlined by Al-shareefi *et al.* (2025) with modifications. The initial stock of the weevil (*Callosobruchus maculatus*) was collected from infested cowpea seeds and reared on healthy cowpea seeds in a container, wrapped in muslin, and fastened with a rubber band under laboratory conditions. Following an oviposition period of 24 hours, the parent insects were removed, and the deposited eggs were preserved and re-cultivated to yield fresh adults of the same generation. Twenty cowpea weevils were released into each container individually.

Insecticidal Efficacy of Plant Material

The insecticidal efficacy of the plant materials was conducted using the methods described by Isinkaye and Oke (2018) with modifications. One hundred (100) healthy cowpea seeds were counted into a plastic container. The pounded scent leaves were added at varying concentrations of 5g, 10g, 15g, 20g, and 25g into individual containers containing 100 cowpea seeds. Twenty cowpea weevils were released into each container and labelled (A). The same treatment procedure was repeated with the pounded garlic powder and labelled (B). Various proportions of scent leaf and garlic powders (1:1, 2:3, 3:2, 4:1, and 1:4) were blended to achieve respective weights of 5g, 10g, 15g, 20g, and 25g which were then added into another container of 100 cowpea seed, and 20 cowpea weevils, labelled (C). A control with the label (D) had no powder treatment. It contained a hundred viable cowpea seeds, along with 20 cowpea weevils. The control was observed for any difference between the survival of cowpea weevils in treatments and the control.

Data Collection

Observations and measurements were recorded at 24-hour intervals for the duration of four days following the experiment. Data collection was based on the weevil death rate for each treatment.

Experimental Design

The experimental unit was arranged using a Randomized Complete Design (RCD) with four (4) distinct treatments, one (1) test organism, and five (5) concentrations (4x1x5) administered in three (3) replicates.

Data Analysis

The results obtained were statistically analyzed through analysis of variance (ANOVA.) and Duncan Multiple Range Test to determine significant differences among treatment means at 0.05 probability level, using SPSS software version 22.

RESULTS

Bean weevils treated with 25g of *Allium sativum* powder for the duration of 4 days showed the highest mortality (10.67), which differed significantly from the control experiment (3.00) at P≤0.05 (Table 1). The least weevil mortality (0.33) was produced by 5g of *Allium sativum* powder applied for a duration of 1 day and did not differ significantly from the control (0.00) at P≤0.05.

Bean weevils treated with different concentrations of *Occimum gratissimum* powder showed variations in mortality after different post-application durations (Table 2). The highest weevil mortality (15.00) was observed after applying 25g of Occimum gratissimum powder for 4 days and differed significantly from control (0.00). Weevil deaths were not observed after the application of 5g and 10g of *Occimum gratissimum* powder for a duration of 1 day. Differences in weevil mortality due to the administration of varying concentration levels of *Occimum gratissimum* powder for various post-application durations were statistically significant (P≤0.05).

The application of varying levels of the combination of *Allium sativum* and *Occimum gratissimum* powders in different ratios on the bean weevil *Callosobruchus maculatus* showed different mortality effects after different post-application duration (Table 3). Weevil mortality increased with increases in plant powder concentrations and post-application duration. The highest weevil mortality (13.00) was observed after the application of 25g of the combination of *Allium sativum* and *Occimum gratissimum* powders for a post-application duration of 4 days, and differed significantly from control (3.00) at P≤0.05. Application of the plant powder combination at 5g concentration for a duration of 1 day yielded the least weevil mortality (0.33) and did not differ significantly from control (0.00) at P≤0.05. Differences in weevil mortality among different concentrations of the combination of *Allium sativum* and *Occimum gratissimum* powders for different durations were significant (P≤0.05).

The investigated plant powders' impact on *Callosobruchus maculatus*, the bean weevil, mortality was concentration dependant (Table 4). The highest mean total weevil mortality (9.17) was observed after the administration of 25g of plant powders, subsequently 20g (4.86), 15g (3.67), 10g (2.61), and lastly 5g (1.89). Differences in mean total weevil mortality produced by different concentrations of plant powders were significant (P≤0.05).

Weevil mortality produced by the application of the different plant powders increased with an increase in post-application duration (Table 5). The highest mean total weevil mortality (7.64) was observed after the application of plant powders for a post-application duration of 4 days, followed by 3 days (5.24), 2 days (3.09), and lastly, 1 day (1.78). Differences in mean total weevil mortality as a result of different post-application durations of the different plant powders displayed statistical significance at P≤0.05.

The application of various botanical powders showed variations in weevil mortality (Table 6). *Allium sativum* powder gave the highest mortality of the tested weevils (5.20) followed by the combinations of both *Allium sativum* and *Occimum gratissimum* powders (4.73), and lastly, *Occimum gratissimum* (3.38). Differences in weevil mortality produced by the application of different plant powders were significant (P≤0.05).

Table 1: Impact of varying levels of *Allium sativum* powder on *Callosobruchus maculatus* mortality.

	Weevil Mortality at Different Concentrations of Plant Powder					
DPA	**5g**	**10g**	**15g**	**20g**	**25g**	**Control**
1	0.33[a]	1.67[ab]	2.33[abc]	2.67[bc]	3.33[bc]	0.00[a]
2	2.33[abc]	3.33[bc]	3.67[bcd]	4.00[bcde]	5.67[defg]	0.00[a]
3	4.67[cdef]	5.67[defg]	6.33[fg]	6.00[efg]	9.00[hi]	1.00[a]
4	6.00[efg]	7.67[gh]	9.33[hi]	9.33[hi]	10.67[i]	3.00[bc]

DPA: Days of Post-Application; Means followed by the same superscripts within the same rows and columns are not significantly different (P≤ 0.05).

Table 2: Effect of different concentrations of *Occimum gratissimum* powders on *Callosobruchus maculatus* mortality.

	Weevil Mortality at Different Concentrations of Plant Powder					
DPA	**5g**	**10g**	**15g**	**20g**	**25g**	**Control**
1	0.00[a]	0.00[a]	0.33[ab]	2.00[bcd]	5.00[fg]	0.00[a]
2	0.33[ab]	0.67[abc]	1.00[abcd]	2.67[de]	7.00[h]	0.00[a]
3	0.67[abc]	1.00[abcd]	2.33[cd]	4.00[ef]	10.67[i]	1.00[a]
4	2.67[de]	2.00[bcd]	4.67[fg]	5.67[gh]	15.00[j]	3.00[bc]

DPA: Days of Post-Application; Values with identical superscripts in the same rows and columns do not differ significantly (P≤ 0.05).

Table 3: Influence of different concentrations of the combination of *Allium sativum* and *Occimum gratissimum* powders on *Callosobruchus maculatus* mortality.

DPA	Weevil Mortality at Different Concentrations of Plant Powder					
	5g	10g	15g	20g	25g	Control
1	0.33[a]	0.67[ab]	0.67[ab]	2.00[bcd]	5.33[g]	0.00[a]
2	0.67[ab]	1.33[abc]	1.67[abc]	3.67[ef]	7.33[hi]	0.00[a]
3	1.33[abc]	2.67[cde]	4.33[fg]	7.00[h]	9.33[i]	1.00[a]
4	3.33[def]	4.67[fg]	7.33[h]	9.33[i]	13.00[j]	3.00[bc]

DPA: Days of Post-Application; No significant difference exists among Means with the same superscripts in the same rows and columns ($P \leq 0.05$).

Table 4: Overall impact of different concentrations of plant powders on weevil mortality

Plant Powder Concentration (g)	Mean Total Weevil Mortality
5.00	1.89[a]
10.00	2.61[ab]
15.00	3.67[bc]
20.00	4.86[c]
25.00	9.17[d]

Values in the same columns carrying identical superscripts show no significant variation ($P \leq 0.05$).

Table 5: Overall outcome of post-application duration on weevil mortality

DPA	Mean No. of Dead Weevils
1	1.78[a]
2	3.09[a]
3	5.24[b]
4	7.64[c]

DPA: Days of Post-Application of Plant Materials; Means assigned the same superscripts in a given column are statistically similar ($P \leq 0.05$).

Table 6: Overall consequence of different plant materials on weevil mortality

Plant Powder	Mean Weevil Mortality
Occimum gratissimum	3.38[a]
Allium sativum	5.20[b]
Occimum gratissimum + Allium sativum	4.73[ab]

Means in the same columns that have matching superscripts are not significantly distinct ($P \leq 0.05$).

DISCUSSION

The outcomes of this research demonstrate that garlic (*Allium sativum*) and scent leaf (*Ocimum gratissimum*) powders exhibit significant insecticidal effects against the cowpea weevil (*Callosobruchus maculatus*).

Garlic powder was found to have the highest insecticidal efficacy among the tested treatments. This is consistent with Abdalla *et al.* (2017), who stated that the volatile oils in *A. sativum* cause significant mortality in *C. maculatus*. The compound allicin, a key constituent of garlic, is known to repel insects, inhibit feeding, and ultimately cause death (Bell *et al.*, 2016; Liu *et al.*, 2023). Similarly, Al-shareefi *et al.* (2025) observed 100% mortality of *Callosobruchus maculatus* using garlic powder and extract on cowpea grains. These results corroborate the efficacy of garlic powder against storage pests.

Scent leaf (*O. gratissimum*) powder also demonstrated notable insecticidal effects, with mortality rates increasing with both concentration and exposure time. This aligns with Okwuonu *et al.* (2023), who reported significant mortality of *S. zeamais* with increasing concentrations of ethanolic extracts of *O. gratissimum*. The insecticidal properties of *O. gratissimum* are ascribed to the volatile essential oils found within its foliage and stems, which contain bioactive substances like flavonoids, tarpenoids, glycosides, and saponins (Ujah *et al.*, 2021). These compounds have ovicidal, toxic, and deterrent effects on stored-product coleopterans (Remesh and Babu, 2025).

Interestingly, the combination of garlic and scent leaf powders showed synergistic effects, producing significant weevil mortality. Although garlic powder exhibited the highest individual efficacy, combining it with *O. gratissimum* enhanced its insecticidal potential.

The insecticidal effects observed in this study were influenced by both the dosage levels and exposure time, with elevated quantities and extended durations leading to a more pronounced lethal impact on weevils. This aligns with Adeniyi *et al.* (2010), who noted that seed treatments with botanical extracts were dose-dependent and did not compromise seed viability. Keita *et al.* (2001) similarly reported that powders of scent leaf and basil provide effective protection against *C. maculatus* without negatively impacting seed germination.

CONCLUSION AND RECOMMENDATION

In conclusion, This research emphasizes the possible benefits of powdered *A. sativum* and *O. gratissimum* as environmentally friendly substitutes for chemical pesticides in the post-harvest control of *C. maculatus*. Their availability, affordability, and effectiveness make them promising options for resource-poor farmers in reducing storage losses of cowpeas.

Further work should be done to ascertain the Long-term effectiveness and reapplication needs of the powders after application and thier expiring date before they are applied.

Leaf powders of *A. sativum* and *O. gratissimum* could also be tested for insecticidal efficacy against insect pests of cereals such as wheat, barley, oats etc.

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