International Journal of Entomology Research
www.entomologyjournals.com
ISSN: 2455-4758
Received: 27-05-2025, Accepted: 26-06-2025, Published: 12-07-2025
Volume 10, Issue 7, 2025, Page No. 95-100

Toxicity of pulverized leaf powder of *Aloe barbadensis* against *Callosobruchus maculatus* (F.) on stored cowpea

Obiefule IE, Ogbuefi EO, Aniefuna CO, Anyanebechi WC, Ekeh NJ
Department of Parasitology and Entomology, Faculty of Biosciences, Nnamdi Azikiwe University Awka, Anambra, Nigeria

Abstract
Cowpea (Vigna unguiculata (L) Walps) is a major legume in many underdeveloped nations farmed mostly for its grains in Nigeria and West Africa. However, a variety of storage pests infest the grain, with *Callosobruchus maculatus* being a major field pest that causes farmers to suffer unimaginable misery and significant losses. To evaluate the effectiveness of *Aloe barbadensis* leaf powder as a preventive measure against *C. maculatus* infesting stored cowpea, laboratory studies were carried out in the Department of Parasitology and Entomology at a temperature of 28 °C and 80% relative humidity. The toxicity was carried out at five dosage rates (0.25 g/mL, 0.5 g/mL, 1.0 g/mL, 1.5 g/mL, and 2.0 g/mL) of the test plant powder and (0.12 g/mL) standard alpha-cypermethrin and a (0.0g/mL) untreated control per 50g of cowpea grains. Ten adults of one-two days old *C. maculatus* was introduced into each vial, and the experiment was set up in a completely randomized design of five treatments replicated three times. The responses of *C. maculatus* to the insecticides and damage assessments were based on percentage adult mortality, oviposition, F_1 emergence, percentage seed damage, and percentage weight loss. The result showed that the plant contains alkaloids, flavonoids, tannins, cardiac glycosides, saponins, and cyanogenic glycosides in different levels of concentrations. Of the six phytochemicals evaluated, Tannins had the highest concentration followed by flavonoid, saponin, cardiac glycoside, cyanogenic glycoside, and alkaloid. Also, tannins were present in the highest amount (92.62mg/100g) of the phytochemicals analyzed followed by flavonoid (29.26mg/100g), saponins (17.53mg/100g), cardiac glycosides (14.65mg/100g), alkaloid (4.72mg/100g), and cyanogenic glycoside (2.35mg/100g). The highest dosage of 2.0g/mL *A. barbadensis* powder extract caused a mortality of 93.3% while 0.25g/mL caused 40% mortality respectively. Also, mortality was time-dependent. The recorded death rate was 4% at 24 hours of exposure, and it rose to 75.7% over 168 hours. This was a substantial difference, nevertheless ($P<0.05$). The LD_{50} and LD_{90} of the leaf powder extracts were calculated as 0.34g/mL and 1.72g/mL, respectively, after the probit values were regressed and plotted against log dosage. A straight line and regression coefficient, R2= 0.9923, were also obtained from this process. Also, regression co-efficient for time, R^2= 0.9149 was obtained from which LT_{50} and LT_{90} of the leaf's extract was determined as (128.02 hours and 414.45 hours) respectively. Additionally, there was a significant difference ($P < 0.05$) in the mean oviposition on seeds treated with the various doses of the test plants compared to the untreated control. For the plant leaf extracts, the mean F_1 progeny that emerged on seeds treated with 2.0g/ml was lower (18.3) than the control (72.0). The treatment dosages of 2.0g/ml (18.3) and 0.25g/ml (30.6) differed significantly ($P < 0.05$). There are significant differences ($P < 0.05$) in the mean percentages of damaged seeds between the treatments. The highest dosage of the test plant had the lowest mean percentage seed damage (12.5%) compared to the control (80.2%) and was significantly different ($P < 0.05$) between them. The powder dosages had a notable impact on the reduction of cowpea seed weight loss. Weight loss was lowest at 2.0g/ml (21.2%) and highest at 1.5g/ml (24%), with a significant difference ($P<0.05$) between the two dosages of the test plant. According to the studies, *Aloe barbadensis* was successful in lowering cowpea pest attacks.

Keywords: Cowpea, *callosobruchus maculatus*, phytochemicals, *aloe barbadensis*. loss assessment

Introduction

In many underdeveloped nations, cowpeas (Vigna unguiculata (L) Walps) are a significant legume that are mostly grown for their grains [1]. For those who cannot afford protein-rich foods like meat and fish, it is one of the least expensive plant protein sources they can include in their diet [2]. Farmers prefer cowpeas due to their capacity to preserve soil fertility, generate revenue for low-resource farmers, serve as animal feed, and produce comparable high yields in abrasive conditions where other food legumes cannot flourish [3]. According to [4], cowpeas are a staple crop for millions of people in developing nations, with an estimated 4.5 metric tons produced annually on 12–14 million hectares worldwide. However, cowpea production is faced with a wide range of biotic constraints due to pest which reduces its yields; like virus (Cowpea Aphids Borne Mosaic Virus, (ABMV), bacteria (Xanthomonas campestris pv vigni), cola), fungi (Choanephora spp), insects (Aphis carccivora, Mega lurothrips sjostedti, *Callosobruchus maculatus*, (also called cowpea beetle, cowpea weevil or bruchid) is regarded as the most important and common pest of cowpea both in Africa and Asia (Desphande *et al*., 2011) [3]. In temperate and tropical parts of the world, *Callosobruchus maculatus* (F), sometimes known as the cowpea bruchid (Coleoptera: Bruchidae), is a major grain pest [5]. It is a field-to-store pest as, if cowpeas are not picked, the attack begins in the field and quickly spreads to the store. The larvae of *C. maculatus* have been blamed for cowpea damage since the adults do not feed [6]. Wholesome grains are penetrated and reduced to powder by the larvae. Due to weevil perforations, which reduce the seeds' degree of utility and render them inappropriate for planting or unpalatable for human eating, weevil attack is estimated to cause losses in both number and quality of seeds in storage of up to 90% [7]. Chemicals (synthetic pesticides) have been used extensively in attempts to control this pest, which has led to issues like resistance development, unacceptable pesticide residue levels, increased production costs, environmental toxicity, and poisoning of farmers and consumers of pest-infested produce [5]. However, ecologically acceptable control methods, such as the use of inert materials, plant powder, oils, and extracts, are receiving increased attention in research efforts on the production of chemical products [8]. Several plants, including *Azadiractha indica*, *Piper guineense*, *Annona muricata*, and *Ocimum gratissimum* [9], have been used for their leaves, stems, roots, and seeds. It has been discovered that *Vernonia amygdalina's* ground leaves work well against storage pests like *Sitophilus oryzae* [10]. This study seeks to assess the efficacy of powdered leaf of *Aloe barbadensis* against cowpea beetle, *Callosobruchus maculatus* (F).

Materials and Methods

The experiment was carried out at 28^0C degrees Celsius with 80% relative humidity in the Parasitology and Entomology Research Laboratory of the Department of Parasitology and Entomology at Nnamdi Azikiwe University Awka.

Source and Type of test cowpea seeds

The study made use of Ife Bpc cowpea seeds that were bought from the Institute of Agriculture Research and Training's (IAR&T) seed storage division at Moore Plantation in Ibadan.

Collection and Culturing of Insect

A local cowpea variety (preferred substrate) was used to raise the *C. maculatus* culture in the laboratory after the original culture was obtained from market-infested cowpea at Awka's Eke-Awka market. Eight pairs of *C. maculatus* were added to a 2-liter wide-mouthed container containing 250g of clean cowpea seeds, which were then covered with muslin net. After five days of ovipositing, the insects were sieved out. After being returned to the container at room temperature, the oviposited seeds were checked every day for the appearance of adults. This culture was preserved and utilized as a *C. maculatus* source.

Fig 1: Diagram showing Male and Female *Callosobruchus maculatus* adapted by kind vision from *https://en.wikipedia.org*

Preparation of Experimental Seeds

Mature, wholesome seeds from the sample devoid of debris and emergence holes were heat sterilized at 40^0C for 2hours before use to clear any existing infestation. Subsequently, 50g of cowpea were weighed into labeled $60cm^3$ glass vials; each vial was covered with ventilated screw cap, sealed with nylon netting to prevent entry of insects but allowed ventilation of the samples.

Source of synthetic pyrethroid

The pyrethroid formulations, alphacypermethrin (5%, 50g/kg WP) (Nelthrin) was purchased from Agrotech Chemical Company, Anthony Village, Lagos.

Collection, Identification and Preparation of Plant powder

Aloe barbadensis leaves were purchased from a horticulturist stands along Enugu-Onitsha express road, Amansea, Awka Anambra state. A botanist from Nnamdi Azikiwe University's Botany Department in Awka recognized the leaves. After cutting open the aloe leaves to extract the gel, the plant leaves were rinsed under running water and allowed to air dry in the shade for seven days to guarantee that the volatile active component was preserved in the dried samples. An electric blender was used to grind the leaves into small powders, which were then collected in a sanitized container after being sieved through a 0.5mm mesh screen.

Fig 2: Diagram of Aloe barbadensis leaf plant adapted by kind vision from

Phytochemical Analysis *https://en.wikipedia.org*

Qualitative and Quantitative phytochemistry were done on the crude extract of plants to determine major constituents using standard procedures as described by [10] and [11].

Formulation of the treatments

Serial dilution of the weighed plant powder extracts (0.25g, 0.5g, 1.0g, 1.5g, 2.0g botanical and 0.12g alpha-cypermethrin) were prepared separately in acetone and 0.5ml gum arabic, shaken thoroughly for admixture and then allowed to stand for ten minutes in the laboratory bench. Acetone was used as a medium of dispensing the crude extracts, while gum arabic was used as a stickant in making the treatment stick on the grains. Each of the crude extracts were dissolved in 20ml of acetone to obtain varying concentrations of 20%, 10%, 5%, 2.5%, 1,25% botanical and 0.6% alphacypermethrin equivalent to 2.0g/ml, 1.5g/ml, 1.0g/ml, 0.5g/ml. 0.25g/ml, and 0.12g/ml [12].

Contact Toxicity Responses and Lethal Dose of the different Leaf Extracts on *C. maculatus*

Each of the Petri dishes used for the experiment was filled with No. 1 Whatmann filter paper, which had a diameter of 9 cm. Three replicates of each of the different dose levels of the plant insecticides, 0.2 g/ml, 0.5 g/ml, 1.0 g/ml, 1.5 g/ml, 2.0 g/ml, and 0.12 g/ml of a typical synthetic insecticide were used. To guarantee that the solution was well disseminated, aliquots of 0.5 ml of each dosage were equally placed over the filter paper and left for approximately an hour. Acetone-only controls were included. For a whole day, the acetone solvent was left to evaporate entirely. A mouth-operated aspirator was then used to insert 10 unsexed 5-day-old adults of C. maculatus into each Petri plate. Each Petri-dish was covered with its lid to prevent escape of the insects. Mortality counts were taken every 24 hours for 168 hours (Seven days).

Bioassay with the extracts

Subsequently, fifty grams of disinfested cowpea seeds were weighed into other sets of $60cm^3$ vial and covered with screw cap sealed with nylon net. The doses of the five plant powders 0.25g/mL, 0.5g/mL, 1.0g/mL, 1.5g/mL, 2.0g/mL, and 0.12g/mL of standard alphacypermethrin (synthetic insecticides) were used to treat 50g of cowpea seeds. Ten, 1–2-day old adults of *C. maculatus* taken from the culture and carefully sexed into males and females using method by [13] were used to artificially infest the cowpea. Infestation ratio of the bruchids was five males to five females. The experiment was laid out in three replications adult mortality count was carried out at 24 hours for seven days after treatment (DAT). The insects were taken to be dead when probed three times with fine forceps at the abdomen without their response. After seven days, all insects (dead or alive) were removed from the vials. Thereafter, the number of eggs per seed was taken to determine the oviposition rate of the bruchid. The cowpea seeds with eggs were placed back in the vials and were observed daily from the 25th day of infestation to the time of F_1 adult emergence. The number of F_1 adults was counted daily for seven consecutive days. Seeds with holes were also counted. The damaged seeds were weighed and the weight difference from the initial input classified as loss after three months in storage.

Data collection

The number of dead insects divided by the total number of insects, then multiplied by 100, was used to calculate adult mortality. The number of adults who emerged at 30 DAT (days after treatment) was used to calculate the adult emergence rate. The infested cowpea seeds were sorted into damaged (characterized by emerging holes) and undamaged groups in order to assess damage. The following formula was used to determine the percentage of grain damage:

$$\% \text{ damage} = \frac{A \times 100}{B}$$

Where A: number of damaged grains

B: total number of grains.

According to [14], the percentage of the difference between the grains' starting and final weights was used to calculate the percentage grain weight reduction.

$$PGWL = \frac{\text{Initial weight} - \text{Final weight}}{\text{Initial weight}} \times 100$$ Where;

PGWL = percentage grain weight loss

Statistical Analysis

Mortality data was corrected using [15]. PT = (Po-Pc/100-Pc x 100), where Pc is the control mortality (if the control mortality is up to 5%), PT is the corrected mortality, and Po is the observed mortality. LD_{50} and LD_{90} (LT_{50} and LT_{90}) were determined using log-probit-regression analysis (Finney, 1971) [24]. After transforming the data on insect number (F1), damage, and percentage weight loss using log transformation (x = log10x), the SPSS version 17 for Windows statistical package's simple factorial ANOVA model was used for analysis [16]. The Student-Newman-Keuls (SNL) test and LSD values at P<0.05 were used to compare and differentiate treatments with significant differences at the 0.05% level of significance. The association between the plant's phytochemical components and loss and damage indices was examined using correlation coefficients.

Results

The concentrations of the several phytochemicals in the two plants under analysis are displayed in Table 1. Alkaloids, flavonoids, tannins, cardiac glycoside, saponin, and cyanogenic glycoside make up the majority of the phytochemicals found. Not present (-), present in small concentration (+), present in moderate concentration (++), and present in high concentration (+++) are the foundations for determining the level of concentrations. Tannins are highly present in all phytochemicals analysed followed by flavonoid, saponin, cardiac glycoside, cyanogenic glycoside, and alkaloid. Tannin has the highest concentration of the phytochemicals analyzed, with cyanogenic glycoside having the least concentration. Also, it shows that flavonoid is present in moderately high concentration in all phytochemicals analyzed. Furthermore, Tannin is present in highest amount (92.62mg/100g) in the phytochemicals analyzed followed by flavonoid (29.26mg/100g), saponins (17.53mg/100g), cardiac glycosides (14.65mg/100g), alkaloid (4.72mg/100g), and cyanogenic glycoside (2.35mg/100g).

Table 1: Qualitative and Quantitative phytochemical composition of *Aloe barbadensis* plants studied

Phytochemicals	*A. barbadensis*	*A. barbadensis*
Alkaloid	++	0.69
Flavonoid	+++	8.64
Tannin	++	11.95
Cardiac glycoside	++	4.91
Saponin	++	2.96
Cyanogenic glycoside	-	0.52

Present in low concentration (+), moderate concentration (++), high concentration (+++), and absent (-).

Table 2 shows the average mortality response of *C. maculatus* to *A. barbadensis* at varying dosages following 168 hours of exposure. The powdered leaf extract of *A. barbadensis* caused increased mortality responses as the dosage of the leaf powder increased with 2.0g/ml causing mortality of 93.3% while 0.25g/ml caused 40% mortality. The time of exposure followed similar trend as the exposure time progressed. The recorded death rate was 4% at 24 hours and rose to 75.7% at 168 hours. Doses and exposure duration were shown to be statistically significant (P<0.05).

Table 2: Mortality response of *C. maculatus* exposed to residual application of *A. barbadensis* leaf powder extracts at 24 hourly intervals

	Exposure time(hours)								
Doses	**24**	**48**	**72**	**96**	**120**	**144**	**168**	**Mean (±s. e)**	**% Mortality**
2.0	0.67	1.33	2.33	3.67	5.00	7.00	9.33	4.19±1.2	93.3
1.5	0.67	1.33	2.33	3.33	4.67	6.33	8.67	3.90±1.1	86.7
1.0	0.33	1.00	2.00	3.00	4.33	6.00	8.00	3.52±1.1	80.0
0.5	0.33	1.00	1.67	2.67	3.67	5.00	6.33	2.95±0.8	63.3
0.25	0.00	0.33	0.67	1.33	2.00	3.00	4.00	1.62±0.6	40.0
Mean (±s. e)	0.4±0.1	0.99±0.2	1.8±0.3	2.8±0.4	3.93±0.5	5.4±0.7	7.27±0.9		
Control	0.00	0.00	0.00	0.33	0.67	1.00	1.33	0.48±0.2	13.3
% mortality	4.0	9.9	18.0	28.0	39.3	54.7	75.7		
Probit	3.25	3.71	4.08	4.42	4.73	5.12	5.70		

Means of three replicates (±s. e), Pvalue=0.016, LSD=5.310

Figure 1 displays the logdose and mortality count probit values for the different dosages of *A. barbadensis* leaf powder extract against *C. maculatus*. The probit values were regressed and plotted against logdose and a straight line as well as regression co-efficient, R^2= 0.9923 were obtained from which LD_{50} and LD_{90} of the leaf powder extract were determined using the regression equation, Y= 1.8512x + 4.0145. The LD_{50} and LD_{90} values of *A. barbadensis* leaf extract were 0.34g/mL and 1.72g/mL respectively (Fig 3).

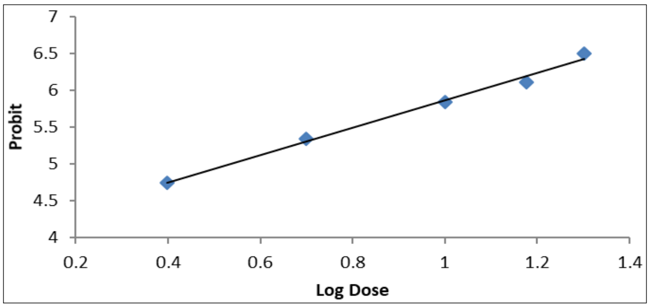

Fig. 1: Probit and Log dose of *A. barbadensis* leaf power extract on mortality of *C. maculatus*

Y = 1.8512x + 4.0145
R^2 = 0.9923
LD_{50}=0.34 g/mL LD_{90}= 1.72 g/mL

The probit value of mortality count and logtime of the various doses of *A. barbadensis* leaf powder extract against *C. maculatus*. The regression equation, Y= 2.6947x – 0.7145, was used to calculate the LT50 and LT90 of the leaf extract after the probit values were regressed and plotted against logtime and a straight line, along with the regression coefficient, R2= 0.9149. The LT_{50} and LT_{90} values of *A. barbadensis* leaf extract were 128.02 hours and 414.45 hours respectively (Fig 4).

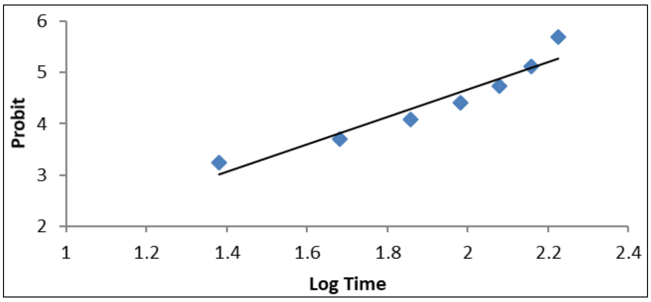

Fig. 2: Probit and Log time of *A. barbadensis* leaf power extract on mortality of *C. maculatus*

Y = 2.6947x - 0.7145
R^2 = 0.9149
LT_{50}=128.02 hours LT_{90}=414.45 hours

There were significant differences (P < 0.05) between the mean oviposition on seeds treated with the various doses of the test plants and the oviposition on untreated control. Whereas, 0.25g/ml recorded 61.3±2.4, 2.0g/ml recorded 20.7±1.2. Significant (P < 0.05) differences were also seen in the impact of different test plant dosages on the emergence of F1 progeny on cowpea seeds. Table 3. The mean F1 offspring that grew from seeds treated with 2.0g/ml was less than the control. The treatment dosage at 2.0g/ml and 0.25g/ml differed significantly (P < 0.05).

Table 3: Effect of powders on the Oviposition count and number of F_1 progeny of *C. maculatus*

Doses of powder (g/ml)	A. Barbedensis Oviposition count	A. Barbedensis F1 progeny
2.0	20.7 ±1.2	18.3 ±1.6
1.5	33.7 ±6.1	21.3 ±1.2
1.0	50.0 ±2.1	21.6 ±1.4
0.5	56.3 ±3.3	24.0 ±2.3
0.25	61.3 ±2.4	30.6 ±4.9
0.12(α-cypermethrin)	12.0 ±0.2	5.0 ±1.5
0.0	93.3 ±1.9	72.0 ±1.7

Means of three replicates (±s. e), Pvalue=0.000, LSD=3.9

There are significant differences (P < 0.05) in the mean percentages of damaged seeds between the treatments. Powdered aloe barbadensis leaves greatly decreased seed damage brought on by C. maculatus infestation. The lowest dosage of 0.25g/ml recorded 16.4±3.0 compared to the control (80.2%), and there was a significant difference (P < 0.05) between the treatment and the untreated control. The test plant's highest dosage, 2.0g/ml, had the lowest mean percentage seed damage, 11.0±0.5. The powder dosages had a notable impact on the reduction of cowpea seed weight loss. In comparison to the untreated control, which had a weight loss of 80.2 ±5.3, the test plant's lowest dosage had a weight loss of 28.6 ±3.3 and its highest dosage, 2.0g/ml, had the lowest weight loss of 21.2%. The amount of weight loss in treated and untreated seeds differed significantly (P < 0.05).

Table 4: Mean percentage seed damage and weight loss after treatment with leaf powder extracts

Doses of powder (g/ml)	*A. barbadensis*	*A. barbedensis*
2.0	12.6 ±1.3	21.6 ±1.3
1.5	13.1 ±0.6	24.0 ±0.6
1.0	14.9 ±2.5	26.4 ±2.5
0.5	15.4 ±1.3	27.4 ±1.3
0.25	17.6 ±3.3	28.6 ±3.3
0.12(α-cypermethrin)	5.4 ±0.5	5.3 ±1.1
0.0	80.2 ±5.3	38.2 ±1.9

Means of three replicates (±s. e), Pvalue=0.001, LSD=2.17

Discussion

This study demonstrates that *A. barbadensis* powder extracts have insecticidal action against C. maculatus and may be utilized as a substitute for synthetic pesticides to provide a high degree of control over *C. maculatus* without endangering human health or the environment. Every plant extract had at least one of the essential phytochemical or bioactive components, according to the results of the phytochemical screening. The bioactive components of *Casurina equisetifolia*, including saponins, tannins, flavonoids, cyanogenic glycosides, alkaloids, and anthracine glycosides, were reported by [17]. Alkaloids, flavonoids, tannins, cardiac glycosides, saponins, and cyanogenic glycosides were found in different concentrations in the two leaf powders after screening. In a similar vein, [18] found that *Casuarina equisetifolia* leaf and bark extracts contained significant levels of tannins, which are poisonous to insects and discourage feeding. According to this study, the two plants met the criteria for chemicals used to control insect feeding on plants, which include toxicity to adults, oviposition reduction, ovicidal activity, and toxicity to immature stages before or right after plant tissue penetration [19]. The powdered leaf extracts were shown to be very poisonous to *C. maculatus* in this investigation. *A. barbadensis* showed the highest toxicity (LD_{50} and LD_{90}) values (0.34g/ml and 1.72g/ml). 128.02 hours and 414.45 hours are the LT_{50} and LT90 values, respectively. This is consistent with research by [13], who employed *Casuarina equisetifola* to combat *Sitophilus zeamais* and found that ethanolic, water, and petroleum ether extracts were toxicity levels of 16.81µg/ml, 18.59µg/ml, and 6.07µg/ml, respectively. Nonetheless, the percentage yield sequence corresponds to their level of pesticidal activity. The coefficient of determination (R2 value) for each regression analysis displayed the degree of variability or percentage mortality of C. maculatus that could be ascribed to the logarithm of time and dosages. Hence, A. barbadensis's R2 value of 0.9923 indicated 93.3% and 75.77% mortality at the maximum dose of 2.0g/ml and exposure duration of 168 hours. The insect mortality rate, oviposition deterrent, emergence of F1 progeny, seed damage, and weight loss were all visibly impacted by the treatments' highest dosage of 2.0g/ml, which demonstrated the highest potency of insecticidal activity/potency in this investigation. At 7DAT, the percentage mortality for *A. barbadensis* at 2.0g/50g seeds was 93.3%, which was in line with a report by [20] that stated that grains treated with pulverized moringa seeds had a death rate of almost 92% at 7DAI. Furthermore, *C. maculatus* treated with neem leaf extracts had higher mortality rates than those treated with synthetic carbofuran [21]. The deterrence of oviposition and the decline in F1 adult were both concentration-dependent. This is consistent with research by [21], which found that Eucalyptus globules, Moringa oleifera, and Annona squamosa leaves were efficient at deterring oviposition. However, the decrease in F1 emergence may be the result of decreased egg hatching, larval mortality, or even egg mortality. According to reports, in order for the larvae that emerge from *Callosobruchus sp*. eggs to live, they must pierce the seeds [22]. As reported by [23] and seen in this work, the decrease in F1 progeny may possibly be due to ovicidal action, which results in fewer offspring, or feeding deterrent, which causes the insect to starve and ultimately die. The reductive impact observed in the adult emergence may be the cause of the decrease in damaged seeds and weight loss. The bitter taste of the leaves and the biochemical components present, which always discourage feeding and dull actions that result in seed damage and weight loss, may be the reason why more dead adults were seen than living ones as the progenies appeared.

Conclusion

This study demonstrates how well *A. barbadensis* leaves shield grains from *C. maculatus* attacks in retail settings. Therefore, it is simple for farmers to get and prepare for use in their stores as a substitute for synthetic pesticides. Furthermore, studies should be conducted to evaluate other parts of the plants for their toxicity. Isolation and testing of the active ingredients present in the two bitter plants for their toxicity to *C. maculatus*.

Author contributions: OIE wrote the first draft, OEO, UCU, edited the manuscript, ENJ, ACO, UUA, AWC, and, ICA proof read the manuscript, NEN developed the protocol and did the experimental design, and OIE oversaw monitoring and study implementation and did the statistical analysis of the work.

Acknowledgements: We are grateful and sincerely appreciate the laboratory assistants for their assistance during the sample collection.

Funding: Not Applicable

Competing interest: The writers affirm that they have no competing interests.

Data availability: The information utilized to bolster the study's conclusions is accessible.
upon judicious request.

References

1. Adam JI, Baidoo PK. Susceptibility of Five Cowpea (*Vigna unguiculata*) Varieties Attacked by *Callosobruchus maculatus* (Fab) (Coleoptera: Bruchidae), *Journal of Ghana Science Association*,2008:8(2):85-92.
2. Lephale S, Addo-Bediako A. Ayodele V. Susceptibility of Seven Cowpea Cultivars (*Vigna unguiculata*) to Cowpea Beetle (*Callosobruchus maculates*). *Agricultural Science Research Journal*,2012:2(2):65-69.
3. Desphande VK, Makanur B, Desphande SK, Adiger S, Salimath PM. Quantitative and Qualitative Losses Caused by *Callosobruchus maculates* in Cowpea during Seed Storage. *Plant Archives*,2011:11(2):723-731.
4. Diouf D. Recent Advances in Cowpea (*Vigna unguiculata* (L) Walp) "Omics" Research for Genetic

Improvement. *African Journal of Biotechnology*,2011:10(15):2803-2810.
5. Ofuya TI, Lale NES. *Pest of Stored Cereals and Pulses in Nigeria*: *Biology, Ecology and Control*. Dave Collins Publications, Akure, Nigeria, 2001, 174.
6. Umeozor OC. Effect of the Infection of *Callosobruchus maculatus* (Fab.) on Weight Loss of Stored Cowpea (*Vigna unguiculata* (L.) Walp). *Journal of Applied Science and Environmental Management*,2005:9(1):169-172.
7. Ali SM, Mahgoub SM, Hamed MS, Gharib MSA. Infestation Potential of *Callosobruchus maculatus* on Certain Broad Bean Seed Varieties. *Egyptian Journal of Agricultural Research*,2004:82:1127-1135.
8. IITA. *International Institute of Tropical Agriculture Research Highlights. Ibadan*, Nigeria, 1995, 68-72.
9. Enobakhare DA, Law-Ogbomo KE. The Use of Leaf Powders of *Ocimum gratissimum* and *Vernonia amygdalina* for the Management of *Sitophilus oryzae* (L.) in Stored Rice. *Journal of Entomology*,2007:4:253-257.
10. Harbone JB. *Phytochemical Methods*. Chapman and Hall, London, 1973, 278.
11. Trease GE, Evans WC. *Pharmacognosy*, (11th Edition), Balliere Tindall, London, 1996, 162.
12. Anita S, Sujatha P, Prabhudas P. Efficacy of Pulverized Leaves of *Annona squamosa* (L), *Moringa oleifera* (Lam) and *Eucalyptus globules* (Labill) against the stored grain pest, *Tribolium casteneum. Recent Research in Science and Technology*,2012:4(2):19-23.
13. Dobie P, Haines CP, Prevett PF. *Insects Arachnids of Tropical Stored Products Their Biology Identification*. Storage Department, Tropical Development Research Institute, London, 1984, 272.
14. Golob P, Mwambula J, Mhango V, Ngulube F. The Use of Locally Available Materials as Protectants of Maize Grain against Insect Infestation during Storage in Malawi. *Journal of Stored Products Research*,1982:18:67-74.
15. Abbot WS, A Method of Computing the effectiveness of an insecticide. *Journal of Economic Entomology*,1925:18:265-267.
16. SPSS SPSS Windows Release 10.0 version SPSS Incoperated, California US. A, 1999.
17. Edeoga H0, Okwu DE, Mbuebie C. Phytochemical Constituents of some Nigerian Medicinal Plants. *African Journal of Biotechnology*,2005:4(7):685-688.
18. Arthur WW, Craig RE. *Casuarina equisetifolia.* Species Profile for Pacific Island Agro-forestry. *Permanent Agriculture Resources* (PAR), 2006, 1-11. *www.traditional tree.org*.
19. Ogunwolu EO, Odunlami AT, Suppression of seed bruchid *(Callosobruchus maculatus*) development and damage on cowpea (*Vigna unguiculata* (L) Walp) with *Zanthoxylumzanthoxyloides* (Lam.) Waterm. (Rutaceae) root bark powder and primphos methyl. *Crop Protection*,1996:15:603-607.
20. Ojo JA, Olunloyo AA, Akanni EO. Efficacy of *Moringa oleifera* Leaf Powder against *Callosobruchus maculatus* (F.) (Coleoptera: Chrysomelidae) on Stored Cowpea (*Vigna unguiculata* L. Walp). *Journal of Insect Science*,2013:5(12):240-244.
21. Nwankwo EN, Onuheneogu BC, Ogbonna CU, Okorocha AO, E. Effects of neem leaf extract, *A. indica* synthetic pesticide (carbofuran) on the root-knot nematode (*Meloidogyne spp*) on cowpea, *Vigna unguiculata* (L) Walp. *International Journal of Entomological Research*,2016:1(3):1-6.
22. FAO. Botanical Oils as Grain Protectants. *In*: The Use of Species Medicinal as Bioactive Protectants for Grains. *FAO Agricultural Services Bulletin*, NO.137; FAO Vialledelle Terme Di Caracalla, 00100 Rome, Italy, 1999.
23. Abdegaleil SA, M, Nakatani M. Antifeeding Activity of Limonoids from *Khaya Senegalensis* (Meliaceae). *Journal of Applied Science Entomology*,2003:127:236-239.
24. Finney DJ, *Probit Analysis. A statistical treatment of the sigmoid response curve*. (3rd edition) Cambridge University Press, London, 1971, 318.