Int. j. adv. multidisc. res. stud. 2026; 6(1):2990-2996

Received: 04-01-2026
Accepted: 14-02-2026

International Journal of Advanced Multidisciplinary Research and Studies

ISSN: 2583-049X

Phytochemical Screening and the Efficacy of Leaf Extract and Powder of *Ageratum Conyzoides* against *Callosobrochus Maculatus* Fabricius (Coleptera: Chrysomelidae) on Stored Cowpea Seeds

[1] Obembe Olusola Michael, [2] Kayode Emmanuel Olamide, [3] Adegbola Mary Adeola

[1, 2] Department of Plant Science and Biotechnology, Ekiti State University, Nigeria

[3] Department of Zoology and Environmental Biology, Ekiti State University, Nigeria

Corresponding Author: **Obembe Olusola Michael**

Abstract

Cowpea weevil is a major pest of stored grains worldwide. This study evaluated the insecticidal efficacy of leaf powder and ethanol leaf extract of *Ageratum conyzoides* against *Callosobruchus maculatus*. Efficacy of *A. conyzoides* was assessed based on adult mortality, oviposition, adult emergence, long-term storage protection, and seed viability. Fresh leaves of *Ageratum conyzoides* were air-dried and ground into fine powder using an electric Binatone 1.5 Liters (Model BLG-401) Blender. A portion of the powder (50 g) was extracted in 250 mL of ethanol and heated at 60 °C for 30 minutes. Phytochemical screening of the leaf powder was conducted using standard procedures. The extract was filtered through Whatman No. 1 filter paper, and the filtrate was concentrated using a rotary evaporator. Extract concentrations of 2, 4, 6, and 8% (v/w) were prepared from the stock solution, while the effects of powder at dosages of 1, 2, 3, and 4 g (w/w) were also tested. The results showed that weevil mortality increased with increasing extract concentration, powder dosage, and exposure time. Cowpea seeds treated with *A. conyzoides* powder at 8 g (w/w) recorded 92.25% mortality within 96 hours, while 100% mortality was achieved with 8.0% (v/w) ethanol extract within the same period. No oviposition occurred on seeds treated with 8.0% (v/w) extract, and no adult emergence was observed in seeds treated with 4 g (w/w) powder. Extract concentrations of 4, 6, and 8% (v/w) completely prevented seed damage for three months of storage. Germination tests conducted after seven days showed 100% germinability for all treated seeds. Phytochemical analysis revealed the presence of alkaloids, glycosides, saponins, anthraquinones, tannins, terpenes, and flavonoids. The study concludes that leaf extract and powder of *A. conyzoides* are effective in controlling *C. maculatus* and can serve as a viable alternative to synthetic insecticides, which are costly and environmentally hazardous.

Keywords: *Agerantum Conyzoides*, *Callosobruchus Maculatus*, Oviposition, Germinability, Phytochemicals and Germinability

Introduction

Cowpea (*Vigna unguiculata*) is a widely cultivated legume in tropical and subtropical regions, particularly in sub-Saharan Africa. It is an important source of affordable protein and vitamins and provides income for many smallholder farmers (Singh *et al*., 2014; Obembe *et al*., 2021) [1, 2]. Despite its importance, cowpea storage is seriously affected by insect pests, among which *Callosobruchus maculatus* Fabricius (Coleoptera: Bruchidae) is the most destructive (Caswell, 1984) [3].

Callosobruchus maculatus, commonly known as the cowpea seed beetle, is a major pest of stored cowpea seeds. The insect is widely distributed in areas where cowpea is grown and stored, especially in warm tropical regions (Ofuya, 2001) [4]. It causes serious economic losses because it reproduces rapidly, has a short life cycle, and can infest cowpea both on the field and in storage (Obembe *et al*., 2021) [2].

Adult *C. maculatus* do not feed on stored seeds; however, the larvae cause severe damage by feeding inside the seeds until maturity. This feeding activity reduces seed weight, lowers market quality, and affects the nutritional value of the seeds. Under heavy infestations, cowpea seeds may become unsuitable for consumption or planting (Adedire and Ajayi, 2003) [5] while under poor storage conditions, losses caused by this pest can be very high (Ofuya and Bamigbola, 1991) [6].

Different methods have been used to control *Callosobruchus maculatus* in stored cowpea. These include the use of synthetic insecticides, fumigants, improved storage structures, and traditional materials such as ash, sand, and plant products (Ofuya, 2001) [4]. Although chemical insecticides are effective, their use is limited by insect resistance, chemical residues in food, high cost, and health risks to users (Isman, 2006) [7].

Due to these challenges, there is increasing interest in the use of botanical insecticides as safer alternatives for controlling storage pests. Plant materials have been reported to show toxic, repellent, anti-feedant, and egg-laying deterrent effects against insects (Adedire *et al.,* 2011) [8]. Studies have shown that plant powders and extracts can reduce adult survival, egg laying, progeny emergence, and seed damage caused by *C. maculatus* (Ileke and Oni, 2011; Obembe *et al.,* 2021) [1, 2].

However, the effectiveness of botanical insecticides varies depending on the plant species, method of preparation, and dosage used. Therefore, further studies on easily available plants such as *Ageratum conyzoides* are necessary to identify effective and affordable control methods for farmers (Isman, 2006) [7].

The use of *A. conyzoides* leaf powder and extracts may therefore provide a practical botanical option for controlling *C. maculatus* in stored cowpea seeds (Adedire *et al*., 2011) [8]. This study aimed at evaluating the effectiveness of *Ageratum conyzoides* leaf powder and leaf extract against *C. maculatus* on stored cowpea seeds. The study will also assess seed damage, weight loss, and germination of treated cowpea seeds (Obembe *et al*., 2021) [2].

The findings of this research are expected to support the development of safe, affordable, and environmentally friendly methods for managing storage pests. The study will also provide useful information to farmers, extension officers, and researchers on the use of *Ageratum conyzoides* as a botanical insecticide.

Materials and Methods

Harvesting and preparation of test plant samples (extracts/powdered substances)

Fresh and matured leaves of the test *Agerantum conyzoides* were harvested from Ekiti State University, Ade Ekiti, Nigeria. The leaves were washed in tap water and air dried in the laboratory with for twenty (20) days. They were grounded into a fine powder, using an electric Binatone 1.5 Liters (Model BLG-401) Blender. The powder was divided into 2 portions. One portions of the dried powder samples weighing 50 g, was dissolved in 250 mL of ethanol and heated in a beaker at the 60ºC for 30 minutes. Afterwards, the mixture was stirred and filtered through a funnel plunged with white cotton and whatman filter paper No. 1. The resultant filtrate was concentrated, using Rotary evaporator. The resulting extract was later air-dried in order to remove any traces of solvent. Different extract concentrations of 2, 4, 6 and 8% were prepared from the stock solution.

Collection and Rearing of Insect Pests

Adult cowpea weevils were isolated from already infested cowpea seeds obtained from Oba's market, Ado Ekiti, Nigeria. The weevils were placed in a plastic container covered with a muslin cloth material tightly fastened with rubber band and taken to the laboratory for rearing. The rearing was done for 50 days to adapt the weevils to the prevailing laboratory condition, thereby ensuring the emergence of new adults, for the purpose of the experiment. The insects were reared on white variety of cowpea at a temperature of 28 ± 2ºC and relative humidity of 75 ± 5% inside a plastic container covered with muslin cloth tightly fastened with rubber band to prevent the escape of insects as well as prevent the entry of intruding insects.

Effects of *A. conyzoides* leaf extracts and powder on adult weevil mortality, oviposition and adult emergence

An aliquot of 1.0 mL of 2, 4, 6 and 8% v/w of the plant extracts of *A. conyzoides* leaves were mixed with 50 g of cowpea seed in separate 500 mL plastic containers. The cowpea seeds were shaken vigorously to ensure uniform coating of the seeds with the extracts. Ten males and ten females *C. maculatus* adult which were freshly emerged in the culture were released into the Plastic container and covered with muslin cloth material tightly fastened with rubber, in order to prevent the exit and entry of other insects. Also 1 g, 2 g, 3 g and 4 g/50 g of *A. conyzoides* leaf powder samples were mixed with 50 g of cowpea seeds in separate plastic container and 10 males and 10 females adult *C. maculatus* which freshly emerged in the culture were released into Petri dish and covered tightly with muslin cloth material fastened with rubber band in order to prevent the entry and exit of insects. Each dosage of the extract and powder was replicated four times. An untreated control experiment with no extract and powder treatment was also prepared as above and ten males and ten females *C. maculatus* were also introduced into the plastic container and covered with muslin cloth. Mortality of the insects was observed and recorded at 24 h interval. This was done by gently probing the insect with a sharp pin on the abdomen. Insect that did not react to the probing were considered dead.

All insects, dead or alive were removed and the number of eggs laid were counted and recorded. The experiment was allowed to stay for another 4 weeks after which the eggs started hatching and the adult insects emerged.

$$\% \text{ Adult emerged} = \frac{\text{Number of adults emerged}}{\text{Number of eggs laid}} \times 100$$

Assessment of seeds damage after treatment with *A. conyzoides* leaf extract

Fifty grams (50 g) of clean cowpea seeds were measured into transparent plastic container and admixed with concentration of 8% v/w of *A. conyzoides* leaf extract. A control experiment containing untreated cowpea seed was also set up. Thereafter, 4 copulating pairs of adult *C. maculatus* were introduced into each of the containers. The plastic containers were covered with muslin cloth held tightly with rubber bands so as to enhance ventilation and to prevent the insects from escaping. All treatments were arranged in a completely randomized design and replicated four times, and then stored in a wooden cage in the laboratory for 90 days. Thereafter, the extent of damage was observed, counted and recorded using the procedure of Fatope *et al*. (1995) [10]. The cowpea seeds in each container were re-weighed and percentage loss in weight was calculated.

$$\% \text{ Weight loss} = \frac{\text{Difference in weight}}{\text{Initial weight}} \times 100$$

In order to calculate the numbers of damaged cowpea seeds: The number of wholesome seeds and seeds with emergence holes were counted and recorded. Percentage seed damaged was calculated as shown below:

$$\% \text{ seed damage} = \frac{\text{Number of seeds damaged}}{\text{Total number of seeds}} \times 100$$

Seed damage was also assessed after 90 days using the weevil perforation index (WPI) as described by Fatope *et al*., (1995) [10]. WPI value exceeding 50 was regarded as enhancement of infestation by the weevil or negative protectant ability of the extract tested.

Effects of *A. conyzoides* extracts on germination of cowpea seeds

Fifty grams (50 g) of un-infested cowpea seeds were weighed into plastic containers treated with concentration 8% (v/w) of each of the extracts and allowed to air dry and replicated four times. The control comprised four replicate samples of untreated seeds. The seeds were treated with Apron plus to prevent fungal growth. The plastic containers were covered with muslin cloth and left in the laboratory for 90 days. Afterwards, 20 cowpea seeds were randomly selected from each treatment and grown on a moistened filter paper in 9 cm diameter Petri-dishes in the laboratory. The number of seeds that germinated were counted and expressed as percentage of total seeds planted.

$$\% \text{ seed germinated} = \frac{\text{No of seeds germinated}}{\text{Total no of seeds}} \times 100$$

Phytochemical screening of the test plant extracts.

This was carried out using the methods of Harbone (2010) [11]. The chemical constituents tested were reducing glycosides, saponins, steroids, flavonoids, anthraquinones, Tannins, Terpenes and alkaloids, using their characteristic colour changes, on application of standard procedure and reagents (Harbone, 1998) [12].

Test for Glycosides

Ten milliliters (10 mL) each of H_2SO_4 and Fehlings solutions was added to 1 mL of extracts and the mixture was heated in boiling water for 15 minutes. A brick red precipitate was confirmatory of the presence of glycoside (Harbone, 2010) [11].

Test for Alkaloids

One milliliters (1 mL) of HCL was added to 3 mL of the ethanol in a test tube and about 2-3 drops of Meyer's reagent added. A creamy and turbid precipitate indicated the presence of Alkaloids (Harbone, 1998) [12].

Test for Saponins

This test is also called the Frothing test. Two milliliters (2 mL) of the extracts was poured into a test tube and vigorously shaken for about 6 minutes. The presence of the frothing in the test tube indicated the presence of saponins in the extract (Harbone, 2010) [11].

Flavonoids Tests

One milliliters (1 mL) of the extracts, was added magnesium Ribbon followed by the addition of HCL in a drop wise manner. A magenta coloration indicated the presence of flavonoids (Harbone, 2010) [11].

Steroids and Terpenes Tests

Preparation: Powdered samples of about 5gm was extracted by maceration with 50 mL of 95% ethylacetate and filtered. The filtrate was then evaporated to dryness. The residue was dissolved in 10 mL of anhydrous chloroform and then filtered again (Harbone, 1998) [12].

(i) **Test for Steroids:**

One of the portions of the filtrate was mixed with 2 mL of conc. H_2S0_4. A reddish brown colour, indicated the presence of a steroids, in the form of steroidal ring (Harbone, 2010) [11].

(ii) **Test for Terpenes**

The other portion of the filtrate was mixed with 1 mL of acetic anhydride, followed by the addition of 1 mL of conc. H_2S0_4, carefully down the wall of the test-tube, to form a layer underneath. The resultant formation of a redish-violet colour indicated the presence of terpenes (Harbone, 1998) [12].

Test for Anthraquinones

Five grams (5 g) of the powder was taken into a test tube and 10 mL of chloroform was added and shaken for 5 minutes. The extract was then filtered and another 5 mL of Ammonia (NH_3) was added to the mixture and shaken. A bright pink colour in the upper aqueous layer indicated the presence of anthraquinones (Harbone, 2010) [11].

Test for Tannins.

To 1mL of aqueous extract, was added about 7 mL of ferric chloride ($FeCl_3$). The presence of blue-black and or blue-green precipitate indicated the presence of Tannins (Harbone, 1998) [12].

Data Analysis

All the data collected from the study were analyzed using analysis of Variance (ANOVA) and means separated by Fisher Least Significant Difference (LSD).

Results

Percentage Mortality of *C. maculatus* Exposed to Different Dosages of *A. conyzoides* Leaf Powder

Table 1 shows the mortality effects of *A. conyzoides* leaf powder on *Callosobruchus maculatus*. Insect mortality increased progressively with increasing dosage of the plant powder and length of exposure. Within 96 hours after treatment, the highest mortality (92.25%) was recorded at the 4 g dosage level. At 72 hours post-treatment, all powder dosages caused insect mortality exceeding 50% while 4 g treatment recorded the highest mortality (78.50%). Furthermore, all dosages resulted in mortality rates above 60% within 96 hours of exposure. However, none of the powder treatments achieved 100% mortality within the 96-hour period. Despite this, mortality levels in all treated groups were significantly higher ($p < 0.05$) than those observed in the untreated control throughout the exposure period.

Table 1: Percentage mortality of adult *C. maculatus* exposed to different dosages of *A. conyzoides* leaf powders

Treatment (g)	% mortality	at hours post	Treatment	
	24	48	72	96
1	16.23 ± 1.10[d]	31.50 ± 1.33[d]	47.14 ± 2.12[d]	58.20 ± 2.15d
2	27.25 ± 1.35[c]	42.75 ± 2.10[c]	56.25 ± 2.14[c]	65.50 ± 3.67[c]
3	38.32 ± 1.18[b]	49.25 ± 2.22[b]	67.35 ± 3.13[b]	84.15 ± 3.17[b]
4	46.39 ± 2.33[a]	66.26 ± 2.45[a]	78.50 ± 3.19[a]	92. 25 ± 4.31[a]
0.0 (untreated)	0.00±0.00[e]	0.00±0.00[e]	0.00±0.00[e]	0.00±0.00[e]

Values in the same column followed by the same letter (s) are not significantly (p<0.05) different from each other using New Duncan's Multiple Range Test.

Percentage Mortality of *C. maculatus* Exposed to Different Dosages of *A. conyzoides* ethanol Leaf Extract

The mortality effects of *A. conyzoides* leaf extract on *C. maculatus* are presented in Table 2. Insect mortality increased with both increasing extract concentration and duration of exposure. Within 24 hours of treatment, only the 8% (v/w) extract concentration produced mortality above 63.42%, and its effect was significantly (p > 0.05) higher than those of the other treatments. At 72 hours post-treatment, the 8% (v/w) extract achieved the highest mortality rate (91.50%), which was significantly different (p < 0.05) from the other concentrations. At 96 hours post-treatment, complete mortality (100%) was recorded at the 8% (v/w) concentration. All extract dosages achieved mortality levels above 60% within 96 hours of exposure.

Table 2: Percentage mortality of *C. maculatus* exposed to different concentrations of *A. conyzoides* leaf extract

Extract Concentration (%) v/w	% mortality	at hours post	Treatment	
	24	48	72	96
1	32.25 ± 1.16[d]	46.25 ± 2.15b[d]	55.35 ± 2.35[d]	64 ± 3.14[d]
4	41.50 ± 2.44[c]	55.25 ± 2.64[c]	68.33 ± 3.27[c]	75.25 ± 3.18[c]
6	52.50 ± 2.55[b]	67.25 ± 2.18[b]	78.15 ± 3.66[b]	95.75 ± 4.14[b]
8	63.42 ± 2.19[a]	78.52 ± 3.52[a]	91.50 ± 4.77[a]	100.00 ± 0.00[a]
0.0 (untreated)	0.00 ± 0.00[e]	0.00 ± 0.00[e]	0.00 ± 0.00[e]	0.00 ± 0.00[e]

Each value is mean ± standard error of three replicates. Values in the same column followed by the same letter (s) are not significantly (p<0.05) different from each other using New Duncan's Multiple Range Test.

Effects of *A. conyzoides* Leaf Extract on Oviposition and Adult Emergence of *C. maculatus*

The effects of *A. conyzoides* leaf extracts on oviposition and adult emergence of *C. maculatus* are presented in Table 3. The leaf extracts significantly reduced oviposition by the weevils, with both the number of eggs laid and the number of adults that emerged decreasing as extract concentration increased. The number of eggs deposited on treated cowpea seeds was significantly lower (p < 0.05) than that recorded on untreated seeds. Notably, no eggs were laid on seeds treated with the 8% extract per 50 g of seeds, and consequently, no adult emergence was observed at this concentration.

Table 3: Effects of *A. conyzoides* leaf extract on oviposition and adult emergence of *C. maculatus.*

Extract Concentration (%) v/w	No of eggs laid	% adult emergence
Untreated	88.13±3.57[a]	87.25±4.16[a]
2	28.15±1.71[b]	21.15±1.14[b]
4	18.26±0.78[c]	12.50±0.49[c]
6	10.25±0.61[d]	0.00±0.00[d]
8	0.00±0.00[e]	0.00±0.00[e]

Each value is mean ± standard error of three replicates. Values in the same column followed by the same letter (s) are not significantly (p<0.05) different from each other using New Duncan's Multiple Range Test.

Effect of *A. conyzoides* Leaf Powder on Oviposition and Adult Emergence of *C. maculatus*

Table 4 shows the effects of *A. conyzoides* leaf powder on oviposition and adult emergence of *C. maculatus*. Both oviposition and adult emergence decreased significantly with increasing powder dosage. Treated seeds recorded significantly lower (p < 0.05) oviposition and adult emergence compared to the control. The 4 g powder dosage resulted in the lowest number of eggs laid and was significantly different (p < 0.05) from the other treatments. Complete suppression of adult emergence was observed in seeds treated with the highest powder dosage. Overall, oviposition and adult emergence in powder-treated cowpea seeds were significantly lower (p < 0.05) than those recorded in the untreated control.

Table 4: Effects of *A. conyzoides* leaf powder on oviposition and adult emergence of *C. maculatus*

Treatment (g)	No of eggs laid	% adult emergence
Untreated	88.13±3.57[a]	87.25±4.16[a]
1	32.25±1.38[b]	24.22±1.18[b]
2	23.15±1.15[c]	14.23±1.33[c]
3	10.25±0.34[d]	4.14±0.24[d]
4	4.13±0.32[e]	0.00±0.00[e]

Values in the same column followed by the same letter (s) are not significantly (p<0.05) different from each other using New Duncan's Multiple Range Test.

Table 5: Effect of *A. conyzoides* leaf extract on long term storage of cowpea seede

Extract concentration (%)	Mean total number of seeds	Percentage seed damage	Mean weight loss (g)	Weevil Perforation Index (WPI)
2	198.50	12.50 ± 0.67[b]	7.25 ± 0.43[b]	15.38 ± 0.81[b]
4	195. 25	0.00 ± 0.00[c]	0.00 ± 0.00[c]	0.00 ± 0.00[c]
6	192. 00	0.00 ± 0.00[c]	0.00 ± 0.00[c]	0.00 ± 0.00[c]
8	194.00	0.00 ± 0.00[c]	0.00 ± 0.00[c]	0.00 ± 0.00[c]
Untreated	197. 25	81.25 ± 3.43[a]	32.50 ± 2.32[a]	58.75 ± 3.45[a]

Means within the same column followed by the same letter(s) are not significantly different (P ≤ 0.05) using New Duncan`s Multiple Range Test.

Protection of Cowpea Seeds with *A. conyzoides* Leaf Extracts

The protective effects of *A. conyzoides* leaf extracts on cowpea seeds are presented in Table 5. Extract concentrations of 4, 6, and 8% (v/w) completely prevented seed damage over a storage period of three months. No seed damage or weight loss was recorded in cowpea seeds treated with these concentrations. In contrast, untreated seeds recorded significant weight loss and damage. The reduction in seed weight in the control was significantly higher ($p \leq 0.05$) than that observed in all treated seeds.

Effects of *A. conyzoides* leaf extracts on germination of cowpea seeds

The percentage of seeds that germinated after treatment with dosage of *A. connyzoides* leaf extracts are presented in Table 6. After 7 days of germination, all the treated seeds and the control recorded high germinability of 100 %, except for the dosage 8% v/w which recorded 96.25%.

Table 6: Percentage germination cowpea seeds that were previously protected for 90 days onexposure to *A. conyzoides* leaf extract

Extract concentration (%) v/w	Percentage germination
2	100.00 ± 0.00^{a}
4	100.00 ± 0.00^{a}
6	100.00 ± 0.00^{a}
8	96.25 ± 2.22^{b}
Untreated	100.00 ± 0.00^{a}

Means within the same column followed by the same letter(s) are not significantly different ($P \leq 0.05$) using New Duncan`s Multiple Range Test.

Table 7: Phytochemical Constituents of *A. conyzoides*

Phytochemical	Result
Alkaloids	+
Glycosides	+
Saponin	+
Anthraquinones	+
Tannins	+
Terpenes	+
Steroids	-
Flavonoids	+

Key: + = Present; - = Absent

Phytochemical Constituents of *A. conyzoides* Leaf

Phytochemical analysis of *A. conyzoides* leaf extracts revealed the presence of several bioactive compounds (Table 7). These included alkaloids, glycosides, saponins, anthraquinones, tannins, terpenes, and flavonoids. Steroids were not detected in the extracts.

Discussion

One of the major challenges associated with post-harvest handling and food storage globally is the infestation and damage caused by stored-product pests. The control of these pests has traditionally relied on the use of synthetic insecticides. However, growing concerns over the adverse effects of synthetic chemicals on human health, non-target organisms, and the environment have necessitated the search for safer and more sustainable alternatives. Consequently, the use of botanicals in pest management has gained increasing attention (Adedire *et al*., 2011; Adesina, 2013 and Obembe, 2021) [8, 13, 14]. The application of indigenous plant materials and other locally available resources for protecting cereals and legumes against insect pests has been widely reported (Ewete, 2007) [15].

Several studies have suggested that tropical plants with proven bioactivity against stored-product insects possess sufficient insecticidal potential to justify their scientific development and formulation (Raghuram, 2015 and Bryant *et al*., 2020) [16, 17]. The findings of the present study demonstrate that both the leaf extracts and powders of *Ageratum conyzoides* are effective bio-insecticides against the cowpea weevil, *C. maculatus*. This effectiveness is evidenced by high adult mortality, significant suppression of oviposition and adult emergence, and effective protection of cowpea seeds during prolonged storage. Notably, the highest extract concentration (8.0% v/w) caused 100% mortality of adult *C. maculatus* within 96 hours of exposure. This observation is consistent with the findings of Adedire *et al*., (2011) [8], who reported complete mortality of *C. maculatus* in cowpea seeds treated with 1.0% (v/w) cashew kernel extracts. Similarly, Kayode and Obembe (2012) [18] reported effective protection of cowpea seeds against *C. maculatus* using aqueous extracts from seven tropical tree species.

The present study established that beetle mortality was directly influenced by both dosage level and duration of exposure. In addition, the leaf extracts exhibited higher toxicity to *C. maculatus* than the corresponding plant powders. Similar observations were reported by Ileke and Bulus (2019) and Obembe *et al*. (2025) [19, 20] on the comparative efficacy of powders and extracts of *Alstonia boonei* against the cowpea beetle. Ileke *et al*., (2020a) [21] also documented comparable results in studies involving *Acanthus montanus*, *Argyreia nervosa*, *Alchornea laxiflora*, and *Acanthospermum hispidum* as protectants of maize grains against *Sitophilus zeamais*. According to Asawalam *et al*. (2007) [22], the insecticidal activity of plant materials largely depends on the nature and concentration of active compounds present in the extracts. Lale (1999) [23] further reported that plant extracts possess a strong affinity for lipids, enabling them to penetrate the insect cuticle and exert toxic effects. In the present study, both the leaf powder and extract of *A. conyzoides* exhibited strong insecticidal activity against *C. maculatus* at all tested dosages.

At the highest dosage (0.8 g per 50 g of cowpea seeds), the plant powders produced over 90% adult mortality. This high mortality rate may be attributed to the fine particle size of the powders, which likely obstructed the spiracles of the insects, thereby disrupting respiration and leading to suffocation and eventual death. Similar modes of action have been reported for botanical powders used against stored-product insects (Arthur *et al*., 2018; Ileke and Bulus, 2019) [24, 19].

The bioactive compounds present in *A. conyzoides* leaf powder and extracts demonstrated strong insecticidal properties, as well as oviposition-inhibitory and reproductive-suppressive effects on *C. maculatus*. Oviposition by female beetles was significantly reduced in treated cowpea seeds compared with the untreated control, while adult emergence was markedly suppressed after 30 days of exposure. These results are in agreement with earlier reports indicating that plant-derived extracts and powders effectively reduce oviposition and inhibit survival across different developmental stages of storage pests (Isman, 2020; Ukeh *et al*., 2021) [25, 26].

The reduction in oviposition observed in this study may be associated with respiratory impairment caused by the extracts, which could disrupt metabolic processes and subsequently affect other physiological functions of the bruchids. Additionally, the extracts may have interfered with locomotion activity, thereby reducing movement, mating behavior, and fecundity. Residual deposits of the extracts on treated cowpea seeds may also have hindered egg adhesion, resulting in reduced egg viability and lower adult emergence. Comparable behavioral and reproductive effects of botanical insecticides have been widely documented (Benelli *et al*., 2017; Pavela and Benelli, 2016; Isman and Grieneisen, 2019) [27-29].

Phytochemical analysis revealed that the leaf powder and extracts of *A. conyzoides* contained alkaloids, glycosides, saponins, anthraquinones, tannins, terpenes, and flavonoids, while steroids were absent. Traditionally, herbal preparations are often obtained through decoctions or infusions using water or alcohol as solvents. Fernando *et al*. (2005) [30] reported that many plants contain secondary metabolites such as terpenoids, saponins, tannins, flavonoids, and alkaloids, which are known to possess insecticidal properties. The toxicity and anti-feedant effects of alkaloids against stored-product insects have also been documented (Yang *et al*., 2006) [31]. Therefore, the observed insecticidal efficacy of *A. conyzoides* in this study can be attributed to the presence of these bioactive phytochemicals, particularly flavonoids, tannins, saponins, and alkaloids (Ileke *et al*., 2014) [32].

Conclusion

The present work investigated the effect of *A. conyzoides* powder and extract against cowpea weevils, *C. maculatus*. The extract was found to be very effective for insecticidal activity against *C. maculatus*. The results obtained in this research work suggested that *A. conyzoides* powder and extract could be used as biopesticides against cowpea beetle.

References

1. Singh BB, Ehlers JD, Sharma B, Freire Filho FR. Recent progress in cowpea breeding. In: Fatokun, C. A. *et al.* (Eds.), Challenges and Opportunities for Enhancing Sustainable Cowpea Production. IITA, Ibadan, 2014.
2. Obembe OO, Adebayo RA, Ajayi OE. Evaluation of botanical insecticides for the control of *Callosobruchus maculatus* on stored cowpea seeds. African Journal of Agricultural Research. 2021; 17(4):512-520.
3. Caswell GH. Damage to stored cowpea in the Northern part of Nigeria. Samaru Journal of Agricultural Research. 1984; 2:11-19.
4. Ofuya TI. Biology, ecology and control of insect pests of stored grains. In: Ofuya, T. I. and Lale, N. E. S. (Eds.), Pests of Stored Cereals and Pulses in Nigeria. Dave Collins Publications, Nigeria, 2001.
5. Adedire CO, Ajayi TS. Potential of sand and plant powders in the control of *Callosobruchus maculatus* (F.) infestation in stored cowpea seeds. Journal of Plant Diseases and Protection. 2003; 110(6):602-610.
6. Ofuya TI, Bamigbola KA. Damage potential of *Callosobruchus maculatus* (F.) on cowpea seeds. J. of Stored Products Res. 1991; 27(2):89-94.
7. Isman MB. Botanical insecticides, deterrents, and repellents in modern agriculture and an increasingly regulated world. Annual Review of Entomology. 2006; 51:45-66.
8. Adedire CO, Obembe OO, Akinkurolere RO, Oduleye O. Response of *Callosobruchus maculatus* (Coleoptera: Chrysomelidae: Bruchinae) to extracts of cashew kernel. Journal of Insect Science. 2011; 11(1):1-10.
9. Ileke KD, Oni MO. Toxicity of some plant powders to cowpea bruchid, *Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae). Journal of Agricultural Technology. 2011; 7(4):1119-1128.
10. Fatope MO, Nuhu AM, Mann A, Takeda Y. Cowpea weevil bioassay: A simple prescreen for plants with grain protectant effect. Int J Pest Mgmt. 1995; 41(2):84-86.
11. Harbone JB. Phytochemical methods: A guide to modern techniques of plant analysis 111. Springer (India) put. ltd. New Delhi, 2010, 40-96.
12. Harborne JB. Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis (3rd ed.). London: Chapman & Hall, 1998.
13. Adesina JM. Insecticidal potential of Mormordica charantia (L.) leaves powder against maize weevil, *Sitophilus zeamais* (Mots) (Coleoptera: Curculionidae) infestation. International Journal of Biosciences. 2013; 3:28-38.
14. Obembe OM. Effects of Processing Methods on Proximate Composition of Groundnut seed (*Arachis hypogea* L.) during Storage Period. FUTA Journal of Life Sciences. 2021; 1(1):53-60.
15. Ewete TI. Use of plant ash for reducing *Callosobruchus maculatus* damage on cowpea seedlings. Journal of Agricultural Science. 2007; 107:467-470.
16. Raghuram CP. Insecticidal activity of botanical pesticides on *Callosobruchus chinensis* L. (Coleoptera: Bruchidae) on the stored green gram, *Vigna radiata* (L.). International Journal of Agricultural Science Research. 2015; 4:13-20.
17. Bryant T, Reaay-Jones FPY. Integrated pest management concepts and strategies, 2020. http:/Igpress.clemson.edu
18. Kayode J, Obembe OM. Assessment of the insecticidal potentials of the aqueous extracts of some Tropical Trees as Protectant of cowpea seed from *Callosobruchus maculatus* infestation. Bio-Science Research Bulletin. 2012; 28(1):39-47.
19. Ileke KD, Bulus DS. Response of *Callosobruchus maculatus* to powders and extracts of botanical insecticides. Journal of Plant Diseases and Protection. 2019; 126:123-131.
20. Obembe Olusola Michael, Mary Tejumade Philip-Attah, Mary Adeola Adegbola. Entomocidal activity of *Alstonia boonei* de wild oil extracts against cowpea beetle, *Callosobruchus maculatus* fabricius (Coleoptera: Bruchidae) infesting stored cowpea seeds. Journal of Bioscience and Biotechnology Discovery. 2025; 10(4):79-85.
21. Ileke KD, Idoko JE, Ojo DO, Adesina BC. Evaluation of botanical powders and extracts from Nigerian plants as protectants of maize grains against maize weevil, *Sitophilus zeamais* (Motschulsky) [Coleoptera: Curculionidae]. Biocatal Agricul Biotechnol, 2020a. Doi: https:// doi. org/ 10. 1016/j. bcab. 2020. 101702
22. Asawalam EF, Esosaire SO, Ekeleme F, Wokocha RC. Insecticidal effects of powdered parts of eight Nigerian

Plant species against Maize weevil, *Sitophilus zeamais* (Mots.) (Coleoptera: Curculionidae). Elect J Entomol Agricul Food Chem. 2007; 6(1):2526-2533.
23. Lale NES, Abdulrahman HT. Evaluation of neem (*Azadirachta indica* A. Juss.) seed oil obtained by different methods and neem powder for the management of *Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae) in stored cowpea. J Stor Prod Res. 1999; 35:135-143.
24. Arthur FH, Starkus LA, Phillips TW. Physical and botanical insecticides for stored-product protection. Journal of Stored Products Research. 2018; 77:1-10.
25. Isman MB. Botanical insecticides in the twenty-first century-Fulfilling their promise? Annual Review of Entomology. 2020; 65:233-249.
26. Ukeh DA, Umoetok SBA, Umoru PA. Botanicals as alternatives to synthetic insecticides in stored-product pest management. Environmental Sustainability. 2021; 4:245-256.
27. Benelli G, Pavela R, Canale A, Mehlhorn H. Tick repellents and acaricides of botanical origin: A green roadmap to control arthropods. Parasitology Research. 2017; 116:2835-2848.
28. Pavela R, Benelli G. Essential oils as ecofriendly biopesticides? Challenges and constraints. Trends in Plant Science. 2016; 21(12):1000-1007.
29. Isman MB, Grieneisen ML. Botanical insecticide research: Many publications, limited useful data. Trends in Plant Science. 2019; 24(9):826-840.
30. Fernando AC, Silva KFSD, Santos KKD, Junior KALR, Ana AEGS. Activities of some Brazilian plant against larvae of the mosquito *Aedes aegypti*. Filoterap. 2005; 76:234-239.
31. Yang Z, Zhao B, Zhu L, Fang J, Xia L. Inhibitory effects of alkaloids from *Sophora alopecuroids* on feeding development and reproduction of *Clostera anastomosis*. Front China. 2006; 1(2):190-195.
32. Ileke KD. Antinutritional factors determining the susceptibility of Cowpea to Cowpea bruchid, *Callosobruchus maculatus* (Fab.) (Coleoptera: Chrysomelidae) infestation. Biosci Meth. 2014; 5(2):1-8.