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# Potentials of *Calotropis gigantea* and *Allamanda cathartica* in controlling*Callosobruchus maculatus* in stored cowpea

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**Abstract**

Use of synthetic insecticides in storage of grains has resulted in hazards to man, animals and environment. Resurgence of pest resistance also occurred which led to search for alternative means for pest control. This study was carried out to evaluate efficacy of powdered, aqueous and solvent extracts of *Calotropis gigantea* and *Allamanda cathartica* in control of *Callosobruchus maculatus* in stored cowpea and determine phytochemical constituents of *C. gigantea* and *A. cathartica.* The experiment was carried out in the laboratory of Department of Crop Protection using a Completely Randomized Design. Eleven (11) treatments applied at 3 rates i.e. 2ml, 4ml and 6ml for aqueous and ethanol extracts and 2g, 4g and 6g for powder. Cowpea variety IT96D-610 was used for the study. Powder, aqueous and ethanol extracts were prepared from mature air-dried leaves of *C. gigantea* and *A. cathartica*. Treatments were applied to 50g of cowpea seeds and replicated 3 times. Ten (10) adults of *C maculatus* ratio 1:1 were introduced into each replicate. Parameters used to assess efficacy of treatments were; adult mortality, oviposition rate, larvae and pupae emergence, $F_1$ progeny emergence, weight loss and seed viability. Findings show leaves of both plants contain alkaloids, cardiac glycosides, tannin, saponin, anthocyanins, steroids, coumarins and terpenoids. The extract of *A. cathartica* at 6ml/50g was most effective in control of stored cowpea seeds. and can be used successfully in the storage of cowpea seeds by resource poor farmers in Ilorin.

**Keywords**: Bio-pesticides, bruchid, efficacy, storage.

## 1. Introduction

Cowpea (*Vigna unguiculata* (L) Walp) is a pulse which play a very important role in the nutrition of the people in Nigeria. They are the most commonly consumed pulse in Nigeria [7] and their edible grains form a cheap and rich source of alternative protein [25]. All parts are used for food. The leaves, green pods, green peas and the dry grains are consumed as different dishes [22]. These parts are nutritious, providing proteins, vitamins and minerals especially micronutrients. The grains are rich in the amino acids lysine and tryptophan making it better than cereals. This makes cowpea a good supplement for cereal and root and tuber-based diets characteristic of many coastal and forest communities [14].

The production of cowpea is restricted by a number of biotic and abiotic factors both in the field and in storage. Among the constraining biotic factors are insect pests [32] of which *Callosobruchus maculatus*, is the major pest of stored cowpea in Nigeria [24]. Attack by this pest begins in the field and continues in storage, causing substantial quantitative and qualitative losses [25] manifested by seed perforation and reductions in weight, market value and germination ability of seeds [19]. This is worsened as.the insect multiplies very fast in storage, giving rise to a new generation every month [29].

The organic compounds, of natural chemicals derived from plants are known as botanical insecticides or bio-pesticides [31]. The bio-pesticides, in general are unstable, have short residue, a high knock down effect, and low mammalian toxicity [9]. Synthetic insecticides such as organochlorine, organophosphate, and carbamate groups have been widely used because of their effectiveness on the control of broad ranges of pest species [6], but a lot of them especially DDT have been banned worldwide due to their adverse side effects on the environment, hazard to humans, animals and beneficial organisms[9] in additionto development of resistance by insects over time. Hence, Scientist have turned back to search for new products with the hope that they can be used in replacing synthetic insecticides. As part of the quest for an alternative to chemical insecticides, research efforts are currently

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being focused on the use of plant products, such as plant powder, extracts and oils, which are cheaper, safer and eco-friendlier [1]. With respect to grain protection, increasing attention has been focused on evaluating their efficacies and identifying the active constituents of these plant materials [17].

The objective of this study is to determine the phytochemical constituents and comparative efficacy of *Calotropis gigantea* (giant milk weed) and *Allamanda cathartica* (golden yellow trumpet) in the control of *Callosobruchus maculatus* in stored cowpea in the search for alternative control methods.

## 2. Materials and Methods

Cowpea seed variety IT96D-610 used in the experiment was sourced from the International Institute of Tropical Agriculture (IITA), Ibadan. The seeds are moderately susceptible to attacks by *C.maculatus*, and can thus suffer serious damage in storage [21]. The seeds were stored in airtight plastic containers and kept in the freezer section of the refrigerator at -4$^{o}$C for 7 days prior to use in the experiment. Sterilization was done to kill any living or developing stage of the weevil in the seeds. The seeds were removed from the fridge and allowed to thaw before being used.

Adult *Callosobruchus maculatus* were obtained from infested cowpea seeds bought from Oja tuntun, a local market in Ilorin. This was used to establish a stock culture. The stock culture of *C. maculatus* was set up by filling 4 (1 lb.) Kilner jars half way with new un-infested cowpea seeds.100 unsexed adults were then introduced into each Kilner jar. The weevils were allowed to mate for seven days and lay eggs after which they were removed. The insects emerging from the culture were used for the study.

Mature leaves of *Calotropis gigantea* and *Allamanda cathartica* used for the experiment were collected from the Senior Staff Quarters of the University of Ilorin. To prepare the aqueous extracts of *C. gigantea* and *A. cathartica*, five kilograms (5kg) each of the leaves were air dried and thereafter ground to powder. Using the dry mill section of a blender. The resultant powders were soaked separately in distilled water for twenty-four hours (24hrs.). After twenty-four hours, the solution was stirred and filtered using a 0.45-micron filter. The filtrates were taken as 100% concentration aqueous solution of the leaf extracts. While in the preparation of ethanol extracts of *C. gigantea* and *A. cathartica*, five kilograms (5kg) each of the leaves were prepared as previously discussed. The powders were soaked in ethanol for twenty-four hours (24hrs.). After twenty-four hours, the solution was filtered using a 0.45-micron filter. The filtrates were taken as 100% concentration solution of the ethanol leaf extract. Both extracts were stored in the refrigerator prior to use.

To screen for phytochemical constituents, dried and pulverized leaves of *A. cathartica* and *C. gigantea*, sieved samples were extracted by maceration using n-hexane, ethyl acetate and ethanol as solvents successively. The extracts were filtered using Whatman filter paper (150mm) and the filtrate concentrated using a rotary evaporator. The screening of the phytochemical constituents was done at the Department of Industrial Chemistry of University of Ilorin.

To determine contact toxicity of *C. gigantea* and *A. cathartica* powder, aqueous and ethanol leaf extracts against adults of *C. maculatus* in stored cowpea, the leaf extracts were applied at 2, 4 and 6 ml/50g cowpea seeds for (aqueous and ethanol extracts respectively) and 2, 4 and 6g/50g cowpea seeds for the powder extract in separate plastic container of 150ml capacity. The mixture of cowpea seeds and extracts were thoroughly agitated for 2-3 minutes to ensure uniform covering of the seeds by the extracts and then allowed to settle for 15 minutes before infestation. Ten freshly emerged adults of *C. maculatus* were placed into each replicate and then covered with muslin material held in place with a rubber band to prevent suffocation and escape of the insects or entry of parasites/predators. The experiment was arranged in a completely randomized design with three replications per treatment making a total of 87 experimental units. In the determination of toxicity bioassay, the insects were considered dead when they remained inactive and showed no movement, the dead insects were removed and discarded after recording. Adult mortality readings were taken at 1, 2, 3, 4 and 5 DAT (Days After Treatment) and then expressed as percentage using the following formula:

% mortality = No of dead insects/ Total no. of insects × 100

Newly emerged $F_1$ progeny were recorded 40 days after infestation. This was continued until no more insect emergence occurred. To determine the seed weight loss, the initial weight and final weight of the seeds were taken. The difference between the initial weight and final weight divided by initial weight were expressed as percentage weight loss 40 days after $F_1$

emergence [28]. The percentage seed weight loss was calculated using this formula:

% Weight loss = initial weight – final weight / initial weight × 100

To determine the seed viability, the floatation method described by [8] was used to evaluate the viability of the seeds. The data collected were subjected to analysis of variance (ANOVA) and means separated using new Duncan's Multiple Range Test at P<0.05. The data were analyzed using IBM SPSS statistics package (version 21).

## 3. Results and Discussion

Plant extracts often consist of complex mixtures of bioactive constituents and these plant metabolites may produce toxic effects if ingested leading to rejection of the host plant by insect pests [30]. These active compounds may act as antifeedants, disturb insect growth, development and inhibit oviposition [11]. Results of phytochemical analysis revealed presence of tannins, saponins, steroids and terpenoids in moderate quantities while alkaloids, cardiac glycosides, anthocyanins and coumarins occurred in lesser quantities in both aqueous and ethanol leaf extracts of *Calotropis gigantea* and *Allamanda cathartica* (Table 1).

This corroborates the work of [27] who reported that latex of *C. gigantea* is a mixture of alkaloids, tannins, gum, sugars, starch, resins and proteins. The presence of terpenoids revealed that the plants can act mainly as anti-feedant and growth disruptor and possesses considerable toxicity toward insects [18]. Frazier [12] reported that antifeedants can be found amongst all major classes of secondary metabolites (alkaloids, flavonoids, terpenoids and phenolics), some of which are found in *A. cathartica* and *C. gigantea*. According to [16] antifeedants have some physiological or toxic actions on insects, depending on the treatment concentrations.

**Table 1.** Bioactive compounds found in aqueous and ethanol extracts of *Allamanda cathartica* and *Calotropis gigantea*

| | Ethanol extracts | | Aqueous extracts | |
|---|---|---|---|---|
| Phytochemicals | *Calotropis* | *Allamanda* | *Calotropis* | *Allamanda* |
| Alkaloids | + | + | + | + |
| Cardiac glycosides | + | + | - | - |
| Saponins | + | - | +++ | +++ |
| Tannins | ++ | + | - | - |
| Flavonoids | - | - | - | + |
| Steroids | +++ | + | ++ | + |
| Terpenoids | + | ++ | ++ | + |
| Anthocyanins | + | + | + | + |
| Coumarins | - | + | - | - |

Absent (-), Present (+), Moderately Present (++), Highly Present (+++).

All treatments increased the mortality of *C. maculatus* when exposed to treated cowpea seeds. In this study, higher mortality was recorded in ethanol leaf extracts than from aqueous leaf extract and powder. Ethanol leaf extract of *C. gigantea* at 6 ml/50 g had the highest insecticidal activity (73.3%) amongst the treatments on day 1 (Table 2a) and its effect is comparable to ethanol leaf extracts of *A. cathartica* at 6 ml/50 g. This resulted in increased mortality of *C. maculatus.* There was no significant difference (P>0.05) between both treatments except on day 2 (Table 2a). The aqueous leaf extracts of *C. gigantea* and *A. cathartica* extracts were not as effective as ethanol leaf extracts.

Leaf powders of *C. gigantea* and *A. cathartica* also showed insecticidal properties which resulted in increased mortality of *Callosobruchus maculatus* exposed to treated seeds when compared to control (Table 2b). Though there was no significant difference (P>0.05) between powders and control, *A. cathartica* and *C. gigantea* at 6g/50g were the most effective of the treatments (Table 2b).

**Table 2a**.Effects of aqueous and ethanol leaf extracts of *Calotropis gigantea* and *Allamanda cathartica* on adult mortality of *Callosobruchus maculatus.*

| | | % Mortality (Days After Treatment) | | | | |
|---|---|---|---|---|---|---|
| Treatment (Extracts) | Conc.(ml/50g) | 1 | 2 | 3 | 4 | 5 |
| *Allamanda (*Aqueous) | 2 | 16.70ghij | 33.30bcd | 26.70bc | 6.70d | 36.70ab |
| | 4 | 16.70ghij | 26.70bcdef | 13.30bc | 0.00d | 6.70b |
| | 6 | 10.00hij | 30.00bcde | 26.70bc | 46.70bcd | 43.30ab |
| *Calotropis* (Aqueous) | 2 | 30.00fghij | 6.70def | 13.30bc | 13.30d | 6.70b |
| | 4 | 23.30fghij | 6.70def | 23.30bc | 16.70cd | 10.00b |
| | 6 | 36.70efghi | 30.00bcde | 10.00bc | 10.00d | 36.70ab |
| *Allamanda* + *Calotropis* (Aqueous) | 2 | 30.00fghij | 10.00cdef | 23.30bc | 6.70d | 6.70b |
| | 4 | 26.70fghij | 16.70cdef | 16.70bc | 0.00d | 10.00b |
| | 6 | 6.70ij | 16.70cdef | 16.70bc | 13.30d | 10.00b |
| *Allamanda* (Ethanol) | 2 | 36.70efghi | 6.70def | 30.00bc | 10.00d | 10.00b |
| | 4 | 43.30cdefgh | 20.00cdef | 10.00bc | 16.70cd | 33.30ab |
| | 6 | 66.70bcde | 53.30b | 46.70ab | 100.00a | 100.00a |
| *Calotropis* (Ethanol) | 2 | 56.70cdef | 13.30cdef | 23.30bc | 36.70bcd | 66.70ab |
| | 4 | 50.00cdefg | 16.70cdef | 16.70bc | 40.00bcd | 33.30ab |
| | 6 | 73.30abcd | 86.70a | 66.70a | 73.30ab | 100.00a |
| *Allamanda* + *Calotropis* (Ethanol) | 2 | 50.00cdefg | 26.70cdef | 3.30c | 43.30bcd | 66.70ab |
| | 4 | 43.30defgh | 30.00bcde | 6.70c | 46.70bcd | 33.30ab |
| | 6 | 40.00defghi | 36.70bc | 13.30bc | 70.00abc | 70.00ab |
| Cypermethrin | | 100.00a | 0.00f | 0.00c | 0.00d | 0.00b |
| Control | 0 | 0.00j | 0.00f | 3.30c | 6.70d | 3.30b |
| S.E.M | | 10.13 | 8.16 | 11.24 | 16.61 | 20.78 |

Values with the same letters down the column are not significantly different at P<0.05
S.E.M: Standard Error of Mean.

**Table 2b**:Effect of *Calotropis gigantea* and *Allamanda cathartica* leaf powder on adult mortality of *Callosobruchus maculatus.*

| | | %Mortality (Days After Treatment) | | | | |
|---|---|---|---|---|---|---|
| Treatment | Conc.(g/50g) | 1 | 2 | 3 | 4 | 5 |
| *Allamanda* Powder | 2 | 6.67c | 6.67b | 10.00bc | 0.00c | 6.67bcd |
| | 4 | 3.33c | 6.67b | 13.33b | 3.33bc | 0.00d |
| | 6 | 6.67c | 6.67b | 0.00c | 3.33bc | 6.67bcd |
| *Calotropis* Powder | 2 | 0.00c | 6.67b | 6.67bc | 3.33bc | 0.00d |
| | 4 | 3.33c | 13.33ab | 10.00bc | 3.33bc | 6.67bcd |
| | 6 | 6.67c | 6.67b | 0.00c | 10.00b | 3.33cd |
| *Allamanda* + *Calotropis* (Powder) | 2 | 6.67c | 6.67b | 6.67bc | 0.00c | 3.33cd |
| | 4 | 3.33c | 3.33b | 6.67bc | 3.33bc | 10.00bc |
| | 6 | 3.33c | 10.00b | 3.33bc | 6.67bc | 13.33b |
| Cypermethrin | 6 | 100.00a | 0.00b | 0.00a | 0.00a | 0.00a |
| Control | 0 | 0.00c | 0.00b | 3.33bc | 6.67bc | 3.33cd |
| S.E.M | | 0.33 | 0.40 | 0.39 | 0.25 | 0.25 |

Values with the same letters down the column are not significantly different at P>0.05
S.E.M: Standard Error of Mean

Oviposition rate of *C. maculatus* was reduced by all treatments (Table 3). Lower oviposition rate, were recorded in ethanol leaf extracts than from aqueous leaf extract and powder. Ethanol leaf extract of *A. cathartica* at 6ml/50g had the lowest oviposition rate (1.67) and was significantly different (P<0.05) from control (16.67) (Table 3). This is followed by aqueous leaf extract of *C. gigantea* at 2ml/50g (2.00). The leaf powder of *C. gigantea* at 4g/50g resulted in the lowest oviposition rate (3.00) amongst powder treatments and was significantly different (P<0.05) from the control (Table 3). The treatment combination did not appear to have a synergistic effect as they resulted in the highest oviposition rate (14.67) observed among treatments and it was not significantly different (P>0.05) from control (Table 3).

**Table 3**: Effect of leaf extracts of *Calotropis gigantea* and *Allamanda cathartica* on oviposition of *Callosobruchus maculatus.*

| Oviposition (7 Days After Treatment) | | | | | |
|---|---|---|---|---|---|
| Treatments | Conc. (ml/50g) | Aqueous | Ethanol | Conc. (g/50g) | Powder |
| *Allamanda* | 2 | 6.67bcdef | 10.00abcde | 2 | 8.33ab |
| | 4 | 2.67def | 3.00def | 4 | 9.00ab |
| | 6 | 5.33cdef | 1.67ef | 6 | 3.33b |
| *Calotropis* | 2 | 2.00ef | 3.00def | 2 | 6.00b |
| | 4 | 9.33abcde | 7.67bcdef | 4 | 3.00b |
| | 6 | 5.67cdef | 4.67cdef | 6 | 4.33b |
| *Allamanda* + | 2 | 4.67cdef | 5.00cdef | 2 | 4.33b |
| *Calotropis* | 4 | 12.00abc | 11.00abcd | 4 | 9.00ab |
| (1:1) | 6 | 14.67ab | 6.00cdef | 6 | 3.60b |
| Cypermethrin | 6 | 0.00f | 0.00f | 6 | 0.00b |
| Control | 0 | 16.67a | 16.67a | 0 | 16.67cd |
| S.E.M | | 2.49 | 2.49 | | 2.73 |

Values with the same letters down the column are not significantly different at P> 0.05

S.E.M: Standard Error of Mean

**Table 4**: Effect of leaf extracts of *Calotropis gigantea* and *Allamanda cathartica* on larvae of *Callosobruchus maculatus.*

| | Mean number of larvae Days After Treatment | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Conc. | Aqueous | | | Ethanol | | | Conc. | Powder | | |
| Treatments | (ml/50g) | 13 | 15 | 17 | 13 | 15 | 17 | (g/50g) | 13 | 15 | 17 |
| *Allamanda* | 2 | 0.33b | 3.00abc | 1.67b | 1.33b | 2.67abc | 2.00b | 2 | 0.67b | 3.00ab | 2.33b |
| | 4 | 2.00ab | 2.00bc | 0.67b | 1.00b | 1.67bc | 1.33b | 4 | 0.33b | 1.00b | 1.00b |
| | 6 | 0.33b | 1.00bc | 1.00b | 0.00b | 0.67c | 0.67b | 6 | 0.67b | 1.33b | 0.33c |
| *Calotropis* | 2 | 0.00b | 0.33c | 1.00b | 1.67b | 1.00bc | 1.33b | 2 | 1.33b | 2.00ab | 1.33bc |
| | 4 | 1.00b | 2.00bc | 1.67b | 1.67b | 1.00bc | 0.67b | 4 | 2.00ab | 1.67ab | 0.33c |
| | 6 | 0.33b | 2.00bc | 0.33b | 0.67b | 0.00c | 0.33b | 6 | 0.67b | 0.33b | 0.67bc |
| *Allamanda* + | 2 | 0.67b | 0.67c | 1.00b | 0.33b | 1.33bc | 0.33b | 2 | 0.67b | 0.67b | 0.67bc |
| *Calotropis* | 4 | 1.67b | 2.67abc | 2.00b | 1.33b | 1.33bc | 1.67b | 4 | 0.67b | 2.00ab | 0.67bc |
| (1:1) | 6 | 2.00b | 5.00a | 1.33b | 1.00b | 1.00c | 1.00b | 6 | 0.00b | 2.00ab | 1.67bc |
| Cypermethrin | 6 | 0.33b | 1.00bc | 2.00b | 0.33b | 1.00bc | 2.00b | 6 | 0.33b | 1.00b | 2.00bc |
| Control | 0 | 4.00a | 4.00ab | 5.67a | 4.00a | 4.00ab | 5.67a | 0 | 4.00a | 4.00a | 5.67a |
| S.E.M. | | 0.69 | 0.89 | 0.59 | 0.69 | 0.89 | 0.59 | | 0.71 | 0.78 | 0.58 |

Values with the same letters down the column are not significantly different at P> 0.05

S.E.M: Standard Error of Mean

Ethanol leaf extracts of *A. cathartica* and *C. gigantea* at 6ml/50g resulted in the lowest significant mean number of larvae observed when compared to control. Amongst aqueous leaf extracts, *C. gigantea* at 2ml/50g had the lowest mean number of larvae and was significantly different (P<0.05) from control (Table 4). *Calotropis gigantea* powder at 6g/50g seeds had the lowest mean number of larvae amongst powder treatments and it was significantly different (P<0.05) from control (Table 4).

Aqueous and ethanol extracts of *A. cathartica* at 6ml/50g seeds had the lowest mean number of pupae for the days observed (Table 5). Though the results were not significantly different from those of *C. gigantea*, they were different when compared to control for the 16th and 18th day after treatment. Ethanol leaf extract of the treatment combination at 6ml/50g seeds was as effective as ethanol extract of *A. cathartica* at 6ml/50g in reducing mean number of pupae (Table 5) and this was not significantly different (P<0.05) from the observed effects of cypermethrin.

**Table 5.** Effect of leaf extracts of *Calotropis gigantea* and *Allamanda cathartica* on Pupae of *Callosobruchus maculatus.*

| Mean no. of Pupae per Days After Treatment | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Aqueous | | | Ethanol | | | | Powder | | |
| Treatment | Conc.(ml/50g) | 16 | 18 | 20 | 16 | 18 | 20 | Conc.(g/50g) | 16 | 18 | 20 |
| *Allamanda* | 2 | 1.00bc | 1.33b | 1.67ab | 1.67ab | 1.67ab | 2.00ab | 2 | 1.67ab | 3.33a | 0.67ab |
| | 4 | 0.67bc | 0.67b | 1.00ba | 1.00bc | 0.67b | 0.00b | 4 | 0.67bc | 2.00ab | 2.00ab |
| | 6 | 0.00c | 0.67b | 0.33ab | 0.33bc | 0.33b | 1.00b | 6 | 0.33bc | 0.67b | 0.33ab |
| *Calotropis* | 2 | 0.00c | 1.00b | 0.33ab | 0.67bc | 1.00b | 2.33ab | 2 | 1.00bc | 1.33b | 2.33ab |
| | 4 | 1.33bc | 1.00b | 2.67ab | 0.33bc | 0.67b | 1.33ab | 4 | 0.33bc | 0.33b | 0.67ab |
| | 6 | 0.67bc | 0.33b | 1.00ab | 0.67bc | 1.00b | 1.33ab | 6 | 0.67bc | 0.33b | 1.67ab |
| *Allamanda + Calotropis* | 2 | 0.33bc | 1.33b | 1.33ab | 0.67bc | 0.67b | 1.00ab | 2 | 0.67bc | 0.33b | 0.00b |
| | 4 | 0.33bc | 1.00b | 2.33ab | 0.33bc | 0.67b | 3.33ab | 4 | 0.33bc | 0.33b | 1.00ab |
| | 6 | 1.33bc | 1.67b | 3.67a | 0.33bc | 0.33b | 1.33ab | 6 | 1.00bc | 0.33b | 1.00ab |
| CYPERMETHRIN | 6 | 0.33bc | 0.33b | 1.33ab | 0.33bc | 0.33b | 1.33ab | 6 | 0.33bc | 0.33b | 1.33ab |
| CONTROL | 0 | 2.67a | 3.33a | 3.00ab | 2.67a | 3.33a | 3.00ab | 0 | 2.67a | 0.33b | 3.00a |
| S.E.M | | 0.40 | 0.57 | 1.01 | 0.40 | 0.57 | 1.01 | | 0.43 | 0.49 | 0.80 |


| Mean no. of Pupae per Days After Treatment | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Aqueous | | | Ethanol | | | | Powder | | |
| Treatment | Conc.(ml/50g) | 16 | 18 | 20 | 16 | 18 | 20 | Conc.(g/50g) | 16 | 18 | 20 |
| *Allamanda* | 2 | 1.00bc | 1.33b | 1.67ab | 1.67ab | 1.67ab | 2.00ab | 2 | 1.67ab | 3.33a | 0.67ab |
| | 4 | 0.67bc | 0.67b | 1.00ba | 1.00bc | 0.67b | 0.00b | 4 | 0.67bc | 2.00ab | 2.00ab |
| | 6 | 0.00c | 0.67b | 0.33ab | 0.33bc | 0.33b | 1.00b | 6 | 0.33bc | 0.67b | 0.33ab |
| *Calotropis* | 2 | 0.00c | 1.00b | 0.33ab | 0.67bc | 1.00b | 2.33ab | 2 | 1.00bc | 1.33b | 2.33ab |
| | 4 | 1.33bc | 1.00b | 2.67ab | 0.33bc | 0.67b | 1.33ab | 4 | 0.33bc | 0.33b | 0.67ab |
| | 6 | 0.67bc | 0.33b | 1.00ab | 0.67bc | 1.00b | 1.33ab | 6 | 0.67bc | 0.33b | 1.67ab |
| *Allamanda + Calotropis* | 2 | 0.33bc | 1.33b | 1.33ab | 0.67bc | 0.67b | 1.00ab | 2 | 0.67bc | 0.33b | 0.00b |
| | 4 | 0.33bc | 1.00b | 2.33ab | 0.33bc | 0.67b | 3.33ab | 4 | 0.33bc | 0.33b | 1.00ab |
| | 6 | 1.33bc | 1.67b | 3.67a | 0.33bc | 0.33b | 1.33ab | 6 | 1.00bc | 0.33b | 1.00ab |
| CYPERMETHRIN | 6 | 0.33bc | 0.33b | 1.33ab | 0.33bc | 0.33b | 1.33ab | 6 | 0.33bc | 0.33b | 1.33ab |
| CONTROL | 0 | 2.67a | 3.33a | 3.00ab | 2.67a | 3.33a | 3.00ab | 0 | 2.67a | 0.33b | 3.00a |
| S.E.M | | 0.40 | 0.57 | 1.01 | 0.40 | 0.57 | 1.01 | | 0.43 | 0.49 | 0.80 |


Values with the same letters down the column are not significantly different at P>0.05

S.E.M: Standard Error of Mean

All treatments significantly reduced mean number of $F_1$ progeny emergence compared to control (Table 6). Ethanol leaf extract of *A. cathartica* at 6ml/50g had the highest reduction (7.00) of $F_1$ progeny emergence and was significantly different ($P<0.05$) from the control (121.33) (Table 6). There was no significant difference in $F_1$ progeny emergence of *A. cathartica* at 6 ml/50 g (7.00) and cypermethrin (0.00).

**Table 6.** Effect of leaf extracts of *Calotropis gigantea* and *Allamanda cathartica* on $F_1$ progeny of *Callosobruchus maculatus.*

| $F_1$ Progeny Treatment | Conc. (ml/50g) | Aqueous | Ethanol | Conc. (g/50g) | Powder |
|---|---|---|---|---|---|
| *Allamanda* | 2 | 31.33bcde | 37.67bcde | 2 | 44.67b |
| | 4 | 20.00bcde | 12.00de | 4 | 32.67b |
| | 6 | 22.33bcde | 7.00de | 6 | 22.33b |
| *Calotropis* | 2 | 11.67de | 29.33bcde | 2 | 30.67b |
| | 4 | 51.00bc | 22.33bcde | 4 | 16.00b |
| | 6 | 13.67cde | 17.33cde | 6 | 17.67b |
| *Allamanda +* | 2 | 19.67bcde | 13.00de | 2 | 16.33b |
| *Calotropis* | 4 | 39.00bcd | 31.67bcde | 4 | 45.67b |
| (1:1) | 6 | 55.67b | 27.67bcde | 6 | 21.00b |
| Cypermethrin | 6 | 0.00e | 0.00e | 6 | 0.00b |
| Control | 0 | 121.33a | 121.33a | 0 | 121.33a |
| S.E.M | | 11.10 | 11.10 | | 13.88 |

Values with the same letters down the column are not significantly different at $P>0.05$
S.E.M: Standard Error of Mean

Table 7. Effect of leaf extracts of *Calotropis gigantea* and *Allamanda cathartica* on percentage weight loss of seeds.

| | % SEED WEIGHT LOSS | | | | |
|---|---|---|---|---|---|
| Treatments | Conc. (ml/50g) | Aqueous | Ethanol | Conc. (g/50g) | Powder |
| *Allamanda* | 2 | 27.88bcd | 25.59bcdef | 2 | 23.28b |
| | 4 | 22.77gh | 24.99efg | 4 | 22.84b |
| | 6 | 26.57bcde | 25.44cdef | 6 | 23.49b |
| *Calotropis* | 2 | 28.03bc | 23.86fgh | 2 | 22.89b |
| | 4 | 27.65bcd | 23.34fgh | 4 | 23.39b |
| | 6 | 28.11b | 25.60bcdef | 6 | 21.26b |
| *Allamanda +* | 2 | 28.16b | 25.74bcdef | 2 | 22.96b |
| *Calotropis*(1:1) | 4 | 24.09efgh | 25.36defg | 4 | 22.94b |
| | 6 | 22.29h | 24.86efg | 6 | 23.07b |
| Cypermethrin | 6 | 17.91i | 17.91i | 6 | 17.91i |
| Control | 0 | 36.03a | 36.03a | 0 | 36.03a |
| S.E.M | | 0.79 | 0.79 | | 0.77 |

Values with the same letters down the column are not significantly different at $P< 0.05$
S.E.M: Standard Error of Mean

The treatments also reduced the percentage seed weight loss when compared to control (Table 7). Amongst powder treatments, *C. gigantea* at 6g/50g seeds had the lowest (21.26) value, while the treatment combination had the lowest value (22.29) amongst aqueous treatments. *Calotropis gigantea* at 4ml/50g seeds had the lowest value (23.34) amongst the ethanol extract treatments (Table 7).

Ethanol leaf extract of *A. cathartica* at 6ml/50g (5.33) and 4ml/50g (6.67) were the most effective in reducing the seed damaged caused by *C. maculatus* and was significantly different (P<0.05) from control (90.33) (Table 8). This observed effect was comparable to that of cypermethrin. Though aqueous extract of *A. cathartica* + *C. gigantea* had the highest seed damage (31.00), it was significantly different (P<0.05) from that of control (90.33) (Table 8).

Table 8: Effect of leaf extracts of *Calotropis gigantea* and *Allamanda cathartica* on seed damage.

| | | SEED DAMAGE | | | |
|---|---|---|---|---|---|
| Treatments | Conc. (ml/50g) | Aqueous | Ethanol | Conc (g/50g) | Powder |
| *Allamanda* | 2 | 20.33bcd | 20.00bcd | 2 | 27.00bc |
| | 4 | 12.00bcd | 6.67d | 4 | 15.00bc |
| | 6 | 15.00bcde | 5.33d | 6 | 12.67bc |
| *Calotropis* | 2 | 7.67d | 17.00cd | 2 | 18.33bc |
| | 4 | 31.67b | 13.33bcd | 4 | 10.67bc |
| | 6 | 8.67d | 7.00bcd | 6 | 9.00bc |
| *Allamanda* + | 2 | 13.67bcd | 9.67cd | 2 | 12.00bc |
| *Calotropis*(1:1) | 4 | 20.67bcd | 21.67bcd | 4 | 29.00b |
| | 6 | 31.00bc | 10.67bcd | 6 | 12.67bc |
| Cypermethrin | 6 | 0.00d | 0.00d | 6 | 0.00c |
| Control | 0 | 90.33a | 90.33a | 0 | 90.33a |
| S.E.M | | 6.44 | 6.44 | | 8.47 |

Values with the same letters down the column are not significantly different at P< 0.05

S.E.M: Standard Error of Mean

The treatments were all effective in maintaining the seed viability (Table 9). Among aqueous leaf extracts, *A. cathartica* at 4ml/50g(100%) and the combination at 2ml/50g (100%) had the highest seed viability while *A. cathartica* at 4ml, 6ml/50g (100%) and combination at 2ml/50 g resulted in the highest (100%) seed viability for ethanol leaf extracts. Powder of *C. gigantea* at 4g/50g, 6g/50g and combination at 4g/50g had the highest (100%) seed viability. All treatments were significantly better (P<0.05) than control which had the lowest seed viability (53.33%) (Table 9).

In this study, higher mortality, lower oviposition rate, larvae, pupae, $F_1$ progeny emergence and reduced seed damage were recorded in ethanol leaf extracts than from aqueous leaf extract and powder. This agrees with [11] who reported that active compounds contained in plants could disturb insect growth, development and inhibit oviposition.

The active compounds appear to have inhibited the development of immature stages of *C. maculatus* which lead to a reduction in larvae, pupae and $F_1$ progeny emergence. This is evident as seeds treated with ethanol leaf extracts of *A. cathartica* were less damaged by *Callosobruchus maculatus*.Nayak et al. [23] and [15] reported that there are reports showing that the active chemical in *A. cathartica* is allamandin which is a toxic iridoid lactone and cathartic which is a defecated substance. Furthermore, *Allamanda cathartica* and *Calotropis gigantea* possess some components such as monoterpenes, phenolic glycosides, 2-tridecanone [5], alkaloids, resins, tannins, saponins, enzymatic proteins and allergens in natural latex that show diverse biological activities [33].

The powders of *A. cathartica* and *C. gigantea* were also effective in suppressing the activities of *C. maculatus* although they were not as effective as the ethanol extracts. This finding supports the works of [20] who stated that neem kernel powder at 5-10g per/100g seed and Eucalyptus leaf powder at 10-20g/100g seed were effective in the control of *C. maculatus*in stored cowpea. Also, [4] and [3] reported the insecticidal potentials of *Ocimum basilicum* against maize weevil, while [26] reported that significantly lower number of adults emerged from seeds treated with extracts of African nutmeg seed (*Monodora myristica*(Gaertn.) Dunal). Products from other plant species such as *Dennitia tripetela*, *Cucurma longa*, *Piper guineensis* and *Azadirachta indica*, *Ocium gratissimum*, *Monodora myristica*, *Momordica charantia*, etc. have also been reported as potential alternatives to synthetic insecticides [2] [10] [13].

Ethanol extract of *Allamanda cathartica* at 6ml/50g seeds proved to be the most effective against *C. maculatus*. This extract was effective in suppressing the damage caused by *C. maculatus* leading to a reduction in seed damage and a near perfect seed viability.

**Table 9**. Effect of leaf extracts of *Calotropis gigantea* and *Allamanda cathartica* on percentage seed viability.

| | % SEED VIABILITY | | | | |
|---|---|---|---|---|---|
| Treatments | Conc. (ml/50g) | Aqueous | Ethanol | Conc. (g/50g) | Powder |
| *Allamanda* | 2 | 97.33a | 94.67a | 2 | 96.00ab |
| | 4 | 100.00a | 100.00a | 4 | 86.67b |
| | 6 | 97.33a | 100.00a | 6 | 96.00b |
| *Calotropis* | 2 | 98.67a | 98.67a | 2 | 97.33a |
| | 4 | 97.33a | 94.67a | 4 | 100.00a |
| | 6 | 97.33a | 98.67a | 6 | 100.00a |
| *Allamanda* + | 2 | 100.00a | 100.00a | 2 | 98.67a |
| *Calotropis*(1:1) | 4 | 96.00a | 97.33a | 4 | 100.00a |
| | 6 | 96.00ac | 97.33a | 6 | 96.00ab |
| Cypermethrin | 6 | 100.00a | 100.00a | 6 | 100.00a |
| Control | 0 | 53.33b | 53.33b | 0 | 53.33c |
| S.E.M | | 1.71 | 1.71 | | 3.29 |

Values with the same letters down the column are not significantly different at $P< 0.05$

S.E.M: Standard Error of Mean

## 4. Conclusion

Plant-based insecticide can be of great value in protecting crops from insect attack and pest infestation and may hopefully replace synthetic insecticides in future. From this study it may be concluded that ethanol leaf extract of *Allamanda cathartica* and *Calotropis gigantea* has insecticidal activity against *Callosobruchus maculatus* though at varying degrees. These botanicals can be used in integrated pest management against *Callosobruchus maculatus* in storage by resource poor farmers in Nigeria.

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