1. **INTRODUCTION**

Protection of agricultural stored products against insect pests has proven to be of utmost importance all over the world so as to achieve continuous and safe food supply. Plant extracts contain biologically active compounds and hence has been the matter of interest for nearly sixty years ago. The phytochemicals are the major subject of interest due to the fact that their large-scale synthesis and production for commercial use is immature. This commercialization can only be achieved when immense knowledge of the phytochemical components and their effect on the stored product as well as human health is acquired. Cowpea, (*Vigna unguiculata*), is an abundant tropical and subtropical edible legume crop (Mulugeta *et al*., 2016).

Due to its high protein content, it is used as an important human food in several part of the world and also used as silage and hay for livestock feed. It is well adapted to drought and short warm weather which serves as an advantage for better yield across different environments. Cowpea grain production is damaged by insects in most cowpea producing nations, which lead to economic losses (Jibrin *et al.,* 2013).

The cowpea weevil, *Callosobruchus maculatus* is the main insect pest of cowpea *(Vigna unguiculata)*, in Latin America and Africa (Murad, *et al*., 2008). It is a worldwide pest, and its larvae develop within various cultivated legumes, such as black eyed beans*, V. unguiculata* (Nabaei *et al*., 2012). Ojebode *et al*. (2016) reported that *C. maculatus* is very destructive on account of its short life cycle. Their damage causes loss of weight, nutritional and commercial values of cowpea seeds and viability of stored grains (Nabaei *et al*., 2012; Suleiman, 2016). Larvae feed and develop inside the seed which become unsuitable for human consumption and when adults emerge they leave a neat circular exit hole. Each adult consumes approximately 25% of the seed from which it develops (Asawalam and Anaeto, 2014). The control of *C. maculatus* in stores has been accomplished by synthetic chemical pesticides like Permethrin (Suleiman and Suleiman, 2014). The extensive use of these chemicals has given rise to so many problems such as insecticide resistance, health risk to consumers and environmental contamination.

* 1. **Justification of the study**

Cowpea (*Vigna unguiculata*) is an important legume crop that serves as a vital source of protein and nutrition in many countries. However, the infestation of stored cowpea seeds by the cowpea weevil *(Callosobruchus maculatus*) poses a significant threat to crop productivity and food security. Developing effective and eco-friendly methods to control these pests is crucial to protect the stored seeds and minimize post-harvest losses.  
Traditional chemical insecticides are often used to control insect pests in stored agricultural commodities. However, the excessive and indiscriminate use of synthetic and unnatural insecticides can lead to adverse environmental effects like pollution, poison in food (toxin), increase insect pest resistance, resurgence, ecological imbalance, and produce residues. Therefore, there is a growing need to explore an alternative environmentally friendly approach for pest management, such as the use of natural plant extracts.  
*Callosobruchus maculatus* is a major pest of cowpea seeds, causing significant economic losses during storage. The use of *Delonix regia* leaf extracts specifically against this pest focuses on the control of the specific insect species infesting the stored seeds. This project helped to determine the potential efficacy of *Delonix regia* extracts as an insecticidal agent against *Callosobruchus maculatus*, providing valuable insights for sustainable pest management strategies. The potentials of natural plant extracts as insecticides are economical, non-toxic, cost effective and very safe to use as it won't affect human's health.

**1.2 Objectives of the study**

The general objective of the study is to determine the insecticidal potentials of *Delonix regia* leaf extracts on *Callosobruchus maculatus.*

The specific objectives are to;

* evaluate the potency of the leaf powders and extracts of *D. regia* on motality of *C. maculatus*.
* access the effect of leaf powders and extracts of *D. regia* on oviposition and adult emergence of *C. maculatus.*

3.0 **MATERIALS AND METHODS**

3.1 **Insect rearing.**

The parent stock of *Callosobuchus maculatus* was obtained from an infested cowpea from a food store in Oba market, Ado Ekiti, Ekiti State, Nigeria. The insects were reared on Ife brown variety of cowpea at ambient temperature inside a plastic container covered with muslin cloth held firmly with rubber band. The purpose of the muslin cloth is to prevent the escape of insects as well as prevent the entry of intruding insects. The culture was maintained by replacing the devoured seeds with un-infested ones. The newly emerged adult *C. maculatus* were used in every stage of this research work.

3.2**: Collection *Delonix regia* leaves and preparation of Extracts.**

Leaves of *Delonix regia* were collected from the Faculty of Science, Ekiti state University, Ado Ekiti, Nigeria. They were washed in clean water in order to remove the adhering dirt. The leaves were air-dried in the laboratory for two weeks in order to reduce the moisture content, so as to prevent moldiness. The air-dried leaves were milled into fine powder using an electric Binatone blender (Model BLG 400). The powder was stored in black cellophane bag until ready needed.

The powders were divided into two portions. One portion was measured into beakers and packed into thimbles and extracted with 250 mL ethanol in a Soxhlet apparatus at 60oC. The extract was concentrated by removing the solvent using rotary evaporator and thereafter exposed to slow blowing fan to remove traces of ethanol. The extract was poured into a bottle and stored in a refrigerator until the commencement of the experiment.

3.3 **Effect of *Delonix regia* leaf extracts on the mortality of *C. maculatus***

Twenty grams (20 g) of un-infested cowpea seeds were measured into four 9 cm diameter Petri-dish. Extracts dosages of 0.5, 1.0, 1.5 and 2.0 mL was pipetted into each Petri-dish containing the cowpea seeds. The mixture was thoroughly agitated and mixed together using a glass rod, to ensure uniform coating of the extracts on the cowpea seeds. The Petri-dishes were exposed to air for 1 h to allow the traces of the solvent (ethanol) to dry off. Thereafter, 20 newly emerged adult cowpea weevils were introduced into the Petri-dishes and then covered with the lid. Untreated cowpea seeds were set up as the control experiment. All treatments were replicated four times in a Complete Randomized Design (CRD). Mortality of the insect was observed and recorded at 24 h interval for 96 h. The insects were confirmed dead when there was no response to probing on the abdomen with a sharp pin

**Effect of *Delonix regia leaves* powder on mortality of *C. maculatus***

Twenty grams (20 g) of clean and dis-infested cowpea seeds were weighed into Petri dishes and leaf powders weighing 0.3, 0.6, 0.9 and 1.2 g were added to the cowpea seeds in Petri dishes. The seeds and the leaf powders were thoroughly mixed together to enhance uniform spreading of the powders. Untreated cowpea seeds were also set up to serve as the control experiment. Twenty teneral adults of *C. maculatus* were introduced into each of the Petri dishes and covered with Petri-plates. Each of the treated and untreated control was replicated four times and laid in Complete Randomized Design (CRD). Insect mortality was observed at 24 h interval for a period of 96 h. After every 24 h, the number of dead insects were counted and recorded. The insects were confirmed dead when there was no response to probing on the abdomen with a sharp pin.

**Effect *Delonix regia leaves* extracts on oviposition and adult emergence of *C. maculatus.***

Twenty grams of clean and un-infested cowpeas seeds were weighed into Petri dishes and treated with 0.5, 1.0, 1.5 and 2.0 mL of the extract. Untreated cowpea seeds serve as the control experiment. The seeds and the extracts were thoroughly mixed with glass rod to facilitate uniform coating of the extract on the seeds. Thereafter, the treated seeds were air-dried for a period of 1 h, after which 2 pairs of newly hatched (0 to 24 h old) copulating adult *C. maculatus* were introduced into the Petri dish containing the treated and the control experiment. Four replicates were prepared for each treatment and the controls and laid in a Complete Randomized Design. Thereafter, the experimental set-up was kept undisturbed for 7 days, after which the number of eggs laid were counted and recorded. The experiment was allowed to stand for another 6 weeks during which the adults started emerging. The number of adults that emerged were counted and recorded.

**Effect of *Delonix regia* leaf powder on oviposition and adult emergence of *C. maculatus.***

Twenty grams (20 g) of dis-infested cowpea seeds were measuredinto each Petri dish and *Delonix regia*leafpowders weighing 0.3, 0.6, 0.9 and 1.2 g were introduced to the cowpea seeds in each of the Petri dishes. The powder and the seeds were thoroughly mixed together to enhance uniform spreading of the extracts on the seeds. Untreated seeds were also set up to serve as the control experiment. Two pairs of newly emerged (0 to 24 h old) copulating adult *C. maculatus* were introduced into each Petri-dish and covered with Petri-plate. Each treated and untreated control was replicated four times and laid in Complete Randomized Design (CRD). Thereafter, the experimental set-up was allowed to stay for 7 days after which the number of eggs laid were counted and recorded. Thereafter, the experiment was allowed to stand for another 6 weeks during which the adults started emerging. The number of adults that emerged were counted and recorded.

3.4**: Data analysis**

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

4.0  **RESULTS**

4.1**. Mortality of *C. maculatus* exposed to different dosages of *Delonix regia* leaf extract.**

Table 1 presented the mortality effect of *D. regia* leaf extracts on *C. maculatus*. The mortality of the insect varied with the dosage of the extracts and the period of exposure. Within 24 h post treatment, 2.0 mL of the extract was able to achieve above 42.50% mortality of the insect and its effect was significantly (p>0.05) different from other treatments. At 72 h of application, 2.0 mL of leaf extract achieved the highest insect mortality rate of 82.40 % and its effect was significantly (p<0.05) different from others treatments. At 96 h post treatment, 2.0 mL of the extract achieved the highest mortality of 100%. Moreover, all the dosages of the extract recorded up to 64 % mortality of the insect within 96 h post treatment.

4.2 **Percentage mortality of *C. maculatus* exposed to different concentration of *Delonix regia* powder**

Table 2 presented the effect of *D. regia* powder on the survival of *C. maculatus*. The mortality of the insect varied with the dosage of the plant powder and the period of exposure. Within 24 h post treatment, 1.2 g dosage of the plant powder recorded the highest beetle mortality of 38.20 % which was significantly (p<0.05) different from other treatments. At 72 h of application, all the dosages of the plant powder recorded above 50 % insect mortality with 1.2 g of the powder achieving the highest insect mortality of 75.5% and its effect was significantly (p<0.05) different from other dosage. Moreover, all the dosages of the plant powders recorded above 70% mortality of the insect within 96 h post treatment. However, none of the dosages was able to achieve 100 % mortality within 96 h post treatment. Nevertheless, the effects of the treatments were significantly (p<0.05) different from that control throughout the period of exposure

4.3. **Effect of *Delonix regia* seed oil on oviposition and adult emergence of *C. maculatus***

The *D. regia* leaf extracts effectively reduced oviposition and number of adult that emerged after a period of seven weeks as revealed in table 3. Oviposition and adult emergence of *C. maculatus* increase with decrease in dosage level of the extracts. Oviposition was totally prevented when exposed to 2.0 mL *D. regia* oil while no adult emerged with dosages levels of 1.5 and 2.0 mL extract dosages which is not significantly different from the control.

4.4. **Effect of *Delonix regia* leaf powders on oviposition and adult emergence of *C. maculatus***

*D. regia* leaf powders effectively reduced the number of eggs laid and hence the number adults that emerged after a period of seven weeks as revealed by table 4. The ability of adult *C. maculatus* to lay eggs and for the eggs to hatch (emerged) increase with decrease in dosages of the powder. Oviposition was totally prevented on exposure to 1.2 g powder dosage while adult emergence was totally prevented when exposed to 0.9 g and 1.2 g dosages of the leaf powders.

Table 1**: Mortality (%) of *C. maculatus* exposed to different dosages of *Delonix regia* leaf extracts**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Treatments (mL) | % mortality in hours | | | |
| 24 | 48 | 72 | 96 |
| 0.5  1.0  1.5  2.0  0.0 (control) | 28.20±1.23d  30.10±2.39c  34.50±2.04b  42.50±2.39a  0.00±0.00e | 45.20±2.23d  52.50±2.33c  58.40±2.04b  68.25±2.14a  0.00±0.00e | 62.50±2.25d  65.34±2.14c  67.50±2.25b  82.40±3.25a  0.00±0.00e | 44.00±3.04d  78.50±3.15c  87.50±3.39b  100.00±0.00a  0.00±0.00e |

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

Table 2: **Mortality (%) of *C. maculatus* exposed to different dosages of seed *Delonix regia* powders.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Treatments (g) | % mortality in hours | | | |
| 24 | 48 | 72 | 96 |
| 0.3  0.6  0.9  1.2  0.0 (control) | 18.20±1.27d  22.15±1.17c  30.30±1.33b  38.60±2.23a  0.00±0.00e | 27.20±2.39d  38.30±2.12c  45.10±2.34b  55.50±2.44a  0.00±0.00e | 52.28±1.44c  45.33±2.32c  58.20±2.18b  75.50±2.39a  0.00±0.00d | 68.50±2.24d  72.25±3.14c  77.50±3.22b  92.00±3.24a  0.00±0.00e |

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

Table 3: **Effect extract of *D. regia* leaf on oviposition and adult emergence of *C. maculatus***

|  |  |  |
| --- | --- | --- |
| Dosage (mL) | Mean eggs laid | Percentage adult emerged |
| 0.5 | 16.20±1.12b | 12.25±0.54b |
| 1.0 | 12.33±0.41c | 8.40±0.68c |
| 1.5 | 8.50±0.52d | 0.00±0.00d |
| 2.0 | 0.00±0.00e | 0.00±0.00d |
| 0.0 (control) | 65.25±3.51a | 59.72±3.48a |

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

Table 4: **Effect of *D. regia* leaf powders on oviposition and adult emergence of *C. maculatus***

|  |  |  |
| --- | --- | --- |
| Dosage (g) | Mean eggs laid | Percentage adult emerged |
| 0.3 | 25.20±1.20b | 20.40±1.20b |
| 0.6 | 16.25±0.82c | 10.50±0.42c |
| 0.9 | 7.15±0.61d | 0.00±0.00d |
| 1.2 | 0.00±0.00e | 0.00±0.00d |
| 0.0 (control) | 65.25±3.51a | 59.72±3.48a |

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

**5.0 CONCLUSION**

This study shows that the leaf of *Delonix regia* is effective to protect *Callosobrunchis* *maculatus* and other grains in the store. It can easily be prepared and applied to the grains in the store to protect them.   
Therefore, this study suggests the use of *Delonix regia* plant extract as an attractive alternative to synthetic insecticides in the management of *C. maculatus*.