



INSECTICIDAL EFFECTS OF ORANGE PEEL POWDER CONCENTRATION ON THE MANAGEMENT OF COWPEA BRUCHID *Callosobruchus maculatus* (Fabricius) (Coleoptera: Bruchidae) IN ALIERO, KEBBI STATE

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ABSTRACT

This study was conducted to evaluate the insecticidal effects of different concentrations of Orange Peel Powder on the management of *Callosobruchus maculatus* infestation on stored cowpea seeds in Aliero, Kebbi State. The experiment was carried out at the Insectary Unit of Molecular Biology Laboratory, Abdullahi Fodio University of Science and Technology, Aliero. The treatments consist of four (4) levels of Orange Peel Powder (2g, 4g, 6g, and 8g per 100g of cowpea seeds), (Permethrin 0.5 mg), and a control. These were arranged in a Completely Randomized Design (CRD) with three replications. Data were collected on Adult Mortality Rate, Number of Holed Seeds, Percentage Seed Damage, Seed Weight Loss, Larvae and Pupa Mortality Rate and Germination Percentage. Data collected were subjected to Analysis of Variance (ANOVA) and significant means were separated using Least Significance Difference (LSD) at (P<0.05%) probability level. The results revealed a significant (P<0.05%) differences among the treatments. The highest adult mortality (0.82%) was recorded by 8g of Orange Peel Powder, closely following the Permethrin (0.91%). Higher Orange Peel Powder levels also resulted in reduced seed damage, fewer holed seeds, lower weight loss, and higher larvae and pupa mortality rates compared to the control. Seed germination remained unaffected across treatments. The research concluded that, the Orange Peel Powder possesses an effective Insecticidal properties capable of suppressing *C. maculatus* in stored cowpea. The study recommends the use of higher concentrations particularly 8 g per 100 g of cowpea seeds for effective Bruchid control, along with continuous monitoring during storage.

Keywords: Cowpea, *C. maculatus*, Orange, Peel, Powder, Permethrin

INTRODUCTION

Cowpea scientifically known as (*Vigna unguiculata* L. (Walp) holds significant importance as a tropical legume crop with its origins in Africa. It has seamlessly integrated into the tropical cropping system, particularly in the semi-arid West Africa Savannah (Omomowo and Babalola, 2021). Cowpea is well known for its adaptability in difficult environments with limited water resources and poor soil quality. This resilience renders it a valuable crop for small scale farmers, particularly in areas where other crops face difficulties in adaptation. Beyond its nutritional value as a seed, cowpea plays a crucial role in nitrogen fixation, enhancing soil fertility, and diminishing the reliance on synthetic fertilizers. This dual functionality points out its significance as a sustainable and resource efficient agricultural choice (Srinivasan *et al.*, 2021).

Despite its significant nutritional and economic value, global post-harvest losses of cowpea have been reported to surpass 45%, with the West Coast region experiencing a particularly high rate of 25%, primarily due to extensive damage caused by the cowpea bruchid (*Callosobruchus maculatus*) (Adomi *et al.*, 2023). These losses not only impact food security but also have economic implications for farmers and traders. Efforts to develop effective pest management strategies and improve storage

facilities are crucial to mitigating the impact of cowpea bruchid infestations and reducing post-harvest losses in Nigeria (Aboagye *et al.*, 2017).

In most African countries, including Nigeria, food security remains a challenge due to pest infestations in stored products. The cowpea bruchid, *C. maculatus*, is a serious pest of cowpea seeds, causing significant losses in the quality and quantity of stored cowpeas (Hamzavi *et al.*, 2022; Kalpna *et al.*, 2022).

Cowpea weevil infestations have been reported to cause substantial reduction in quality and quantity of cowpea seeds within three to five months of storage (Ileke *et al.*, 2012). It has been recognized that postharvest loss to storage coleopterans pests such as *C. maculatus* is a major constraint to food security in developing nations such as Nigeria (Udo, 2011). It has become necessary to protect agricultural products from pests and diseases in order to meet the world's demand for food. However, management of insect pests to secure agricultural products has been found to be of utmost importance all over the world so as to achieve continuous and safe food supply (Abdel-Salam, 2010). Synthetic chemical insecticides have effects which includes, risks to human health, environmental pollution and leads to development of a new resistance of pests (Thiaw and Sembène, 2010), currently synthetic chemical insecticides are the major means of managing beetles' infestations in stored cowpea seeds (Onekutu *et al.*, 2015).

The conventional use of synthetic chemicals in insect-pest control raises concerns due to their inherent toxicity, which poses risks to the health to farmers, animals, and consumers alike. Synthetic chemicals are mostly dangerous because they are toxic.

The use of natural products, such as Orange Peel Powder which is cheap, effective and less toxic to human, easy to adopt and environmentally friendly is the best alternative in controlling cowpea bruchid. Therefore, this necessitates the conduct of this research. The findings of this research will be of great benefits to cowpea farmers, traders and other researchers on cowpea storage.

MATERIALS AND METHODS

DESCRIPTION OF THE STUDY AREA

The research was conducted at the Insectary unit of Molecular Biology Laboratory of Faculty of Agriculture, Abdullahi Fodio University of Science and Technology, Aliero (AFUSTA) figure 1.



Figure 1. *Experimental Set-up at the Insectary Unit of Molecular Biology Laboratory of Abdullahi Fodio University of Science and Technology, Aliero*

Source of Cowpea Seeds

Cowpea seeds were obtained from Jega Central Market; the seeds were also visually checked to ensure that they are not infested by the insect pests. The seeds were then placed in freezer for 2 days to ensure that all stages of insect present are destroyed by the cold temperature.

Source of Orange Peel and Preparations

A freshed Orange Peels were sourced from the orange sellers at Jega Motor pack, the Orange Peels were dried at the ambient temperature (28 ± 3 °C and 53.73 ± 2.7 % r.h) in order to maintain the actual active ingredients (a.i), the dried Orange Peels were grinded using mortar and pestle, sieved and stored in an airtight container in a refrigerator prior to used figure 2.

Treatment and Experimental Design

The treatments consisted of four (4) levels of orange peel powder, one synthetic insecticide and control (2g Org, Peel pwd, 4g Org, Peel pwd, 6g Org, Peel pwd, 8g Org, Peel pwd, Permetrin 0.5mg and Control). The experiment was laid out in **Complete Block Design (CBD)** with three replications, given a total number of 18 treatments within an experiment figure 2.

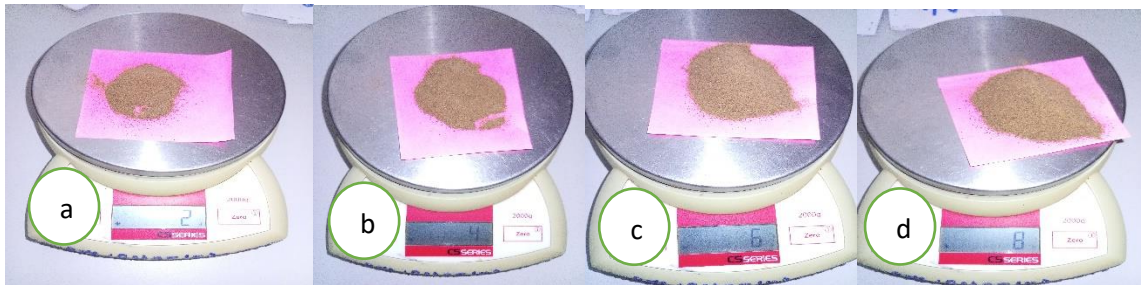


Figure 2. (a) 2g Orange Peel Powder, (b) 4g Orange Peel Powder, (c) 6g Orange Peel Powder and (d) 8g Orange Peel Powder

Maintenance of the *C. maculatus* Culture

The *C. maculatus* Culture was established by placing 100 adults in 1kg of cowpea seeds in two-liter jar. Muslin cloth was used to cover the top of the jar so that the cowpea weevils could not escape. This was allowed mating, oviposition and other further multiplication of the insect until the required number is obtained. The F₁ generation obtained was used for the experiment.

Source of Synthetic chemical

Permetrin powder was purchased from Jega central market of Kebbi State and expiry date was checked vividly to avoid error during the experiment.

Bioassay

The experiment comprises the study on the insecticidal effects of Orange Peel Powder on the *C. maculatus* infecting Cowpea Seeds. Hundred grams of cowpea seeds were placed in a 500ml glass jar while the synthetic insecticide (Permetrin) was applied at 0.5mg/100g of cowpea seeds as standard check and untreated seeds serve as control. 15 pairs of newly emerged adult insects were then introduced into each jar containing orange peel powder and cowpea seeds using new tooth brush. The jars were covered with muslin cloth and tightly secured with rubber band.

Data Collection

Adult Mortality Rate (%)

At seven (7) days after infestation, dead insect in each treatment was removed, counted and recorded. Insect were probed three times with the tip of pen to confirm.

Adult Mortality rate was calculated using the formula:

$$\text{Adult Mortality Rate (\% AMR)} = \frac{\text{Number of dead } C. maculatus}{\text{Total number of lived } C. maculatus} \times 100$$

Percentage Seed Damage (%)

At the end of the experiment, 30 seeds were randomly selected from different varieties and treated seeds from the bottles, the seeds were separated into damaged and undamaged categories and each will be counted and calculated as follows;

$$\text{Seed Damaged (\% SD)} = \frac{\text{Number of seed damaged}}{\text{Total number of seed}} \times 100$$

Loss in Grain Weight (g)

At the end of the experiment, the seeds were sorted, removed dead insects and other debris from the cowpea seeds. The seeds were weighed to obtain the final weight.

$$\text{Loss in Grain Weight (\% LGW)} = \frac{\text{Initial seed weight} - \text{final weed weight}}{\text{Initial seed weight}} \times 100$$

Germination Percentage (%)

At the end of the experiment, 20 cowpea seeds were randomly selected from each treatment and replication and placed in a petri dish lined with moistened filter paper. The seeds were left on the



laboratory bench at the ambient temperature and relative humidity for 7 days after which germination percentage were calculated using the formula:

$$\text{Germination Percentage (\%G)} = \frac{\text{Number of germinated seed}}{\text{Total number of seed planted}} \times 100$$

Data Analysis

Data obtained were subjected to Analysis of Variance (ANOVA) and significant means were separated using Least Significance Difference (LSD) at 5% Probability level.

RESULTS

The results shows that there is significance difference among the treatments on the Adults. Mortality Rate (%), Number of holed Seed and Percentage Seed Damaged (%). Permetrin 0.5ml recorded higher adult mortality rate % (0.91^a) over 8g Org. Peel, Pwd (0.82^a) which were statistically the same, followed by 6g Org. Peel, Pwd, (0.45^b) which was ranked same with 4g Org. Peel, Pwd (0.31^{bc}), the least were observed in 2g Org. Peel, Pwd (0.22^c) and 0g (Control) (0.03^d). However, 0g (Control) had the highest Number of holed Seed (27.00^a) while similar results were observed in 2g Org. Peel, Pwd and 4g Org. Peel, Pwd (10.67^b), 6g Org. Peel, Pwd and 8g Org. Peel, Pwd treatments recorded lowest Number of holed Seed and the least were revealed in (Permetrin 0.5ml) (1.33^c) Table 1. Moreover, 0g (Control) had more damaged seeds (0.89^a) than 4g (Org. Peel, Pwd) and 2g Org. Peel, Pwd (0.16^b and 0.13^b), 6g Org. Peel, Pwd and 8g Org. Peel, Pwd (0.11^{bc} and 0.08^{bc}) were ranked third while the least was observed in (Permetrin 0.5ml) (0.03^c) Table 1.

Table 1. Effects of Orange Peel Powder on the Bruchids Mortality Rate, Number of Holed Seeds and Seed Damage

| Treatments | Adults Mortality Rate (%) | NHLEDS | SD (%) |
|---------------------------|---------------------------|--------------------|--------------------|
| 2g (Org. Peel, Pwd) | 0.22 ^c | 10.67 ^b | 0.13 ^b |
| 4g (Org. Peel, Pwd) | 0.31 ^{bc} | 10.67 ^b | 0.16 ^b |
| 6g (Org. Peel, Pwd) | 0.45 ^b | 7.67 ^{bc} | 0.11 ^{bc} |
| 8g (Org. Peel, Pwd) | 0.82 ^a | 2.67 ^{bc} | 0.08 ^{bc} |
| (Permetrin 0.5ml) | 0.91 ^a | 1.33 ^c | 0.03 ^c |
| 0g (Control) | 0.03 ^d | 27.00 ^a | 0.89 ^a |
| Sig. | * | * | * |
| LSD_{0.05} | 0.16 | 8.24 | 0.08 |

Mean followed by the same letter (s) are not significantly different at 0.05% level of probability

Org. Peel, Pwd: Orange Peel Powder, **NHLEDS:** Number of holed Seed, **SD (%):** Percentage Seed Damaged.

The results revealed that orange peel powder had significant effects on the cowpea weight loss, larvae mortality rate, pupa mortality rate and seed germination.

However, 0g (Control) had more cowpea weigh (88.70^a) over 2g Org. Peel, Pwd, 4g Org. Peel, Pwd and 6g Org. Peel, Pwd which were statistically similar (18.73^b, 14.37^b and 13.63^b), the least were record by the treatments 8g Org. Peel, Pwd and (Permetrin 0.5ml) (3.97^c and 1.87^c) Moreover, (Permetrin 0.5ml) (0.89^a) had highest Percentage Larvae Mortality Rate than 8g Org. Peel, Pwd (0.71^{ab}), followed by 6g Org. Peel, Pwd (0.49^{cb}), 4g Org. Peel, Pwd (0.43^c) was ranked third while the least were recorded by 2g Org. Peel, Pwd and 0g (Control) (0.25^{cd} and 0.03^d) Table 2. Similar results was obtained as (Permetrin 0.5ml) (0.81^a) revealed the highest Pupa Mortality Rate over 8g Org. Peel, Pwd (0.69^{ab}), followed by 6g Org. Peel, Pwd and 4g Org. Peel, Pwd (0.55^{cab} and 0.43^{cb}), the lowest were recorded by 2g Org. Peel, Pwd and 0g (Control) (0.34^{cd} and 0.08^d).Furthermore, Seed Germination Rate revealed a significance variation as all the treatments were ranked same except for the 0g (Control) (0.06^b) which was statistically different Table 2.

Table 2. Effects of Orange Peel Powder on the Cowpea Weight Loss, Larvae Mortality Rate, Pupa Mortality Rate and Seed Germination

| Treatments | CSWL | LMR (%) | PMR (%) | SG (%) |
|---------------------------|--------------------|--------------------|---------------------|-------------------|
| 2g (Org. Peel, Pwd) | 18.73 ^b | 0.25 ^{cd} | 0.34 ^{cd} | 0.62 ^a |
| 4g (Org. Peel, Pwd) | 14.37 ^b | 0.43 ^c | 0.43 ^{cb} | 0.57 ^a |
| 6g (Org. Peel, Pwd) | 13.63 ^b | 0.49 ^{cb} | 0.55 ^{cab} | 0.55 ^a |
| 8g (Org. Peel, Pwd) | 3.97 ^c | 0.71 ^{ab} | 0.69 ^{ab} | 0.66 ^a |
| (Permetrin 0.5ml) | 1.87 ^c | 0.89 ^a | 0.81 ^a | 0.70 ^a |
| 0g (Control) | 88.70 ^a | 0.03 ^d | 0.08 ^d | 0.06 ^b |
| Sig. | * | * | * | * |
| LSD_{0.05} | 6.89 | 2.27 | 0.28 | 0.34 |

Mean followed by the same letter (s) are not significantly different at 0.05% level of probability

Org. Peel, Pwd: Orange Peel Powder, **CSWL:** Cowpea Seed Weight Loss, **LMR (%):** Percentage Larvae Mortality Rate, **PMR (%):** Percentage Pupa Mortality Rate, **SGR (%):** Seed Germination Rate.



Figure 3. (a) 8g Orange Peel Powder (b) 0g (Control)

DISCUSSION

The results of this study on the insecticidal effects of orange peel powder on the cowpea bruchid (*C. maculatus*) showed that there are significant differences at ($P>0.05$) among all the parameters during the experiment. The study revealed that orange peel powder had an insecticidal impact on the mortality of cowpea bruchid. However, the higher level of orange peel powder recorded the higher mortality rate over control and the rest of the treatments except for the Permetrin which was the synthetic. This finding is in accordance with the report of Owusu-Akyaw (1991) who reported that some botanicals do not only exhibit insecticidal properties, but also serves as antifeedant that inhibit the activities of *C. maculatus*. According to some early research work done on similar botanical plant materials, it was reported that varying degrees of successes were recorded on the insecticidal, repellent and antifeedant properties of the botanicals on some storage insect pest (Arannilewa *et al.*, 2019; Obeng-Ofori *et al.*, 2020; Assawalam *et al.*, 2022).

Moreover, less number of holed cowpea seeds and seed damage were recorded in the higher level of orange peel powder and Permetrin than control treatments, this indicated that, the treatment exhibits insecticidal effects excellently on the insect pest of cowpea. This supports the earlier findings by (Udo 2021; Lale, 2002) that some of the botanicals possessed stomach and respiratory poisoning properties which reduces the activities and population of storage insect pest. Similar effects of plant materials as crop seed protectants have been observed as a treatment of cowpea and maize grains against maize beetles (Asawalam *et al.*, 2007) It has been observed and reported that the insecticidal property of any plant material, would depend on the active constituents of the plant material (Ofuya and Dawodu, 2020). However, the results obtained from the study, disagreed with that of Danjumma *et al.* (2009) who reported that 100g of *N. tabacum* applied to 50g of maize grains resulted in 100% mortality rate of *S. zeamais*, as findings from this study revealed that the best performance of 8g Orange Peel Powder per 100g of cowpea seeds was 82% adult mortality rate.



CONCLUSION AND RECOMMENDATIONS

The research concluded that, the Orange Peel Powder has an insecticidal potentiality in controlling *Callosobruchus maculatus* particularly the higher concentration which recorded the higher number of mortality rate on adult, larvae and pupa as well.

1. The research findings recommends the use of high level of Orange Peel Powder for the effective control of *Callosobruchus maculatus* in the Aliero, Kebbi State.
2. The research findings also recommends the use of Orange Peel Powder for a long-term cowpea storage with constant supervision.

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