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Evaluation of Ripe and Unripe Pawpaw Seeds Powder in the Control of *Callosobruchus maculatus* in Stored Cowpea

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Abstract: As alternative to the use of these synthetic insecticides, plant extracts, powders and ash have been used as cheaper and eco-friendly means of controlling *C. maculatus* infestation of stored cowpea seeds. This study was carried out to investigate the contact toxicity of ripe and unripe pawpaw seeds powder, both at concentration of 0.2g, 0.4g, 0.6g, 0.8g, and 1.0g per 20g of cowpea seeds. The plant powders were effective in controlling the population of *C. maculates* at 48 hours of treatment across the treatment concentrations, the unripe pawpaw seeds powder were more effective at the treatment rate of 1.0g in the mortality rate. However, their effectiveness was dependent on dosage rate and period of application. The high mortality rate, reduction in the number of eggs laid, low adult emergence and low seed weight loss achieved by the effects of plant powders on the beetles was directly proportional to the increase in their application rates. The effective control of the activities of *C. maculatus* in seeds treated with ripe and unripe pawpaw seeds powder may have been due to their toxicity effects.

Keywords: Evaluation, Ripe and Unripe Pawpaw Seeds, *Callosobruchus maculatus*, Cowpea

1. Introduction

Cowpea *Vigna unguiculata* (L.), a dietary protein, is a staple food crop of significant economic importance and is widely grown in Nigeria, West Africa [8]. In the field, the crop is the target of many pests and diseases, whereas in storage, the main problem, apart from molds and rodent damage is caused by only one insect species, the cowpea beetle *Callosobruchus maculates* [16]. [6] reported that Nigeria produces about 800,000 tonnes of cowpea annually, 80% of which comes from the Northern part of the country. However, recent report revealed that substantial part of the world cowpea production comes from Nigeria with about 4 million hectares and approximately 1.7 million tons of beans produced annually [16].

The mature seeds are an important pulse, chiefly in Africa and are often ground into meal of different kinds, such as bean powder used in preparation of bean cake popularly known as 'Akara', 'Ekuru' and 'Moinmoin' in Yoruba land of Nigeria [12]. Cowpea seed pods and leaves are consumed in fresh form as green vegetables in some African countries [9], while the rest of the cowpea plant after the pods have been harvested serves as a nutritious fodder for livestock [1] and also a source of cash income [7]. The nutritive value of cowpea makes it an extremely important protein source to vegetarian and people who cannot afford animal protein [2]. It can be referred to "protein source for all" because it is affordable for both the rich and poor citizens.

The production and storage of cowpea have faced so many constraints, throughout West Africa such as diseases and the limited use of fertilizers and irrigation inputs [5] but the major constraints is the insect pest known as *Callosobruchus maculates* [14], which infests it before and after harvest consequently leading to loss of economic value [3]. Infestations on stored grains may reach 50% within 3-4 months of storage [17]. Attack from cowpea seed beetles, *Callosobruchus maculates* (F.) has adversely affected the production of cowpea difficult.

The cowpea seeds are seriously affected by the beetle infestation and the insect multiplies very fast in storage, giving rise to a new generation every month causing weight losses of up to 60%. However, post-harvest losses are serious

problems and as much as 20 - 50% of grain is lost because of infestations from *C. maculatus* [17]. The damage caused by this beetle is constrained to consumption quality only. In other to reduce infestation to the barest minimum, various methods such as use of synthetic insecticides, biological control, mechanical control, cultural control have been utilized. Moreover, the use of synthetic insecticides has been found most effective but with adverse environmental, biological and economic consequences. These effects include pollution poisoning, residue accumulation, development of pest resistance and high cost of application and reapplication [10]. As alternative to the use of these synthetic insecticides, plant extracts, powders and ash have been used as cheaper and eco-friendly means of controlling insect infestation of stored cowpea seeds [15]. Attention is being given to the use of edible plant materials as grain protectant [11] and the tropics is well endowed with these plant species some of which are also used for medicinal purposes.

Plant materials that are safe to the environment, users and consumers' alike, inexpensive, repellents and anti-feedants need to be exploited as suitable alternatives to the expensive, toxic and environmentally unsafe synthetic insecticides [13]. Mixing of different plant materials with grains for the protection of insect pests is an old practice adopted by farmers, particularly in developing and under developed countries [18]. More so, researches have shown that botanicals have been extensively used on agricultural pests and to very limited extent on insect pests of stored products [4] were evaluated in the laboratory for the control of *Callosobruchus maculatus* in stored cowpea.

2. Methodology

2.1. The Experiment Site

The experiment was carried out in the research laboratory of the Crop, Soil and Pest management department of The Federal University of Technology, Akure (FUTA). Nigeria.

2.2. Method

2.2.1. Laboratory Culturing of C. maculatus

The *C. maculatus* used was cultured in the research laboratory of the department of Crop, Soil and Pest Management, FUTA. The emerged adults were sub-cultured in the research laboratory of the Department of Crop, Soil and Pest Management, FUTA. The sub-culture was maintained in Kilner jar in the laboratory until emergence of adult *C. maculatu*s. Adult males and females were introduced into clean cowpea seeds in Kilner jar covered with a muslin cloth and a cut cover to allow in flow of air, and to also prevent the adult cowpea weevils from escaping, and this was kept on a shelve in the laboratory. After 2 days, all the adults introduced were removed. By this time, eggs had been laid on most of the seeds. A day old freshly emerged adults from the cultures were used for the Experiment.

2.2.2. Preparation of Ripe and Unripe Pawpaw Seed Powder

Ripe and unripe pawpaw fruits were obtained from the local market in Akure, Ondo State, Nigeria. The fruit were air dried and blended into powder by using electric blender, the blended powder were sieved with 2 mm sieve in order to obtain fine powder particles for the experiment.

2.2.3. Toxicity Effect of Ripe Pawpaw Seeds Powder on C. maculatus

Ripe pawpaw seeds powder at treatment application rate of 0.2g, 0.4g, 0.6g, 0.8g. 1.0g was measured into petri dishes containing 20g o cowpea seeds and 10 introduced *C. maculatus* (5 males and 5 females) of three replicates each. Adult mortality was taken at 12, 24 and 48 hours respectively. Number of eggs laid on the treated cowpea seeds was counted and recorded, Adult emergence of F1 progeny was equally recorded and seed weight loss was recorded after emergence of F1 progeny of *C. maculatus*

2.2.4. Toxicity Effect of Unripe Pawpaw Seeds Powder on C. maculatus

Unripe pawpaw seeds powder at treatment application rate of 0.2g, 0.4g, 0.6g, 0.8g. 1.0g was measured into petri dishes containing 20g o cowpea seeds and 10 introduced *C. maculatus* (5 males and 5 females) of three replicates each. Adult mortality was taken at 12, 24 and 48 hours respectively. Number of eggs laid on the treated cowpea seeds was counted and recorded, Adult emergence of F1 progeny was equally recorded and seed weight loss was recorded after emergence of F1 progeny of *C. maculatus*

2.2.5 Data Analysis

Data were transformed using square root and arcsine transformation and analyzed using Statistical Package for Social Sciences (SPSS) version 17.0. Means were separated with Tukey's HSD test at 5% of significance

Linear correlation and regression of data was also done.

3. Results and Discussion

Mean percentage adult mortality of *C. maculatus* in cowpea seeds treated with different application rate of ripe pawpaw seeds powder at different time interval is illustrated in table 1. At 12 hours of treatment, there was no significant difference in the percentage adult mortality of *C. maculatus* in the treated and untreated seeds. At 24 hours and 48 hours, adult mortality was significantly higher in cowpea seed treated with 1.0g of ripe pawpaw seeds powder than the mortality recorded in the untreated seeds.

Means in each column bearing the same letter are not significantly different at the 5% level of variance by Tukey test.

Mean number eggs laid and F1 adult emergence in cowpea seeds treated with ripe pawpaw seeds powder is presented in table 2. The results shows that number of eggs laid on seeds treated with ripe pawpaw seeds powder at treatment rate of 0.2g, 0.4g, 0.6g, and 0.8g were significantly lower from

number of eggs laid in untreated seeds (control). However, number of eggs laid in seeds treated with ripe pawpaw seeds powder at treatment of 1.0g was significantly lower than the control and other treatment.

Table 1. *Mean percentage adult mortality of Callosobruchus maculatus in cowpea seeds treated with ripe pawpaw seed powder.*

Treatment application rate (g/20g)	Mean percentage mortality n=10; 12hrs	Mean percentage mortality n=10; 24hrs	Mean percentage mortality n=10; 48hrs
0.0	6.7 ± 5.77^{a}	10 ± 0^{a}	23.3 ± 15.28^{a}
0.2	6.7 ± 5.77^{a}	23.3 ± 5.77^{ab}	33.3 ± 17.32^{ab}
0.4	$13.3 + 5.77^{ab}$	26.7 ± 5.77^{ab}	40 ± 10^{abc}
0.6	23.3 ± 5.77^{ab}	36.7 ± 5.77^{bc}	46.7 ± 5.77^{bc}
0.8	26.7 ± 11.55^{ab}	36.7 ± 11.55^{bc}	50 ± 0^{abc}
1.0	30 ± 10^{a}	53.33 ± 5.77^{c}	63.3 ± 5.77^{c}

Table 2. *Mean number of eggs laid and F1 Adult emergence of Callosobruchus maculatus in cowpea seeds treated with ripe pawpaw seed powder.*

Treatment Application Rates (g/20g)	Mean Oviposition	Mean Adult emergence
0.0	13.97 ± 5.24^{e}	6.43 ± 3.61^{c}
0.2	10.26 ± 3.95^{d}	3.63 ± 10.81^{b}
0.4	7.01 ± 4.89^{c}	1.68 ± 13.32^{a}
0.6	6.08 ± 9.85^{bc}	1.27 ± 18.69^{a}
0.8	5.20 ± 12.74^{b}	1.22 ± 19.14^{a}
1.0	3.36 ± 14.74^{a}	0.88 ± 27.64^{a}

Means in each column bearing the same letter are not significantly different at the 5% level of variance by Tukey test.

Significant fewer adults emerged from the cowpea seeds treated with different rates of application of ripe pawpaw seeds powder when compared with the untreated seeds. Mean adult emergence was lower in treatment involving 1.0g/20g of seeds which was not significantly different from the number of eggs laid on cowpea seeds treated with 0.4-0.8g of ripe pawpaw seeds powder.

Mean percentage seed weight loss in seeds treated with ripe pawpaw seeds powder is presented in table 3. The results shows that the seed weight loss in seeds treated with ripe pawpaw seeds powder at treatment rate of 0.4g, 0.6g, 0.8g and 1.0g were not significantly different. However, seed weight loss in seeds treated with ripe pawpaw seeds powder at treatment of 0.2g and above was significantly lower than the untreated seeds (control) and the lowest seed weight loss was recorded at the treatment rate of 1.0g.

Table 3. *Mean percentage Seed weight loss in cowpea seeds treated with ripe pawpaw seed powder.*

Treatment Application Rates (g/20g)	Mean percentage Seed weight loss
0.0	1.46 ± 14.09^{c}
0.2	0.43 ± 17.84^{b}
0.4	0.60 ± 21.13^{a}
0.6	0.17 ± 26.72^{a}
0.8	0.17 ± 24.48^{a}
1.0	0.10 ± 33.31^{a}

Means in each column bearing the same letter are not significantly different at the 5% level of variance by Tukey test.

Mean adult mortality of *C. maculatus* in cowpea seeds treated with unripe pawpaw seeds powder is presented in table 4. At 12 hours of treatment, there was no significant difference at the treatment rate of 0.2g, 0.4g and 0.6g. However, cowpea seeds treated with 0.8g and 1.0g were significantly different from the control.

Table 4. *Mean percentage adult mortality of Callosobruchus maculatus in cowpea seeds treated with unripe pawpaw seed powder.*

Treatment application rate (g/20g)	Mean percentage mortality n=10; 12hrs	Mean percentage mortality n=10; 24hrs	Mean percentage mortality n=10; 48hrs
0.0	3.33 ± 5.77^{a}	10.00 ± 10^{a}	23.33 ± 5.77^{a}
0.2	6.67 ± 5.77^{a}	20.00 ± 10^{ab}	26.67 ± 5.77^{a}
0.4	13.33 ± 5.77^{ab}	23.33 ± 5.77^{ab}	33.33 ± 5.77^{bc}
0.6	20.00 ± 0^{ab}	33.33 ± 5.77^{abc}	46.67 ± 5.77^{bc}
0.8	26.67 ± 5.77^{b}	40.00 ± 10^{bc}	53.33 ± 5.77^{c}
1.0	30.00 ± 10^{b}	50.00 ± 10^{c}	83.33 ± 5.77^{d}

Means in each column bearing the same letter are not significantly different at the 5% level of variance by Tukey test

At 24 hours and 48 hours, adult mortality was significantly higher in cowpea seed treated with 1.0g of unripe pawpaw seeds powder than the mortality recorded in the untreated seeds.

Mean number of eggs laid and F1 adult emergence in cowpea seeds treated with unripe seeds powder is presented in the table 5. This result shows that number of eggs laid in seeds treated with unripe seeds powder at treatment of. 0.2g, 0.4g, 0.6g, 0.8g and 1.0g were significantly different from the untreated seeds (control).

Mean F1 adult emergence of *C. maculatus* in seeds treated with unripe pawpaw seeds powder at 0.2g and above were significantly different from the untreated seeds (control). However, there was no significant difference of F1 adult emergence in seeds treated with unripe pawpaw seeds powder at the treatment rate 0.2g and above

Table 5. *Mean number of eggs laid and F1 Adult emergence of Callosobruchus maculatus in cowpea seeds treated with unripe pawpaw seed powder.*

Treatment Application Rates (g/20g)	Mean Oviposition	Mean Adult emergence
0.0	11.97 ± 1.15^{d}	7.76 ± 0.98^{b}
0.2	8.00 ± 1.09^{c}	2.02 ± 0.40^{a}
0.4	7.47 ± 0.28^{bc}	1.58 ± 0^{a}
0.6	6.44 ± 0.16^{bc}	1.17 ± 0.44^{a}
0.8	5.62 ± 0.62^{ab}	1.05 ± 0.29^{a}
1.0	3.75 ± 0.34^{a}	0.88 ± 0.29^{a}

Means in each column bearing the same letter are not significantly different at the 5% level of variance by Tukey test.

Table 6 present the result of percentage seed weight loss of cowpea seeds treated with unripe pawpaw seeds powder. This result shows that the lowest seed weight loss was recorded in cowpea seeds treated with 1.0g of unripe pawpaw seeds powder which was not significantly different from seeds treated with 0.2g, 0.4g, 0.6g and 0.8g of the unripe pawpaw seeds powder.

Table 6. *Mean percentage Seed weight loss in cowpea seeds treated with unripe pawpaw seed powder.*

Treatment Application Rates (g/20g)	Mean percentage Seed weight loss
0.0	$2.13 + 0.45^{b}$
0.2	$0.10 + 0.06^{a}$
0.4	$0.03 + 0.01^{a}$
0.6	$0.03 + 0.03^{a}$
0.8	$0.17 + 0.01^{a}$
1.0	$0.13 + 0.01^{a}$

Means in each column bearing the same letter are not significantly different at the 5% level of variance by Tukey test.

4. Conclusion and Recommendation

From the results obtained, it can be concluded that the Ripe and Unripe pawpaw seeds powder possess insecticidal activities against *C. maculatus,* thus resulted in reduction in oviposition and adult emergence of the cowpea beetle. Therefore, Ripe and Unripe pawpaw seeds powder are recommended for use, to protect the stored cowpea to achieve more reasonable result within short period of time and to achieve longer protection against the insect pest. Also, to achieve more effective control over this insect pest, ripe and unripe pawpaw seeds powder should be applied at high treatment concentrations since the powder have active insecticidal properties.

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