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Studies on the Resistance of Cowpea Seeds (*Vigna unguiculata)* to Weevil *(Callosobruchus maculatus)* Infestations

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Abstract Three cowpea varieties namely: Kafanji, Brown variety and Ex-potiskum were used in this study to test their resistance on weevil infestation. Cowpea samples of 60grams were measured from each variety and were artificially infested with different weevil densities made up of male and female ratios of 5:10, 10:15 and 15:15. The samples had three replicates and a control treatment each. These were allowed to stand on the shelves without disturbance, thus making it possible for the weevils to mate and oviposit naturally. The results were analysed statistically and the differences between the treatments with respect to weight loss and adult emergence were significant (P>0.05) and the damages were also closely related to the infestation density increasing with the densities. Kafanji suffered more damage while the Brown variety and Ex-potiskum suffered less damage. This indicates that Ex-potiskum and Brown-variety exhibits more resistance qualities to the weevil attack than Kafanji which is more susceptible to the weevil attack. The physical as well as the chemical characteristics of the seeds were also found to influence the growth and development of the weevil forming the basis for resistance in the varieties. Breeding programmes utilizing the resistance characters in certain varieties are therefore suggested.

Keywords: *oviposition, grains, Ex potiskum, kafanji*

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1. Introduction

Cowpea is a warm weather crop that is well adapted to drier regions of the tropics like Nigeria where other food legumes do not thrive well [1]. It is one of the most economically and nutritionally important indigenous African grain legumes produced throughout the tropical and subtropical areas of the world [1]. Nigeria is its largest producer and consumer, accounting for about 45 percent of its world's production [2,3] while Africa accounts for about 75% [4]. Cowpea seed pods and leaves are consumed in fresh form as green vegetables in some African countries [5], while the rest of the cowpea plant after the pods have been harvested serves as a nutritious fodder for livestock [6] and also a source of cash income when sold to farmers who use them as livestock feed. [7]. Its nutritive value makes it an extremely important protein source to vegetarian and people who cannot afford animal protein [8]. Cowpea seeds are also a rich source of minerals and vitamins [9]. Cowpea is sometimes called "poor man's meat" or "vegetable meat" by researchers due to its high protein content. Cowpea grain contains 23.4% protein, 1.8% fat and 60.3% carbohydrates and also a good source of vitamins and phosphorus [8].

However, the production and storage of this important food crop, Cowpea has faced so many constraints, such as diseases and the limited use of fertilizers and irrigation inputs [4] but insect pest is one of the major constraints. The major storage pest of cowpea is *Callosobruchus maculatus* [4]. It infests cowpea before harvest, the higher the infestation levels before harvest, the greater the damage to the seeds in storage. This will result in higher weevil emergence causing a greater weight loss, larger number of holes and consequently loss of economic value [10]. Infestations on stored grains may reach 50% within 3-4 months of storage [7]. *Striga gesnerioides*, commonly called witch-weed, is also a major constraint to growth and productivity of cowpea (*Vigna unguiculata* L. Walp) throughout West Africa [11]. If cowpea seeds are to be stored for longer periods, then it is advisable to treat the seeds with recommended insecticides [11].

Today, researches are focusing on the discovery of new therapeutic substances of natural origin, based on ethno medical and ethno veterinary practices with possible low or no toxicity to human, animal and environment [12].

One modest way of increasing food availability to cope with the Nigerian ever-increasing population at low cost is to protect what has been produced and to achieve this, plant materials that are inexpensive, safe to the environment, users and consumers alike, need to be exploited as suitable alternatives to the expensive, toxic and environmentally unsafe synthetic insecticides [13]. Insecticides are widely used, and misused, to control

storage insects, as evident in the Nigerian press reports on poison cases. Sudden deaths, blindness, and skin irritation are among the problems attributed to use of inappropriate storage chemicals in Nigeria [13]. Control of insect with chemical insecticides has serious disadvantages such as the development of resistant strains, toxic residue, worker's safety and increasing costs [15]. The international institute of Tropical Agriculture (IITA) in Ibadan Nigeria is the center for worldwide collection and testing of cowpea germplasm. The IITA and collaborators are currently working on varietal improvement based on host plant resistant varieties that are ready for harvest in 60days.A breakthrough was achieved in 1995 when the resistance genes from wild cowpea species were successfully transferred into cultivated cowpea varieties including resistance to the storage weevil *Callosobrochus maculatus*, leafhopper and aphids using an in-vitro rescue techniques. Partial resistance to other pests and diseases has also been incorporated into elite varieties multiple resistances.

The main objective of the study is to investigate if different cowpea varieties have resistance to weevil infestation. Other objectives of the study are to determine the major nutrient composition in the different cowpea varieties through bio chemical analysis, study the development of *Callosobruchus maculates* on different varieties of cowpea (Kafanji, Ex-Potiskum and Brown Variety) at different population densities. The study is also aimed at determining the weight loss and damage in some cowpea varieties infested with *C. maculatus.*

2. Materials and Methods

The study was carried out in the laboratory of the Department of Zoology, Nnamdi Azikiwe University, Awka. Three cowpea varieties were used in this work and they were labeled thus: Kafanji, (Sample A), Brown variety (Sample B) and Ex-potiskum (Sample C). These varieties were purchased from a local farmer at Zamfara State. The clean uninfested cowpea grains were selected and heated in the oven at 100ºC for 5 minutes to ward off any stage of insect infestation. Sixty grams each of the cowpea varieties were measured into transparent containers with perforated lid covered with mosquito nets. Transparent containers were preferred because they aided clear observation of the insects. *Callosobruchus maculatus* was cultured in white transparent plastic containers covered with mosquito nets and its lids were perforated to prevent escape of the insect and entrance of other insects. Adult insects were used for the culture.

At the end of the culture period juvenile weevils were removed from the culture jars and introduced to the cowpea varieties with the use of an aspirator at different male /female densities of 5:10, 10:15 and 15:15 in three replicates. The sexes were separated into male and female by noting their morphological differences. Uninfested samples were maintained as control treatments for each variety and treatments were allowed to stand on the shelf undisturbed. The biochemical composition of the cowpea varieties was done at The National Agency for Food and Drug Administration and Control (NAFDAC) laboratory, Agulu Nigeria. One hundred grams seeds of each variety were taken for the analysis using the methods of AOAC [14].

Data collected at the end of the six weeks study were: total number of adult emergence, number of holed and unholed seeds and weight loss in seeds. Data generated from the study were subjected to analysis of variance (ANOVA) at (0.05) significant level with SPSS statistical package (version 19) and Duncan`s Multiple Range Test was used for means separation.

3. Result

The population of adult emergence of *C. maculatus* at different population densities is presented in Table 1. Kafanji had more adult emergence than others (Plate 1). It was followed by Brown variety while Ex-potiskum had the least emergence of adult *C. maculatus*. The proximate composition of the cowpea varieties is reported in Table 2. The greatest weight loss in seeds was observed on Kafanji with mean value of 16.5 while the least weight loss was observed on Ex-potiskum with mean value of 1.0. The greatest weight loss was also obtained on the 15:15 density, indicating that weight loss increases with the insect density (Table 3). There is a significant difference ($p<0.05$) in the actual weight loss in the cowpea varieties. Test for means show that Brown variety and Ex-potiskum are statistically the same but statistically different from Kafanji variety. The percentage holed seeds was higher in Kafanji and least in Ex-potiskum (Table 4). The difference in the mean percentage holed seed was significant at $p < 0.05$, implying that Kafanji had the least resistance to weevil infestation.

Table 1. Population of Adult Emergence of *Callosobruchus maculatus*

Infestation density	Kafanji	Brown variety	Ex-potiskum	Mean
5:10	177	37	3	72.3
10:15	132	43	8	61
15:15	155	52	17	74.6
Total	464	132	28	
Mean	**154.6**	**44**	**9.3**	

Table 2. Proximate Analysis (%) of Cowpea Varieties

Chemical Content	Kafanji (%)	Brown Variety (%)	Ex-potiskum (%)
Moisture	5.75	6.56	**6.81**
Ash	1.5	3	**3**
Protein	21.8	17.9	**20.5**
Fat	0.75	0.91	**1.42**
Crude fibre	9	7	**6**
Carbohydrate	**61.2**	**64. 63**	**62.27**

Table 3. Actual Weight Loss (%) in Infested Seeds

Infestation densities (Male: Female)	Kafanji	Brown variety	Ex-potiskum	Total	Mean
5:10	9.4	2.4	0.5	12.3	**4.1**
10:15	15.8	5.4	1.0	22.2	**7.4**
15:15	24.3	3.5	1.6	29.4	**9.8**
TotaL (∑)	49.5	11.3	3.1	63.9	
Mean (X)	**16.5±7.47^{a}**	**3.8±1.51^{b}**	**1.0±0.55^{b}**		

Rows with the same superscript are not significantly different

Table 4. Percentage Holed Seeds

Infestation density	Kafanji (%)	Brown variety (%)	Ex-potiskum (%)	Total (%)	Mean (%)
15:10	11.2	8.2	0.92	2.32	6.77
10:15	4.5	9.9	2.76	53.16	17.72
15:15	44.7	13.4	3.7	61.8	20.6
Total	96.4	31.59	7.38	135.28	
Mean	32.1±18.25[b]	10.5±2.7[b]	2.46±1.41[a]	45.0	

Rows with the same superscript are not significantly different

Plate 1. Kafanji variety after infestation

4. Discussion

The result of the present study has shown that some of the cowpea varieties evaluated show various degrees of resistance and susceptibility to adult *C. maculatus* attack. This supports the findings of Oke and Olajire, [16] who reported that the cowpea varieties studied exhibited some levels of resistance and susceptibility to *Callosobruchus maculatus*, a major storage insect pest of cowpea. From the results obtained, Ex-potiskum was found to be more resistant to *C. maculatus* followed by Brown variety and least resistance was observed in the Kafanji variety. It had least emergence of adult *C. maculatus*, least weight loss, and least percentage damaged seeds recorded. It has been reported that variables such as adult emergence, growth index, developmental period and weight loss are the most reliable indicators for resistance of cowpea to damage by *C. maculatus* [17,18].

From the biochemical analysis carried out, Ex-potiskum and Brown variety contained high ash content which could be the cause of its high resistance to weevil infestation. Ash is known to possess insecticidal properties and is found effective in controlling storage insect pests, mainly Coleopterae [19,20]. Giga, [21] reported the use of fine sand, wood ashes and plant materials with insecticidal properties by farmers to protect their products. Wolfson *et al*. [22] reported that a minimum ratio of 3 parts of ash to 4 parts of cowpeas prevented population growth of *C. maculatus* and that a 3 cm layer of ash on top of stored seeds prevented infestation by adults. They further stated that storing cowpeas with ash to protect them against *Callosobruchus maculatus* is a traditional storage method in Northern Cameroon. Moreso, the Kafanji variety had the highest protein content (21.8%) than the other two varieties studied. This could be the reason for its high adult *C. maculatus* emergence, high weight loss, and high percentage damaged seeds recorded. This implies that it has low resistance to weevil infestation. Research studies have shown that the increase of protein concentration in seed coat of cowpea may play a role towards susceptibility to weevil pest [23]. Also [24] revealed that high protein content was linked to susceptibility to the stored- product insect infection.

Considering texture of the cowpea varieties, Kafanji possessed a smooth coat while the other two varieties are rough. This feature may be the reason for its low resistance to the weevil during the study period. This supports the findings of [25] who reported that *C. maculatus* prefers smooth-coated and well-filled seeds to their rough and wrinkled counterparts for oviposition. [26] indicated that seed coat texture plays significant role in inducing ovipositional response.

The study further reveals that cowpea variety with highest adult emergence (Kafanji) recorded extensive damage (i.e. higher percentage holed seeds and weight loss). In other words, increasing population of adult emergence causes more extensive damage and vice versa. This agrees with the findings of [27] who reported that the number of emerging adult determines the extent of damage, and consequently, seeds permitting more rapid and higher levels of adult emergence will be more extensively damaged. Statistically, the differences between the treatments with respect to adult emergence, percentage damage and actual weight loss were significant at ($P<0.05$).

The physical examination of the three cowpea varieties shows that there is difference in the size, texture, moisture content and seed testa colour. However, seed properties including seed testa colour, mass, size and moisture content generally do not influence the susceptibility of cowpea seeds and other cereals grains to *C. maculatus* and *Sitophilus* species in storage respectively [28,29,30].

The greatest weight loss was obtained on the 15:15 density indicating that it increases with the insect density. Seeds challenged with higher female: male ratios of bruchids were more damaged than those challenged with lower female: male. However, those challenged with equal male: female ratios were the most damaged in the cowpea varieties except in the Brown variety. This is in contrast to the findings of [31] who reported that seeds challenged with higher male: female ratios of bruchids were more damaged than those challenged with lower male: female or equal male: female ratios. Samples treated with more males than females caused severe damage, since a single female has been observed to mate several times with different males (depending on the number of times a female bruchid would mate in order to continue producing eggs).

5. Conclusion

Cowpea varieties can resist insect infestation to some extent even without the application of toxic chemical insecticides. Of the three cowpea varieties studied, Kafanji was more susceptible to adult *C. maculatus* attack hence would not be suitable for longer storage except insecticides are employed. This study rates Ex-potiskum higher than the other variety because of its low population of adult weevil emergence, weight loss, percentage whole seed and high ash content. It is highly recommended for

both farmers and consumers but when not readily available, Brown variety should be used.

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