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# Evaluation of Different Particle Sizes and Rates of Application of Xylopia Aethiopica (Dunal) A. Rich Fruit Powder Against Callosobruchus Maculatus (F.) (Coleoptera: Chrysomelidae) On Stored Cowpea

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***Abstract:***
*Particle sizes have been known to enhance insecticidal action of botanical powders. This study investigates the manipulation of different particle sizes and rates of application of Xylopia aethiopica (Dunal) A. Rich fruit powder for the control of Callosobruchus maculatus (F.). Powder of different particle sizes (75 µm, 150 µm, 300 µm and 425 µm) was made from dried fruits of X. aethiopica. They were evaluated at five rates of application (0.2, 0.4, 0.6, 0.8 and 1.0 g/20 g of seeds) against C. maculatus under ambient laboratory conditions of (28 ± 3°C and 70 ± 5% relative humidity). Adult mortality, number of eggs laid, adult emergence and seed weight loss were the parameters assessed. The experiment was carried out using a completely Randomized Design. Results showed that the powder of X. aethiopica at different application rates in each of the particle sizes did not significantly (p>0.05) influence mortality of C. maculatus. Mean number of eggs laid, adult emergence and percentage seed weight loss decreased with an increase in application rates and decreased in size of the particle of X. aethiopica powder, with 75 µm particle size significantly (p<0.05) reduced oviposition and adult emergence in all rates of application compared with the control. In addition, X. aethiopica powder with 75 µm particle size was more potent than powder of particle size 150 µm, 300 µm and 425 µm.*

***Keywords***: *Xylopia aethiopica, callosobruchus maculatus, particle sizes, application rates*

## 1. **Introduction**

The major constraint in the storage of cowpea in the tropics is infestation and damage by bruchids, particularly Callosobruchus maculatus (F.) (Coleoptera: Chrysomelidae). The control of storage insects like C. maculatus has centered mainly on the use of synthetic insecticides (5, 10). However, the use of these chemicals is hampered by many attendant problems such as development of insect resistant strains, their toxic residues getting into food of animals and man, workers safety and high cost of procurement (7, 18). These problems have necessitated research on the use of alternatives that are eco-friendly and cheaper for insect pest control methods, amongst which are the use of powdered plant parts and their extracts (2). Quite a number of botanicals have been screened for preventing post-harvest losses due to insect pest infestation (3, 6, 15) this approach has gained attention in the control of storage insects (8) In Nigeria the insecticidal activity of X. ethiopica has been investigated by some workers (1, 17) and was reported to be weak insecticidally against C. maculatus. Finer particle sizes have been reported to enhance the efficacy of botanical powders. However, the effect of different particle sizes of X. aethiopica against C. maculatus has not been duly investigated. This paper presents results of an investigation on manipulation of different particle sizes at different application rates of X. aethiopica on C. maculatus infesting cowpea seeds in storage.

## 2. Materials and Methods

*2.1. Insect culture*

The C. maculatus used in this study was obtained from colony originating from infested cowpea seeds collected from Erekesan local market in Akure, Nigeria. The colony has been maintained in Kilner jars in a cooled incubator at 30 ± 5°C and 50 ± 5% relative humidity for two generations. All batches of the cowpea variety used for the experiment (Ife Brown) were disinfested by deep-freezing for three weeks and acclimatized to the open laboratory conditions for 24 hours. Cultures were started every 26 days by adding twenty females and ten males to about 300 g of clean cowpea seeds. The study was carried out under ambient laboratory conditions (28 ± 3°C and 70 ± 5% relative humidity).

## 3. Preparation of X. Aethiopica Fruit Powder

Dried fruits of X. aethiopica were purchased from local herbal shop in Erekesan market, Ondo State, Nigeria. Identity of the plant material was confirmed at Herbarium in the Department of Botany, Obafemi Awolowo University, Ile-Ife Nigeria. The fruits were further dried in an oven at 40°C for 24 hours. Thereafter, the dried fruits were pulverized in laboratory mill and sieved to powders of different particle sizes (75 µm, 150 µm, 300 µm and 425 µm) using a British laboratory test standard sieves. The plant powder with each particle size was immediately stored in separate tightly fitted covered plastic containers under ambient laboratory conditions. This powder was used within two days of preparation.

## 4. Effects of Particle Sizes and Application Rates of Xylopia Aethiopica Fruit Powder on C. Maculatus

Powder from dried fruit of X. aethiopica at four different particle sizes (75 µm, 150 µm, 300 µm and 425 µm) was tested separately for their insecticidal action at 0.2, 0.4, 0.6, 0.8 and 1.0g per 20g of seeds. Ten pairs of freshly emerged adults of C. maculatus were used to infest Ife Brown cowpea seeds in plastic plates (8.5 cm diameter) with lids. Each of the treatment was replicated four times. A control experiment involving no treated seeds was set up and also replicated four times in a completely randomized design. The insecticidal effect of the plant powder against C. maculatus was measured by beetle mortality at 48 hours post treatment, numbers of eggs laid by the introduced females and number of emerged adults. The percentage seed weight loss was estimated by taking the weight of the seeds after adult insect emergence.

## 5. Data Analysis

Data collected were subjected to Analysis of Variance (ANOVA). Where necessary, data were transformed before analysis. Percentage data were arcsine transformed while data based on counting were square root transformed. Where the ANOVA indicated significant difference between treatment means, Tukey's test was used to separate the mean at 5% level of probability.

## 6. Results

The mean percentage mortality of C. maculatus on cowpea seeds treated with X. aethiopica fruit powder of the different particle sizes and at different application rates are given in Table 1. All rates of application did not significantly ($p>0.05$) reduced percentage adult mortality of C. maculatus on treated cowpea seeds compared with the control irrespective of the particle size. Similarly, irrespective of the application rates, X. aethiopica powder in each of the particle size did not significantly ($p>0.05$) reduced percentage adult mortality of C. maculatus on treated seeds compared with the control. Also, there was no adult mortality of C. maculatus on cowpea seeds treated with 300 µm and 425 µm particle sizes of X. aethiopica irrespective of the application rates

Table 2 shows the mean numbers of eggs laid by C. maculatus on cowpea seeds treated with X. aethiopica powder of different particle sizes and application rates. The trend in number of eggs count with different application of X. aethiopica powder varied significantly depending on the particle size. Specifically, the 75 µm article size from X. aethiopica powder at all rates of application significantly ($P<0.05$) reduced oviposition compared to the control (Table 2). In all the application rates, the mean number of eggs laid on cowpea seeds treated with 75 µm particle size of X. aethiopica powder was lower than eggs laid on seeds treated with 150 µm, 300 µm and 425 µm.

Similarly, the number of adult emergence on cowpea seed treated with different application rates of X. aethiopica powder varied significantly depending on the particle size (Table 3). 75 µm particle size of X. aethiopica powder caused significant ($p<0.05$) reduction in insect emergence in all rates of application compared with the control. In all rates of application, the mean number of adult emergence on cowpea seeds protected with 75 µm X. aethiopica powder was lower than that adult emergence from seeds protected with 150 µm, 300 µm and 425 µm.

The percentage seed weight loss of cowpea seed treated with each of the four-different particle size of X. aethiopica at application rate of 0.2 g/20 g of seed did not differ significantly ($P>0.05$) from the control (Table 4). However, at higher application rate > 0.2 g/20 g of seed in each of the particle sizes used significantly ($p<0.05$) reduced weight loss in cowpea seeds compared to the control.

## 7. Discussion

The results of this study corroborate the findings that pulverized fruit of X. aethiopica was weak Olonosikan et al. (2006), Oparaeke and Bunmi (2004), (Oparaeke, 1997, unpublished data), at causing mortality of C. maculatus as there were no significant differences observed in adult mortality at 24 hour and 48 hours post infestation, at different rates of application and particle sizes. Although, Okoro et al. (1991) reported that X. aethiopica powder caused mortality in pest when mortality linearly increased from 48 hours to 96 hours, however, he did not state whether the pest mortality was significant or not, in this study X. aethiopica fruit powder at different particle sizes and at application rates did not significantly kill C. maculatus which failed to manifest interaction effect. However, these interactions manifested and occurred both in magnitude and direction of response for mean number of eggs laid and adult emergence, as well as seed weight loss caused by C. maculatus. For example, the trend in egg count, adult emergence and seed weight loss decreased with increasing rate of application and decrease in particle size of X. aethiopica powder. This is a general phenomenon with insecticidal material at higher concentration implies a higher quantity of active components available to cause control and the finer the particle size the better the medium for efficacy. The percentage of damage to cowpea seeds that was estimated by taking the weight of the seeds after adult insect emergence was significantly reduced at application rate >0.2 g/20 g of seed for all the particle of X. aethiopica. This is in line with the observation of Oparaeke and Bunmi (2006) that, there seemed to be a reduction in seed damage of stored bambara groundnut Vigna subnerranea (L.) Verd as concentration of X. aethiopica increased. It has been observed in this study that particle size had significantly enhance insecticidal activity of X. aethiopica on oviposition and adult emergence of C. maculatus infesting stored cowpea. The most finely ground powder of X. aethiopica powder with particle size 75 µm generally showed greater insecticidal activity against C. maculatus than 150 µm, 300 µm and 425 µm particle sizes. Ivbijaro and Agbaje (1986) reported that when applied as ground powder, Piper guineense was more active insecticidally than when applied as whole fruits and seeds. Ogunwolu and Idowu (1994) reported that the more finely ground powder particle size 150 µm of root bark of Zanthoxylum zanthoxyloides Lam. Waterm. and seed of Azadirachta indica A. Juss. were more effective insecticidally than the coarsest particle size 2mm. Ofuya and Dawodu (2002) reported that the most finely ground powder (particle size 212 µm) of P. guineense was more active insecticidally to C. maculatus than the coarsest particle size 1mm. Olotuah et al. (2010) similarly reported that Eugenia aromatica and P. guineense formulated dusts of particle size 150 µm, 212 µm and 300 µm showed greater insecticidal activity against C. maculatus than those with particle of 500 µm. These observations are consistent with the findings in this study. Particle size affects dispersion, and the finer the particle, the more uniformly the dusts will coat treated seeds thus enhancing contact with the insects.

## 8. Conclusion

It was observed in this study that toxicity of *X. aethiopica* increases as the particle size decreases, causing mortality of the adults and reductions in the other measured biological parameters. Pulverizing *X. aethiopica* to particle size of 10 µm or less may enhance their insecticidal efficacy against *C. maculatus*. Such particle sizes were not investigated in this present study. Therefore, these can be subjected to empirical verification in further experiment.

## 9. Tables

| Rate of application g/20 g of seed | Mean number (± S.E.) of eggs laid by *C. maculatus* | | | |
|---|---|---|---|---|
| | 75 µm | 150 µm | 300 µm | 425 µm |
| 0 (control) | 0.3 ± 10.64a | 0.3 ± 10.64a | 0.3 ± 10.64a | 0.3 ± 10.64a |
| 0.2 | 0.0 ± 0.00a | 0.0 ± 0.00a | 0.0 ± 0.00a | 0.0 ± 0.00a |
| 0.4 | 0.3 ± 10.64a | 0.0 ± 0.00a | 0.0 ± 0.00a | 0.0 ± 0.00a |
| 0.6 | 0.3 ± 10.64a | 0.0 ± 0.00a | 0.0 ± 0.00a | 0.0 ± 0.00a |
| 0.8 | 0.3 ± 10.64a | 0.3 ± 10.63a | 0.0 ± 0.00a | 0.0 ± 0.00a |
| 1.0 | 0.3 ± 10.64a | 0.3 ± 13.61a | 0.0 ± 0.00a | 0.0 ± 0.00a |
| | NS | NS | NS | NS |

*Table 1: Mean Percentage (± S.E.) Mortality of C. Maculatus on Cowpea Seeds Treated with X. Aethiopica Fruit Powder of Different Application Rates and at Different Particle Sizes*

Means in each column followed by the same letter (s) are not significantly different (p>0.05) using Tukey test.

| Rate Of Application g/20 g of seed | Mean Number (± S.E.) Of Eggs Laid By *C. Maculatus* | | | |
|---|---|---|---|---|
| | 75 µm | 150 µm | 300 µm | 425 µm |
| 0 (control) | 414.0 ± 0.07g | 414.0 ± 0.07g | 414.0±0.07g | 414.0 ± 0.07g |
| 0.2 | 326 0 ± 0.62ef | 365.0 ± 0.84fg | 351.0 ± 0.3fg | 368.7± 0.39fg |
| 0.4 | 309.0±0.83bcdef | 320.0 ± 0.65cdef | 354.0 ± 0.64efg | 349.0±0.51efg |
| 0.6 | 261.3 ± 0.66abcd | 284.0 ± 0.55abcde | 284.7±0.64cdef | 329.3±1.16def |
| 0.8 | 245.7 ± 0.57ab | 246.0 ± 0.65ab | 284.3 ± 0.46abcd | 313.3±1.31cdef |
| 1.0 | 230.0 ± 0.47a | 230.0 ± 0.47a | 252.3±0.05abc | 272.3±0.63bcd |

*Table 2: Mean Number (± S.E.) of Eggs Laid By C. Maculatus on Cowpea Seeds Treated With X. Aethiopica Fruit Powder of Different Application Rates and at Different Particle Sizes*

Means in each column followed by the same letter (s) are not significantly different (p>0.05) using Tukey test.

| Rate of application g/20 g of seed | Mean number (± S.E.) of adult emergence of *C. maculatus* | | | |
|---|---|---|---|---|
| | **75µm** | **150µm** | **300µm** | **425 µm** |
| 0 (control) | 375.0±0.15h | 375.0±0.15h | 375.0± 0.07g | 375.0±0.15h |
| 0.2 | 297.3±0.37fg | 320.7±0.85hg | 298.0±0.46fg | 329.0±1.27gh |
| 0.4 | 283.3±0.24efg | 282.0±0.46efg | 268.0±0.41efg | 294.7±0.93fg |
| 0.6 | 232.0±0.12bcde | 221.7±0.10abcd | 248.3±0.46cde | 262.7±0.93fg |
| 0.8 | 209.3±0.23abc | 216.0±0.36abcd | 225.7±1.27abcd | 252.0±0.98cdef |
| 1.0 | 194.7±0.21a | 198.7±0.15ab | 216.0 ± 0.93abcd | 226.7±0.25abcd |

*Table 3: Mean Number (± S.E.) of Adults That Emerged from Eggs Laid by C. Maculatus on Cowpea Seeds Treated with X. Aethiopica Fruit Powder of Different Application Rates and at Different Particle Sizes*

Means in each column followed by the same letter (s) are not significantly different (p>0.05) using Tukey test.

| Rate of application g/20 g | Mean Percentage (± S.E.) Seed Weight Loss Caused By *C. Maculatus* | | | |
|---|---|---|---|---|
| | **75µm** | **150µm** | **300µm** | **425 µm** |
| 0 (control) | 18.2 ± 0.52d | 18.2 ± 0.52b | 18.2 ± 0.52c | 18.5 ± 0.52c |
| 0.2 | 13.3 ± 0.52bcd | 13.5 ± 2.47b | 13.7 ± 2.35bc | 13.3 ± 5.10bc |
| 0.4 | 11.1 ± 1.08ab | 11.2 ± 2.25a | 11.3 ± 0.88ab | 11.3 ± 2.21ab |
| 0.6 | 9.8 ± 0.74ab | 9.6 ± 1.29a | 9.9 ± 0.49ab | 10.0 ± 1.04ab |
| 0.8 | 9.3 ± 0.26ab | 8.8 ± 0.69a | 8.7 ± 0.38ab | 8.6 ± 0.28ab |
| 1.0 | 7.2 ± 2.04a | 7.6± 2.04a | 7.3± 0.03a | 7.7 ± 0.72a |

*Table 4: Mean Percentage (± S.E.) Seed Weight Loss after Adult Emergence of C. Maculatus from Eggs Laid on Cowpea Treated with X. Aethiopica Fruit Powder of Different Application Rates and at Different Particle Sizes*

Means in each column followed by the same letter (s) are not significantly different (P>0.05) using Tukey test.

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