American Journal of Biology and Life Sciences
2014; 2(2): 63-67
Published online April 30, 2014 (http://www.openscienceonline.com/journal/ajbls)

Evaluation of the efficacy of mixed powders of *piper guineense* and *Zingiber officinale* against *Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae)

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To cite this article
Akunne C. E., Afonta C. N., Mogbo T. C., Ononye B. U., Ngenegbo U. C.. Evaluation of the Efficacy of Mixed Powders of *Piper Guineense* and *Zingiber Officinale* against *Callosobruchus Maculatus* (F.) (Coleoptera: Bruchidae). *American Journal of Biology and Life Sciences.* Vol. 2, No. 2, 2014, pp. 63-67.

Abstract
Powders prepared from two plant species, *Piper guineense* and *Zingiber officinale* were used against adult cowpea weevil, *Callosobruchus maculatus* (Fab.) on cowpea grains. The powders of *Piper guineense* and *Zingiber officinale* were applied separately and in mixtures in the ratios of Zg0%:Pg100%, Zg100%:Pg0%, Zg20%:Pg80%, Zg80%:Pg20% and Zg50%:Pg50% respectively. They were evaluated under ambient laboratory conditions (30±3°C and 75±3%). Mortality of adult *C. maculatus* at 24, 48 and 72hrs after treatment were recorded and compared with the control. All concentrations recorded higher mortality than the control except the mixture with the ratio Zg20%:Pg80%. The powder application at Pg100% proportion caused the highest mortality, during the exposure period. However, no significant difference exist (P>0.05) in the mortality count of adult *C. maculatus* between the various powder applications and the control.

Keywords
Evaluation, Vigna Unguiculata, Piper Guineense, Zingiber Officinale, Callosobruchus Maculatus

1. Introduction

Cowpea, Vigna unguiculata (L.) Walpers, is a common food crop throughout Nigeria but particularly in the middle belt and drier northern regions (Ojuederie et al., 2009). Sub-Saharan Africa accounts for over 70% of cowpea produced and consumed worldwide. The name cowpea probably originated from the fact that the plant was an important source of hay for cows in the southeastern United States and in other parts of the world. Some important local names for cowpea around the world include “niebe,” “agwa,” “wake,” and “ewa” in much of West Africa and “caupi” in Brazil. In the United States, other names used to describe cowpeas include “southernpeas,” “blackeyed peas,” “field peas,” “pinkeyes,” and “crowders.” These names reflect traditional seed and market classes that developed over time in the southern United States. It has been consumed by humans since the earliest practice of agriculture in the developing countries of Asia, Latin America and Africa, where it is a valuable source of proteins, vitamins and mineral salts (Singh et al., 2003). High protein contents and lysine contents make cowpea a natural supplement to staple diets of cereals, roots and tubers commonly grown in many poor countries (Adekola and Oluleye, 2007). Most often the seeds and pods of cowpea are boiled and eaten as vegetable or are consumed after cooking to provide protein and several vitamins and minerals while the leaves or stems serve as fodder for livestock feeding. In Nigeria, cowpea is consumed in the form of bean pudding, bean cake, baked beans, fried beans, and bean soup among others (Mbah and Silas, 2007). The research on cowpea is rapidly increasing due to population explosion, food shortage and demand for plant protein. The crop is also a valuable and dependable commodity that produces income for many small holder farmers and traders in Sub-Saharan Africa (Langyintuo, 2003). Cowpea is a valuable component of farming systems in many areas because of its ability to restore soil fertility for succeeding cereal crops grown in rotation with it (Carsky et al., 2002).

Provision of adequate food has always been a challenge facing mankind. This is particularly true in the tropics and sub-tropics where the climate provides a favourable environment for a wide range of insects and massive efforts are required to suppress population densities of the different pests in order to achieve an adequate supply of food. In developing countries the problem of insect pests is further compounded by the rapid increase in human population (2.5-3.0%) in comparison to a 1.0% increase in food production (Mvumi and Stathers, 2003). Considering the recurrence of droughts in Africa, considerable losses of agricultural products add a serious burden to people's daily lives. Successful storage of cowpeas throughout the season has been hampered by insect pest damage from Callosobruchus spp. Belmam and Stevenson, (2003) noted that storage losses due to insect is a serious threat to food security and household incomes. In Nigeria, its availability continues to be hampered by storage pests of which the cowpea Seed beetle, Callosobruchus maculatus (F.) (Coleoptera: Bruchidae), attacks on cowpea pods in the field and continue in stored seeds reducing their nutritional value. The female C. maculatus deposits eggs singly on the surface of cowpea seeds. Each female bruchid may lay up to 100 eggs (Beck and Blumer, 2007). On hatching, the larva penetrates the testa and remains in the seeds until it is fully developed. Adults emerge out of the pupae in about a month (Ofuya and Lale, 2001). The damage caused includes seed weight loss, reduced viability and reduced commercial value; negate efforts at self sufficiency in food production and poverty alleviation (Emeasor et al., 2007). As legumes provide the cheapest and richest source of plant protein to man and animals they are nicknamed poor man's meat and control of this pest becomes essential (Singh and Pandey, 2001). However, according to Toye, (1976), for any nation to grow and develop economically, she must rise to control pests.

Presently, pest control measures in storage rely heavily on the use of synthetic insecticides and fumigants. The use of conventional synthetic insecticides has played a major role in the control of the pest at all stages of development. However, there are problems associated with the use of toxic synthetic pesticides which include human and eco-toxicity (Ukeh, 2008) also in Nigeria, the abuse and misuse of these chemical pesticides have several repercussions including acute and chronic poisoning in man, sudden deaths, blindness and skin irritation (Akunne and Okonkwo, 2006). One modest way of increasing food availability to cope with the Nigerian ever-increasing population at less 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 (Magaji et al., 2005).

There is therefore, a pressing need for the development of safer, alternative crop protectants such as botanical insecticides, which undergo biodegradation rapidly and do not contaminate the environment. The search for alternative sources for the containment of storage insect pests has continued in order to discourage the use of poisonous insecticides. Generally, botanical insecticides cause less damage to human and environmental health than conventional insecticides (Ukeh, 2009).This research was therefore designed to study the efficacy of the mixed powders of two common botanicals, ginger (Zingiber officinale) rhizome and black pepper (Piper guineense) seed in controlling adult Callosobruchus maculatus.

2. Materials and Methods

2.1. Experimental Site

This research was carried out in the Botany Department laboratory of Nnamdi Azikiwe University, Awka. Awka is the capital of Anambra State and lies within coordinates 6°12′N and 7°04′E. It is in the tropical zone of Nigeria and wooded savannah grassland predominates primarily to the north and east of the city (Onyido *et al*., 2011).

2.2. Sources and Preparation of Plant Materials

Fresh ginger rhizome and West African black pepper seed were obtained from Relieve market Onitsha. The ginger rhizome was washed and then air-dried for two weeks while the West African black pepper seed was sun dried .When these plant materials where properly dried they were ground with an electric mill into a fine powder and then the finely ground powders were stored in an air-tight container to prevent the active ingredients from being lost and then they were stored in a cool dry place until when needed.

2.3. Culture of *C. Maculatus*

The adult *C. maculatus* used for the experiment were cultured in a plastic container under laboratory temperature. The infested cowpea grain was purchased from Eke Awka market Awka, Anambra state. The infested cowpea was kept for about a month until there was enough oviposition and then the newly emerged adults were used for the experiment.

2.4. Experimental Set Up

The infested cowpea grains were heated in the oven at 125ºC for 35minutes to ward off any stage of insect infestation and dead insects were discarded. 30g each of the cowpea grains were weighed into plastic transparent containers covered with perforated lids to allow ventilation. The transparent containers were preferred because they aided clear observation of the insects. 5g of the both powders of *Zingiber officinale* and *Piper guineense* were used in the proportions of Zg0%:Pg100%, Zg100%:Pg0%, Zg20%:Pg80%, Zg80%:Pg20% and Zg50%:Pg50% and then admixed with the 30g of cowpea grains. Cowpea grains not treated at all with any of the plant materials (Zg0:Pg0) were used as control.

Each of the treatments had three replicates. After the introductions of the powders, the containers were shaken vigorously and the twenty newly emerge adults were introduced into each of the containers. All of the treatments were arranged in a completely randomized design (C.R.D). The time of the infestation was duly noted.

2.5. Data Collection

Data were generated and recorded from mortality count of adult *C. maculatus* at 24, 48 and 72hrs which would be used to determine the most efficient proportions of the powders. Before every count, the containers were kept in the freezer for 5 minutes to incapacitate the live weevils. Dead *C. maculatus* were removed and discarded after every count.

2.6. Statistical Analysis

Data were generated and recorded from mortality count of adult *C. maculatus* at 24, 48 and 72hrs and were recorded and used to determine the most efficient proportions of the powders. Dead *C. maculatus* were removed and discarded after every count. Data generated on mortality of the *C. maculatus* due to efficacy of powders were subjected to analysis of variance (ANOVA) at 0.05 significant levels.

3. Results

The result shown in Table 1 indicates that the mean mortality count of adult *C. maculatus* (4.22±2.33) is highest in the cowpea seeds treated with *Piper guineense* powder (Pg100%) than those of *Zingiber officinale* powder (Zg100%) (3.22±2.39) though the lowest mean mortality (3.00±2.24) was recorded in the control. Analysis of Variance (ANOVA) for the mean mortality count of adult *C. maculatus* on cowpea seeds treated with the two plant powders used in the experiment and the control, indicates that there is no significant difference (P-value = 0.86) in the mortality count of adult *C. maculatus* between *Zingiber officinale* and *Piper guineense* powder application and the control at 5% level of significance.

The result shown in Table 1 indicates that the mean mortality count of adult *C. maculatus* is slightly highest in cowpea seeds treated with powder mixture of Zg50%:Pg50% (3.33±2.00) followed by Zg80%:Pg20% (3.11±2.89) and Control (3.00±2.24) while the treatment with Zg20% +Pg80% mixture recorded the lowest mortality count (2.89±2.03).

Table 1. *Mean Mortality Count of C. maculatus on Cowpea Seeds Treated with Leaf Powders of Zingiber officinale and Piper guineense*

Powder application	Mean mortality count*
Zg 100%	3.22±2.39
Zg 80% +Pg 20%	3.11±2.89
Zg 50% +Pg50%	3.33±2.00
Zg 20% +Pg 80%	2.89±2.03
Pg 100%	4.22±2.33
Control	3.00±2.24

*mean ± SD

4. Discussion

The result of the present study shows that *Piper guineense* seed powder at 100% produced the highest mortality of *C. maculatus* followed by equal proportion of the powder mixture of *Z. officinale* and *P. guineense* and then *Z. officinale* at 100% concentration. This shows that the two plant powders used caused mortality of adult *C. maculatus*. This findings supports the work of (Rajapakse, 2006; Parugrug and Roxas, 2008; Asawalam and Emosairue, 2006) who reported that plant powders of *P. guineense*, *Z. officinale* and so many others can be used in suppressing the population of storage pests. Arong *et al*., (2011) also reported that *P. guineense* has shown to posses phyotochemicals that confer on it significant insect repellent and insecticidal value. Also, Abdullahi and Muhammad (2004) showed that powders of *Piper guineense* had pronounced effects on the egg laying capacity and survival of *C. maculatus,* comparable to treatment with Actellic dust. The high mortality rate observed in the treatment with *P. guineense* seed powder could be as a result of direct feeding of the insects on the various resins particularly chavicine and a yellow alkaloid, piperine which is contained in the seeds. The pungency of *P. guineense* seed has been attributed to the presence of these various resins and piperine (Asawalam and Emosairue, 2006). It could also be as a result of the insects being suffocated as it has been reported by Lale, (2002) that the powders of these plant materials are capable of blocking the spiracles of insects.

Cowpea seeds treated with equal proportions (50%:50%) of the plant powders *Z. officinale* and *P. guineense* had a higher adult mortality of *C. maculatus* compared to those of unequal proportions (Zg80%:Pg20% and Zg20%:Pg80%) which recorded the lowest mortality count and were similar in the mortality of *C. maculatus* with those of the control. The higher mortality in the treatment with equal proportions (50%:50%) of the plant powders *Z. officinale* and *P. guineense* could mean that there were additive effects from mixing the two plant powders. Similar findings on mortality of *C. maculatus* were obtained from Dawudo and Ofuya (2000) who observed that the mixture of the fruit powders of *Piper guineense* and *Dennettia tripetala* in equal proportion (50%:50%) significantly caused mortality, reduced oviposition and adult emergence.

Moreso, no significant difference exist in the mortality of *C. maculatus* between the various powder mixtures of *P. guineense* and *Z. officinale* at the unequal proportions Zg20%:Pg80%, Zg80%:Pg20% and Zg50:Pg50 used. This could be attributed to the lower concentration (5g) of the powder used. For instance the study conducted by Yahaya (2002) and Maina (2006) similarly reported that the oil and powder of *P. guinnense* significantly reduced the egg laying capacity of adult *C. maculatus* weevils, as well as their survival on cowpea grains. Both factors were observed to greatly decrease with increasing concentration of the botanical oil and powder applied. This is in contrast to findings of Emeasor *et al.,* (2007) who reported that mixing seeds powders of *Piper guineense* and *Thevetia peruviana* in the proportion of 80%:20% caused 56.4% mortality of adult bruchids.

The result of this study shows that the application of *Piper guineense* seed powder only and then the mixture of *Zingiber officinale* rhizome and *Piper guineense* seed powders increased adult mortality of *C. maculatus*. The *Piper guineense* seed powder performed best in the control of *C. maculatus*, hence could serve as bioinsecticides for the storage of cowpea grains. Further research should be conducted so as to know the longevity of the potency of these plant materials in suppressing oviposition and in causing mortality of the *C. maculatus*. Therefore, further researches are needed to determine the efficacy of the mixed powders of *Piper guineense* seed and *Zingiber officinale* rhizome using higher concentrations and on a wide range of other common insect pests of stored products.

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