Mixed Application of Peel and Leaf Powders of Two Common Fruits as Wheat Grain Protectant against *Sitophilus oryzae* (L.) (Coleoptera: Curculionidae)

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Abstract

Powders of guava (*P. guajava*) leaf and orange (*C. sinensis*) peel were tested for their insecticidal actions against adult rice weevil, *Sitophilus oryzae*, (Coleoptera: Curculionidae) under ambient laboratory conditions (27±2°C and 75±2 % R.H). 10g of the experimental powders in the proportions of Pg100 %, Cs100 %, Cs20 %: Pg80 %, Cs80 %: Pg20 % and Cs50 %: Pg50 % was admixed separately into 20 g of wheat grains. Mortality of adult *S. oryzae* at 24, 48, 72, 96 and 120hrs of post infestation were recorded and compared with the control. The powder application at Cs100 % caused the highest mortality during the period of exposure. It also was significantly different (P<0.05) from the control. The use of *P. guajava* leaf and *C. sinensis* peel powder mixture in any proportion does not significantly increase the mortality of adult *S. oryzae* in treated wheat grains (P<0.05). The consistent use of orange peel in pest management is recommended as it will help reduce heaps of waste capable of polluting the environment.

Keywords: Mixed, *Citrus sinensis*, *Psidium guajava*, Wheat, *Sitophilus oryzae*

INTRODUCTION

Globally, wheat is the leading source of vegetable protein in human food, having a higher protein content than other major cereals, maize or rice (USDA, 2014). In terms of total production tonnages used for food, it is currently second to rice as the main human food crop and ahead of maize, after allowing for maize’s more extensive use in animal feeds. The grain is eaten as a snack and during social gatherings as ‘nifro’ (boiled whole grain often mixed with pulses), ‘kollo’ (roasted grain) and ‘dabo-kollo’ (ground and seasoned dough, shaped and deep fried) (Oyekanmi, 2014). It is the most important stable food crop for more than one third of the world population and contributes more calories and proteins to the world diet than any other cereal crops (Adams, 2002; Shewry, 2009). Wheat is considered good source of protein, minerals, B-group vitamins and dietary fiber i.e. an excellent health-building food. Thus, it has become the principal cereal, being more widely used for the making of bread than any other cereal because of the quality and quantity of its characteristic protein called gluten. Gluten makes bread dough stick together and gives it the ability to retain gas. It has several medicinal virtues; starch and gluten in wheat provide heat and energy; the inner bran coats, phosphates and other mineral salts; the outer bran, the much-needed roughage the indigestible portion that helps easy movement of bowels; the germ, vitamins B and E; and protein of wheat helps build and repair muscular tissue (Kumar et al., 2011). However, these highly nutritional cereal crops are susceptible to storage pests which cause substantial qualitative and quantitative losses of various magnitudes depending on the pest species and duration of storage (Macharia et al., 2006). Post harvest losses by stored insect pests are 9% in developed countries and 20% or more in developing countries (Phillips and Throne, 2010). The most economically important insect pests of stored wheat grains includes but not
limited to *S. granarius*, *S. zeamais*, and *S. oryzae* (Ileke and Oni, 2011). *S. oryzae* is an important pest of stored cereals and processed cereal products in tropical and warm temperate regions of the world (Dal Bello *et al.*, 2001; Rees, 2004). It has been universally regarded as one of the most destructive primary pests of stored cereals such as barley, maize, rice, and wheat (Atwal and Dhaliwal, 2002). Damage of these grains by weevils occurs in form of emergence holes, weight loss, consequently loss of economic value (Baidoo *et al.*, 2010). *S. oryzae* are prolific breeders and can build up huge populations in stored grain to the point where the grain has little value as a food product (Koehler, 2012). The storage pest of wheat grains is normally managed by the application of DDT which, however, remains in the wheat grain, even after cleaning, and affects human health (Mishra and Nigam, 2011). The use of synthetic insecticides for controlling stored product insects is associated with problems such as their persistent toxicity in grains, development of resistance in insect populations and effects on non-target organisms (Iram *et al.*, 2013). For these reasons, there is a steady increase in the use of plant products as an easier and safer means of protecting small scale stored products against insect infestation (Musa and Adewale, 2014). Mixing of different plant materials with grains for the protection of insect pests constitutes one of the age old and indigenous practices adopted by the farmers, particularly in developing and underdeveloped countries (Yadu *et al.*, 2000). In Nigeria, there is paucity of information about the insecticidal effects of mixed application of powders of these common fruits, *C. sinensis* and *P. guajava* against adult *S. oryzae* in stored wheat grains.

**MATERIALS AND METHODS**

**Experimental Site**

This research was carried out in the Department of Botany laboratory of Nnamdi Azikiwe University, Awka. Awka is located between latitude 5˚ and 6˚25΄ and longitude 7˚E and 8˚E. It lies at an altitude approximately between 46m - 48m above sea level (Obiakor, 2010).

**Insect culture**

The adult *S. oryzae* used for the experiment were cultured in a plastic container under ambient laboratory temperature of 27±2°C and 75±2 %. The infested wheat grains were purchased from Eke-Awka market, Awka, Anambra State. The infested wheat grains were left in the culture vial (19cm in diameter) and kept in the laboratory cupboard so that the old insects will mate and oviposit. This was left undisturbed till the emergence of adults. The newly emerged adults were used for the experiment.

**Collection and preparation of plant materials**

The matured fresh leaves of *Psidium guajava* were collected from a farm at Ogwa in Mbaiteoli Local Government Area in Imo State while the orange peels were obtained from orange sellers in Ifite market, Awka, Anambra State. The plant materials were air dried for seven days. The dried leaves were ground separately into powder and sieved to obtain fine powders. The plant powders were put in air tight containers separately to ensure that the active ingredients are not lost. The powders were stored in a cool dried place until when needed.

**Experimental Protocol**

The wheat grains were heated in the oven at 60°C for 2 hours to ward off any stage of insect infestation. 20g of wheat grains were measured separately into each of the white transparent plastic containers measuring 12cm in diameter with perforated lids to allow ventilation and prevent entry or escape of insects. 10g of the experimental leaf powders in the proportions of Pg100 %, Cs100 %, Cs20 %:Pg80 %, Cs80 %:Pg20 % and Cs50 %:Pg50 % was added separately into the containers holding 20g of wheat grains and shake vigorously to admix thoroughly. 20g of wheat grains not treated with the plant materials were also measured into the same type of container and used as control. The treatments were replicated thrice. Ten newly emerged adult *S. oryzae* unsexed were introduced into each of the experimental containers including the control. The experimental set-ups were kept in the laboratory cupboards. The time for the infestation was noted and recorded properly. All Treatments were arranged in Completely Randomized Design (C.R.D).
Table 1. Mean Mortality of S. oryzae in Treated Wheat Grains at 120hrs of Post Infestation

<table>
<thead>
<tr>
<th>Powder Application</th>
<th>Mean Mortality of S. oryzae ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pg100 %</td>
<td>0.07±0.258</td>
</tr>
<tr>
<td>Cs100 %</td>
<td>0.60±0.737</td>
</tr>
<tr>
<td>Cs80 %:Pg20 %</td>
<td>0.07±0.258</td>
</tr>
<tr>
<td>Cs20 %:Pg80 %</td>
<td>0.33±0.488</td>
</tr>
<tr>
<td>Cs50 %:Pg50 %</td>
<td>0.27±0.594</td>
</tr>
<tr>
<td>Control</td>
<td>0.13±0.516</td>
</tr>
</tbody>
</table>

Data Collection and Statistical Analysis

Data were collected and recorded from mortality count of adult S. oryzae in wheat grains at 24, 48, 72, 96 and 120hrs. The data collected were used to determine the most efficient proportions of the powders. Data were subjected to analysis of variance (ANOVA) using SPSS Computer Software Package (version 20) at 0.05 significant levels. Means were separated using Least Significant Difference at P=0.05 level of significance.

RESULTS

The result shown in Table 1 indicates that the mean mortality of adult S. oryzae (0.60±0.737) is higher in the wheat grains treated with C. sinensis peel powder than those of P. guajava leaf powder (0.07±0.258). However the mean mortality of adult S. oryzae (0.60±0.737) in the wheat grains treated with the peel powder of C. sinensis was higher than those of the control (0.13±0.516). Analysis of Variance (ANOVA) for the mean mortality of adult S. oryzae on wheat grains treated with the two powders used in the experiment and the control revealed that there was significant difference (P<0.05). There was significant difference between the mortality of caused by C. sinensis peel powder application when compared with the control (P<0.05). Also, there was significant difference between the mortality caused by the powders of C. sinensis peel and P. guajava leaf (P<0.05). There was no significant difference between P. guajava leaf powder and the control (P>0.05).

Table 1 also indicates that the mean mortality of adult S. oryzae is slightly higher in wheat grains treated with powder mixture of Cs20 %:Pg80 % (0.33±0.488) followed by Cs50 %:Pg50 % (0.27±0.594) and the control (0.13±0.516). However it is lowest in treatment with Cs80 %:Pg20 % mixture (0.07±0.258). Analysis of Variance (ANOVA) result indicates that there was no significant difference in the mortality recorded between the various powder mixtures (P>0.05). This result reveals that the use of P. guajava and C. sinensis powder mixture in any proportion does not significantly increase the mortality of adult S. oryzae in treated wheat grains.

DISCUSSION

Plant natural products that constitute effective safer alternatives to synthetic insecticides without producing adverse effects on the ecosystem have been tested in the management of stored-product pests (Isman, 2006; Ukeh et al., 2009; Mao and Henderson, 2010). In this study, we evaluated the insecticidal properties of mixed application C. sinensis and P. guajava against adult S. oryzae in stored wheat grains, under laboratory conditions. The result of the recent study showed that powders of Citrus sinensis peel and Psidium guajava leaf when mixed separately with stored wheat grains as bioinsecticides caused mortality of adult S. oryzae compared to the control. This indicates that C. sinensis and P. guajava possess insecticidal property. This is in line with previous reports. Researchers have reported that Citrus sinensis has insecticidal properties (Ezeonu et al., 2001) as well as P. guajava (Orwa et al., 2009). Comparison between the mortality caused by the two plant powders revealed that Citrus sinensis peel powder caused significantly higher mortality of adult S. oryzae than Psidium guajava leaf powder. This is in contrast to the results of Akhtar et al., (2013) who evaluated the repellent effect of the ethanol extract of Psidium guajava, Citrus reticulata, Citrus limon, Citrus sinensis and Azadirachta indica against S. oryzae and reported that P. guajava had the strongest repellent effects against S. oryzae. This strongest efficacy of C. sinensis might be attributed to presence of some secondary metabolites. Orange peels contain secondary metabolites that show insecticidal activity against several coleopteran and dipteran (Belmain and Stevenson, 2001; Salvatore et al., 2004; Shrivastava et al., 2010). The use of these plants is acceptable to
farms because of general safety and ease of handling. Heaps of orange peels are sources of environmental pollution (Emeasor and Okorie, 2008) and converting them for use in crop protection would reduce pollution (Musa and Adewale, 2014). Moreo, the implication of the result obtained from the mixed application of orange and guava is that the powder mixture of C. sinensis and P. guajava in any proportion was not very effective in the control of adult S. oryzae in rice grains. Similar reports was given by Akunne et al., (2013) who stated that the use of V. amygdalina and A. indica leaf powder mixtures in any proportion does not significantly increase the mortality in adult C. maculatus.

The study shows that orange peel powder was most effective in suppressing weevil population. The insecticidal action of orange peel and guava leaf powder when mixed was not very effective in the control of insect pest of stored wheat grains (S. oryzae). The consistent use of orange peel in pest management is recommended as it will help reduce heaps of waste capable of polluting the environment. The orange plant is very common and highly relished in Nigeria, therefore making its peel readily available for the control of insect pests of stored grains.

References


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