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Lethal effects of *Anarcadium occidentale* (L.), *Carica papaya* (L.) and *Azadirachta indica* (A. Juss) leaf powders on *Sitophilus oryzae* (L.) in rice grains

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Abstract
Bioinsecticides prepared from three plant species, *Anarcadium occidentale* (cashew), *Carica papaya* (pawpaw) and *Azadirachta indica* (neem) were used against adult rice weevil, *Sitophilus oryzae* on rice grains respectively. The leaf powders were applied separately on rice grains in the concentrations of 0 g (Control), 5 g, and 10 g respectively. They were evaluated under ambient laboratory conditions Mortality of adult *S. oryzae* were taken daily for a period of 21 days and compared with the control. All concentrations recorded higher mortality than the control. The leaf powders of *A. indica* and *A. occidentale* caused the highest mortality at 10g concentration in treated rice grains. The analysis of variance result showed that there was significant difference between mortality caused by *A. indica* and the control ($P<0.05$).

Keywords: Lethal, *Azadirachta indica*, *Anarcadium occidentale*, *Carica papaya,* Rice.

1. Introduction
The rice weevil known as *Sitophilus oryzae* is a serious pest of stored rice in Africa [1] and other stored grains of warm climatic areas. They cause damage to grains which are stored at 25-30 °C and at low relative humidity as these conditions favour the development of this pest [2]. The economic importance and wide distribution of *Sitophilus* species have prompted many researchers to go into studies on various aspects of the weevils [3, 4].
Synthetic pesticides are effective and reliable; their use can prevent loss of yield and reduce losses. They work quickly, which makes them suitable for use in emergency situations and frequently, they are the only remedy when crops are under immediate threat of infestation but there are ever increasing dangers from the dispersion of these chemical agents into the environment [5]. The abuse and misuse of these chemical pesticides in Nigeria have several repercussions including acute and chronic poisoning in man, sudden deaths, blindness, skin irritation [6] and pest resurgence in the ecosystem [7, 8].
However, natural methods of plant protection are assuming new importance as an alternative to commercial synthetic products, which are expensive, unavailable at critical periods and may pose health hazards to man and livestock [9]. Many plants possess activities against stored grain pests [10, 11, 12] including the plant powders of cashew [13, 14] neem and pawpaw [15]. According to [16], these plant materials are not only used as insecticides but also as insect repellents and insect antifeedants. There is therefore an urgent need to search for more of these safe and effective biodegradable pesticides with non-toxic effects on non-target organisms [17]. The major aim of this work is to determine the efficacy of leaf powders of *Azadirachta indica*, *Anarcadium occidentale* and *Carica papaya* against adult *S. oryzae* in rice grains.

2. Materials and Methods
2.1 Experimental Site
This research lasted for a period of two months. It was carried out in the Department of Botany laboratory of Nnamdi Azikiwe University, Awka. Awka is the capital of Anambra State with an estimated population of 301,657 inhabitants as of 2006 Nigeria census. Awka lies within coordinates 6°12_N and 7°04_E in the tropical zone of Nigeria [18].

2.2 Sources and Preparation of Plant Materials
The matured fresh leaves of *Azadirachta indica* and *Anarcadium occidentale* were obtained beside the Multi-purpose hall in Nnamdi Azikiwe University, Awka while *Carica papaya* from a farm at Ifite, Awka, Anambra State. The three plant leaves were air-dried for 8 days. The dried leaves were ground into powder using electric blender (Binatone model) 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 dry place until when needed.

2.3 Culture of the experimental insect
The adult *S. oryzae* used for the experiment were cultured in separate plastic containers under ambient laboratory temperature of 27±2 ˚C and 75±2% relative humidity. The infested rice grains were purchased from Eke Awka market Awka, Anambra State. The infested rice grains were left in the culture vial (19 cm 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.

2.4 Experimental set up
The infested rice grains were oven-dried at 100 ºC for 1 hour to remove any possible stages of insects' infestation while dead insects were discarded. 20 g of treated rice grains were measured into each of the white transparent plastic containers with perforated lids to allow ventilation. 5 g and 10 g concentrations of the experimental leaf powders were added separately into the containers holding 20 g of rice grains and shook vigorously to admix thoroughly. 20 g of rice grains not treated with the plant materials were also measured into the same type of container and used as control. Each of the treatments was replicated three times.
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).

2.5 Data Collection and Statistical Analysis
Data were collected and recorded from mortality count of adult *S. oryzae* in the rice grains respectively on daily basis for 21 days. The data collected were used to determine the most efficient concentrations of the powders. Dead weevils were removed and discarded after every count. Data generated on mortality of the weevils due to efficacy of leaf powders were subjected to analysis of variance (ANOVA) using SPSS computer Software package (version 20) at 0.05 significant levels and Duncan's multiple range tests were used to compare the means of the treatments.

3. Results
Table 1 shows the mean mortality of *S. oryzae* in rice grains treated with three leaf powders *A. indica, A. occidentale* and *C. papaya*. 5 g concentration of leaf powder of *A. indica* and *C. papaya* showed high mean mortality of adult *S. oryzae* (7.67±1.528 and 7.67±0.577) respectively while the control recorded the lowest mean mortality (3.33±0.577). The table 1 also shows that 10g concentration of leaf powder *A. indica* had the highest mean mortality of adult *S. oryzae* (8.33±1.528) followed by *A. occidentale* (6.67±0.577) and control (3.33±0.577).
However, the analysis of variance of the mean mortality of *S. oryzae* in treated rice grains showed that there was significant difference among various treatments ($P< 0.05$). The Duncan's multiple range test results showed that there was significant difference between *A. indica* and the control; *A. indica* and *A. occidentale* but no significant difference was found to exist between *A. indica* and *C. papaya*.

Table 1: Mean Mortality ± SD of Adult *S. oryzae* in Rice Grains Treated with Three Leaf Powders at Two Concentrations.

Concentrations	Mean Mortality ± SD of *S. oryzae* Treated with Leaf Powders		
	A. indica	***A. occidentale***	***C. papaya***
5 g	7.67±1.528	6.00±1.000	7.67±0.577
10 g	8.33±1.528	6.67±0.577	6.33±1.528
Control	3.33±0.577	3.33±0.577	3.33±0.577

4. Discussion
The results of the present investigation showed that the mortality of *S. oryzae* in rice grains admixed with the 5 g and 10 g leaf powders of *A. indica, A. occidentale* and *C. papaya* (Table 1) as pest control biological agents were higher than those of the control. This implies that the leaf powders possessed insecticidal properties. This supports previous findings of Mohapatra GK, Oparaeke AM, Nyamandi P [10, 13, 15] who reported these plants as biopesticides for stored food protection. Prasantha R [20], reported that the smoke generated by heating *A. indica* leaves caused cent per cent mortality of *S. oryzae* after 48 hours of the treatment. Akhtar M [21] suggested that all tested plants including *A. indica* could be incorporated in IPM programs for the effective control of *S. oryzae*.
Furthermore, the best protection given to rice grains by *A. indica* leaf powder at 5 g and 10 g concentrations supports previous studies. Similar reports on the effect of concentration has been given by Akunne CE [22] who stated that the powder application at Az100% (5 g) proportion caused the highest mortality of *C. maculatus*, during the exposure period and was also significantly ($P<0.05$) different from the control in adult mortality.
The leaf powders of neem, cashew and pawpaw caused mortality of *S. oryzae* in rice grains. This revealed that the tested plant materials has lethal effect on the insect pest of stored product especially rice and thus could serve as a protectant. These plants are safer than synthetic methods of protecting stored product as they possess medicinal values. They are cheap and affordable for all farmers and households. Neem leaf powders are recommended for use since they gave the highest mortality of *S. oryzae* when admixed in rice grains. However, when not available, pawpaw and cashew leaves could be used. Therefore, further research is needed in the use of neem, pawpaw and cashew leaves against the storage pests of other economic crops.

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