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INSECTICIDAL AND INSECT PRODUCTIVITY REDUCTION CAPACITIES OF *ALOE VERA* AND *BRYOPHYLLUM PINNATUM* ON *TRIBOLIUM CASTANEUM* (HERBST)

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ABSTRACT

Two important medicinal plants, *Aloe vera* and *Bryophyllum pinnatum* were admixed with maize grains (Popcorn) at dosages of 1g, 2g and 5g treatments per 50g of maize. Results showed that both lower and higher dosages had toxic effects on *Tribolium castaneum* but the best results were obtained in the grains treated with 5g dosages. Mortality (within 7 days) and percentage weight loss (within 30 day periods) in *Aloe vera* root ash 80.00±0.11% and 0.22±0.01%, *A. vera* leaf ash 50.01±0.01% and 0.23±0.01, *B. pinnatum* leaf ash 50.01±0.01% and 0.32±0.15%, *A. vera* root powder 30.02±0.01% and 0.46±0.04%, *B. pinnatum* leaf powder 60.01±0.01% and 0.52±0.01 while *A. vera* leaf powder gave 10.05±0.02% and 0.67±0.03% respectively. Within a period of 2 weeks all the beetles introduced into treated grains died without laying eggs. The insect production rate recorded for control was 23.33±0.23 while no value was observed in treated grains because the insects died before they could lay eggs.

Key words: *Tribolium castaneum, Bryophyllum pinnatum,* popcorn, Insect productivity, protectants.

INTRODUCTION

The cereals and grain legumes, which are generally referred to as grains are the most commonly stored durable food commodities in the tropics (Odeyemi and Daramola 2000). These food commodities provide the bulk of man's foodstuffs and are a major staple food in the tropics (Haines 1991). Various methods have been employed in storing these food commodities and they include, the open storage system, semi-open storage system and closed storage system (Anonymous 1982, Gwinner et. al. 1990). Despite adherence to all these methods of pest control, insects are found to be booming inside stored farm produce. This is presumably because of the optimal conditions of temperature and humidity, which favour their development in the tropics (De Lima 1987). However, unless the populations of insects are controlled, the total decimation of farm produce in storage is inevitable.

Other insect pests control methods that have been employed are the use of commercial pesticides (Hadler 1990), biological control (Sagnia 1994), use of oil, extracts and powders (Daniel 1991, Omotoso 2004) and the planting of hybrid varieties (Adeduntan and Ofuya 1998). The use of plant products in treating grains is also becoming popular among subsistence farmers in the tropics because the plants have a wide spectrum of action, safe to apply, have no harmful effects on the people and they are very easy to process (Talukder and Howse 1995).

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Some aromatic medicinal plants have been tested for their insecticidal activities on insects and some of them were reported to have actually restricted pest infestation of maize (Omotoso 2004). *Bryophyllum pinnatum,* and *Aloe vera* are medicinal plants which are used to treat headache, typhoid, mild and chronic piles by the local herbalists (Omotoso 2004). However, these plants have not been tested for their insecticidal activities on *Tribolium castaneum*. Adults *T. castaneum* are 2-4mm in length, reddish-brown to dark brown in colour and they attack farm products such as cereals, cereal products, groundnuts, nuts, spices, coffee and cocoa (Odeyemi and Daramola 2000).

In this present work, powders, and ashes of these medicinal plants were admixed with maize at various dosages (1g, 2g and 5g) to determine the mortality and insect productivity rate of *T. castaneum* as well as to find the percentage weight loss of grains.

MATERIALS AND METHODS

PLANT POWDERS/EXPERIMENTAL MAIZE

The selected medicinal plants and part used are given in table 1 below. The plant parts were taken from the wild (an uncultivated plot) along Federal Polytechnic, Ado-Ekiti, Ekiti State, Nigeria. The identities, of these plants were confirmed at the Department of Plants Science and Forestry herbarium, University of Ado-Ekiti, Nigeria. The plants were dried naturally outside the laboratory until they were crisp dry. Powders were prepared by grinding each of the plant parts separately in a sterilized laboratory electric grinder and then passed through a mesh size of 0.25mm. Some of the dried plant parts were burnt separately inside fume cupboard in the laboratory. The residues were later transferred into a furnace, which was maintained at 550°C for 4 hours. The powders and the ashes were used as direct admixtures to treat maize grain (Popcorn) separately before infestation. The powders and the ashes were mixed separately with maize inside rearing boxes at 3 different dosages of 1g, 2g and 5g of plant powder per 50g of maize grain. The maize grains (Popcorn) used for the work were disinfested by oven drying at 40° C for 4h (Santhoy and Rejesus 1975).

TABLE 1: MEDICINAL PLANTS AND THE PARTS USED

Plant spp.	Family	Parts used.
Bryophyllum pinnatum	Crassulaceae	Leaves
Aloe vera	Liliaceae	Leaves and Roots

INSECT CULTURE

Tribolium castaneum used to establish the culture were obtained from naturally infested maize grain bought from Oba's market, Ado-Ekiti, Nigeria. The weevils were reared on uninfested maize under fluctuating ambient temperature (25-30°C) and relative humidity (60-65%) in the laboratory inside rearing boxes (10x12x8cm). The methods reported by Santhoy and Rejesus (1975) was employed in disinfesting maize grains in the laboratory by oven drying at 40°C for 44h.

TOXICITY ASSAYS

The method reported by Omotoso (2004) was adopted in determining the toxicity of the medicinal plants to *Tribolium castaneum*. The pulverized plant powders and ashes were dry-mixed separately inside rearing boxes with maize at 3 different dosages of 1g, 2g and 5g plant powder per 50g of maize. Each of the boxes was tumbled for 15minutes to ensure homogeneous mixing. Five copulating pairs of *Tribolium castaneum* were introduced into each of the boxes and covered with nylon mesh. The nylon mesh was held in place with rubber bands. In the control experiment, 5 copulating pairs of *Tribolium castaneum* were introduced into a box containing 50g of untreated maize. The box was covered with nylon mesh and the mesh was held in place with rubber bands. Each of the experiments was performed in triplicates. The experiments were monitored for 30 days. Data were collected on insect mortality in each of the boxes. The content of each of the boxes was poured in a dish and dead insects (i.e. those that did not respond to pen probes) were sorted out of the powdered materials and counted. Percentage insect mortality was calculated by using the formula:

$$\% \text{ mortality} = \frac{\text{No of dead insects}}{\text{Total no of insects}} \times 100$$

INSECT PRODUCTIVITY TEST AND % WEIGHT LOSS TEST

A modified procedure of Odeyemi and Daramola (2000) was adopted in determining the insect productivity and the percentage weight loss of grains. Fifty grams of maize was weighed and treated with 1g of the plant powder and put in rearing boxes. Then 5 copulating pairs of *Tribolium castaneum* were introduced and the box was covered with a mesh, which was held in place with rubber bands. The set up was monitored for 30 days. On the thirtieth day, the content of the box was poured on a plane sheet and maize grains were separated from the plant powder. Insects were also separated from the plant powder and counted. The same method was used for each of the plant powders and ashes for dosages 2g and 5g. In the control trial, 50g of untreated maize were weighed into a box and 5 copulating pairs of *Tribolium castaneum* were introduced and the box was covered with mesh. The mesh was held in place with rubber bands. All experiments occurred in triplicates. The insect productivity and the growth reduction rates were calculated using the formulae:

$$\% \text{ Insect productivity} = \frac{\text{Total number of emerged adults}}{\text{30 adult days}} \times 100$$

$$\% \text{ weight loss} = \frac{\text{Initial weight of maize - Final weight of maize}}{\text{Initial weight of maize}} \times 100$$

RESULTS AND DISCUSSION

The effects of various plant treatments on mortality of *T. castaneum* at different dosages and periods are presented in Table 2. The results revealed that *A. vera* root ash was the most toxic powder to *T.*

castaneum as 80.00±0.11% of them died within 7 days at 5g dosage treatment. This is because ashes adhere strictly to the grains than plant powders, which settled at the base of the rearing boxes. Lower dosages of 1g and 2g caused the death of 50.00±0.03% and 60.01±0.11% of the insects respectively. All the remaining insects in the boxes died within 2 weeks after application. *A. vera* root powder caused the death of 20.00±0.02%, 30.00±0.02% and 30.02±0.01% of insects at 1g, 2g and 5g dosages within 7 days. All the rest of the insects died within 2 weeks. *B. pinnatum* leaf ash caused the death of 40.02±0.15%, 50.02±0.03% and 50.01±0.01% of the insects at 1g, 2g and 5g dosages respectively within 7 days. The rest of the insects died within 2 weeks. *B. pinnatum* leaf powder caused the death of 10.03±0.01%, 50.03±0.01% and 60.01±0.01% of the insects at dosages of 1g, 2g and 5g respectively within 7 days. These results revealed that at 2g and 5g treatments, *B. pinnatum* is highly toxic to *T. castaneum* and so are good produce protectants. *A. vera* leaf ash performed better than *A. vera* leaf powder at various treatments. At 5g treatments, *A. vera* leaf ash caused the death of 50.01±0.04% of the insects while 30.01±0.02% and 20.01±0.11% were killed at 2g and 1g treatments. The effect of *A. vera* leaf powder was negligible as it caused the death of only 10.05±0.02% of the insects at the highest dosage of 5g. This result is similar with what Omotoso (2004) reported in *Sitophilus zeamais* (10%). One gramme and 2g dosages had no effect on the insects within 7 days. In both powder and ashes, all the insects were decimated within 2 weeks. In the control trial, none of the insects died.

TABLE 2: % MORTALITY OF *T. CASTANEUM* IN TREATED MAIZE GRAINS (7-14 DAYS)

Plants	Dose (g) % mortality	7 days	14 days
Control	-	-	-
A. vera leaf powder	1	-	100.00±0.01
A. vera leaf ash	1	20.01±0.11	80.02±0.10
A. vera root powder	1	20.00±0.02	80.00±0.01
A. vera root ash	1	50.00±0.03	50.00±0.01
B. pinnatum leaf powder	1	10.03±0.01	90.01±0.05
B. pinnatum leaf ash	1	40.02±0.15	60.05±0.12
A. vera leaf powder	2	-	100.00±0.12
A. vera leaf ash	2	30.01±0.02	70.00±0.01
A. vera root powder	2	30.00±0.02	70.00±0.12
A. vera root ash	2	60.01±0.11	40.00±0.12
B. pinnatum leaf powder	2	50.00±0.02	50.02±0.14
B. pinnatum leaf ash	2	50.02±0.03	50.00±0.20
A. vera leaf powder	5	10.05±0.02	90.03±0.02
A. vera leaf ash	5	50.01±0.04	50.03±0.01
A. vera root powder	5	30.02±0.01	70.02±0.03
A. vera root ash	5	80.00±0.11	20.01±0.02
B. pinnatum leaf powder	5	60.01±0.01	40.00±0.03
B.pinnatum leaf ash	5	50.01±0.01	50.02±0.11

Each value is a mean of three replicates ± standard deviation of the mean.

Table 3 revealed the results of percentage insect productivity in treated maize. In all treated maize, insects mating were observed but all the insects died before they could lay eggs (i.e. died within 2 weeks) because of the toxicity of the plant materials. Thus, the percentage insect productivity was zero in each of the treated grains. In the control trial, the percentage insect productivity rate was 23.33±1.10%. Haines (1991) reported that *T. castaneum* is capable of multiplying 70 times within a lunar month, a record higher than that recorded for any other stored product beetle. The zero value recorded for insect productivity rate in treated maize could have been that the plant materials made it impossible for the female beetles to lay eggs, that the plants have ovicidal properties against the beetles eggs or it could have been due to cannibalism of the eggs by the adult beetles since cannibalism and predation play an important role in the nutrition of *T. castaneum* (Delobel and Malonga 1987, Ofuya 1990).

TABLE 3: % INSECT PRODUCTIVITY OF *T. castaneum* ON TREATED MAIZE GRAINS (30 DAYS)

Plants	Dose (g)	% product.
Control	-	23.33±0.23
A. vera leaf powder	1	0
A. vera leaf ash	1	0
A. vera root powder	1	0
A. vera root ash	1	0
B. pinnatum leaf powder	1	0
B. pinnatum leaf ash	1	0
A. vera leaf powder	2	0
A. vera leaf ash	2	0
A. vera root powder	2	0
A. vera root ash	2	0
B. pinnatum leaf powder	2	0
B. pinnatum leaf ash	2	0
A. vera leaf powder	5	0
A. vera leaf ash	5	0
A. vera root powder	5	0
A. vera root ash	5	0
B. pinnatum leaf powder	5	0
B.pinnatum leaf ash	5	0

Each value is a mean of three replicates ± standard deviation of the mean.

Table 4 revealed the results of the percentage weight loss of grains. At 1g dosage, the highest grain loss was recorded by the maize treated with *A. vera* leaf powder (0.84±0.04%) while the best result was given by *A. vera* root ash (0.22±0.01%). From the results in table 4, all the plants are good grain protectants against *T. castaneum.* The weight loss recorded for the control trial was 3.71±1.01%. From these results, it is evident that *T. castaneum* is not a serious pest of maize grains. This confirmed the findings of Adedire (2001) that *T. confusum, T. castaneum* and *Oryzaephilus surinamensis* are secondary pests of cereal grains, which needed initial damage by primary pests before they could attack grains.

TABLE 4: % WEIGHT LOSS OF MAIZE TREATED WITH PLANT MATERIALS

Plants	Dose (g)	% wt. loss
Control	-	3.71±1.01
A. vera leaf powder	1	0.84±0.04
A. vera leaf ash	1	0.56±0.03
A. vera root powder	1	0.80±0.22
A. vera root ash	1	0.37±0.07
B. pinnatum leaf powder	1	0.65±0.01
B. pinnatum leaf ash	1	0.43±0.10
A. vera leaf powder	2	0.70±0.07
A. vera leaf ash	2	0.43±1.04
A. vera root powder	2	0.60±0.13
A. vera root ash	2	0.35±0.04
B. pinnatum leaf powder	2	0.43±0.03
B. pinnatum leaf ash	2	0.40±0.11
A. vera leaf powder	5	0.67±0.03
A. vera leaf ash	5	0.23±0.01
A. vera root powder	5	0.46±0.04
A. vera root ash	5	0.22±0.01
B. pinnatum leaf powder	5	0.52±0.01
B.pinnatum leaf ash	5	0.32±0.15

Each value is a mean of three replicates ± standard deviation of the mean.

The use of plant products in the control of stored insect pests of farm produce is very significant especially in cereals. Some powders made from fruits, seeds, flowers, leaves, shoot, bark and roots of local medicinal/insecticidal plants have been demonstrated to be effective in protecting stored cereals and legumes against pest depredation (Raja et.al. 1998, Ashamo and Odeyemi 2001). The mode of action of medicinal/insecticidal plants include: toxicity to adults, reduction of oviposition, ovicidal activity, toxicity to immature stages prior or immediately following penetration of plant tissue (Lale 1995). Mixing farm produce with inert dusts made from clays, diatomite, wood ash, silicates and sand have been traditionally used and empirically verified to reduce insect populations in storage (Ofuya 1986, Wolfson et.al. 1991, Chinwada and Giga 1997).

Appreciable levels of control of damage to grains by the tested insect species were achieved with the plant products especially the plant ashes and powders. The chemical composition of the plants used is currently under way to determine the specific compounds actually responsible for the observed biological activities in them.

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