USE OF *ANCHOMANES DIFFORMIS* (P. BEAUV.) POWDER AS GRAIN PROTECTANT AGAINST FIVESTORAGE BEETLES

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Abstract

Toxicity effect of *Anchomanes difformis* (P.) powder on mortality of *Sitophilus zeamais, Tribolium castaneum, Oryzaephilus mercator, Callosobruchus maculatus* and *Lasioderma serricorne* was tested in the laboratory at ambient temperatures of 26 to 32°C and 65 to 75% relative humidity. Five treatment levels of 0.1, 0.2, 0.3, 0.4, 0.5g of powder per 20g grains, which correspond to 0.5%, 1.0%, 1.5%, 2.0% and 2.5% g/g, were used. Percentage beetle mortality at 1, 2, 3 and 4 days post- treatment was calculated to assess the effectiveness of the plant powder. The plant powder was found to be toxic on all the test beetles at 0.5% treatment within one day of plant powder application except on *L. serricorne* where mortality was first recorded at 1.0% wt/wt. The results showed that the powder of *A. difformis* was effective against all the beetles. The highest mortality of 100% was recorded at 2.5% in *T. castaneum* and *C. maculatus* after 3 days and after 4 days in *C. maculates* and *T. castaneum*. Based on the LD_{50} and LD_{90} values at four days post treatment, *C. maculatus* was most susceptible to *A. difformis* powder while *L. serricorne* was most resistant. Thus, application of *A. difformis* plant powder at the rate of 2.5% w/w is recommended for the protection of grains against these beetles.

Keywords: *Anchomanes difformis, Sitophilus zeamais, Tribolium castaneum, Oryzaephilus mercator, Callosobruchus maculatus, Lasioderma serricorne*, biopesticides, LD_{50}, LD_{90}

1. Introduction

The use of plant materials for the protection of stored products is an old practice in developing countries because of the high rate of post-harvest losses and quality deterioration caused by storage pests (Sighamony *et al.*, 1986). This practice is very common among poor smallholder farmers in the tropics and subtropics (Golob and Webley, 1980; Delobel and Malonga, 1987). However, this practice was progressively abandoned with the advent of synthetic insecticides in the 1940s. However, the high cost of production, high mammalian toxicity, high level of persistence in the environment and workers safety presented problems for the wide use of synthetic insecticides for the protection of stored products. (Sighamony *et al.*, 1986). These problems necessitated the need for alternative insect pest control methods. The use of biopesticides and plant products, which are believed to be relatively safe and biodegradable, is one of such methods being explored. In the tropics, plant materials such as dried pepper and its inert dust have been in use as powders and admixtures for a long time. These have been found to reduce post-harvest losses of stored grains and grain legumes (Delobel and Malonga, 1987). In the light of this, a comprehensive review of the use of plant products for the control of insect pests of stored cereal grains had been undertaken by Boeke *et al.* (2001). This showed the increasing significance of biopesticides. The current study was therefore undertaken to evaluate the potential of *Anchomanes difformis* powder as a biopesticide

Anchomanes difformis (family: Araceae) is a large herbaceous plant with stout prickly stem, which grows up to 3m in height and has large divided leaves (Burkill, 1985). It grows in the wild forest of West Africa. Farmers in Southern Nigeria also grow it for various uses. Morton (1961) reported that young *A. difformis* rhizome is eaten after prolonged washing and cooking. The rhizome is also used for making rubefacients and vesicants for external application and for internal medication respectively (Burkill, 1985). The plant is considered to be a powerful purgative in Cote d'Ivoire and it is also used to treat oedema as well as a (snake/ scorpion) poison antidote. Any of the plant parts: root, stem or leaves is used to treat urethra discharge, jaundice and kidney pains. *Anchomanes difformis* contains strong alkaloids (Adegoke *et al.*, 1968), which have been used as medicine and poison by man for ages. Alkaloids are toxic chemical substances that act on the central nervous system.

This paper evaluates the lethal effect of the extracts of the rhizome of *A. difformis* in powdered form on the adults of *Sitophilus zeamais* (Motschulsky), the maize weevil; *Tribolium castaneum* (Herbst), the rust-red flour beetle; *Oryzaephilus mercator*

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(Fauvel), the saw-tooth grain beetle; *Callosobruchus maculatus* (Fabricius), the cowpea weevil and *Lasioderma serricorne* (Fabricius), the cigarette beetle.

2. Materials and Methods

Adults of *S. zeamais, T. castaneum, O. mercator* and *C. maculatus* used for this study were obtained from infested maize or cowpea grains in 'Oba' market in Akure, Nigeria while *L. serricorne* adults were obtained from The International Institute for Tropical Agriculture (IITA), Ibadan, Nigeria. From these stocks, new generations were raised on specified grains in Kilner jars covered with muslin cloth at ambient temperatures of 26 to 32 °C and 65 to 75 % relative humidity.

Anchomanes difformis used for the experiments were collected from farmlands in and around Federal University of Technology Akure. The rhizome part of *A.difformis* used was first dried naturally on laboratory benches and then pulverized in a Kenwood blender and stored in airtight containers. The maize grains and cowpea seeds used were disinfected in a deep-freezer (-32 °C) for 72 h and later air-dried for 2 to 3 hours in the laboratory in order to prevent mouldiness. Samples of *S. zeamais, T. castaneum, O. mercator, C. maculatus* and *L. serricorne* used in this study were obtained from established laboratory cultures of the insects. Five concentrations namely, 0.1, 0.2, 0.3, 0.4 and 0.5 g powder corresponding to 0.5, 1.0, 1.5, 2.0 and 2.5 % g/g respectively, were measured into Petri-dishes containing 20 g of uninfected grains and thoroughly mixed manually by agitating the dishes. A control containing no plant powder was also set up. Four replicates of each treatment were used. Ten pairs of adult beetles were introduced into each Petri-dish containing the grains which had been previously mixed with the plant powder except the control. The Petri dishes were then covered. Maize grits were used for *T.castaneum*; whole wheat for *O. mercator*; whole maize for *S. zeamais* while whole cowpea seeds were used for *C. maculatus* and *L. serricorne*. Mortality was recorded at 1, 2, 3 and 4 days post infestation. The data obtained were analysed using the two-way Analysis of Variance (ANOVA) and where there were significant differences, the means were separated using Tukey's Test at Pd"0.05. Dose-response was calculated by simple regression of mean percentage mortality against log of powder concentration (Finney, 1971). The doses at which 50 and 90 % mortalities were achieved (LD_{50} and LD_{90} respectively) were thereafter calculated.

3. Results and Discussion

Adult mortality of all the test beetles was high after treatment with *A. difformis* powder (Table 1). The mortality rates of all the storage beetles (*S. zeamais, T. castaneum, O. mercator, C. maculatus* and *L. serricorne*) increased with increase in the concentration of *A.difformis* powder and with exposure period. Mortality of 100 % was recorded within 3 days of exposure to 2.5 % concentration of A. difformis powder for *T. castaneum* and *C. maculatus* while mortalities of 88.75 %, 90.00 % and 81.25 % were recorded after 4 days for *O. mercator, S. zeamais and L. serricorne* respectively for the same treatment (Table 1). Overall susceptibility of the storage beetles to *A. difformis* powder was ranked in the following order: *L. serricorne* <*O. mercator*<*S. zeamais*<*T. castaneum*<*C. maculatus* respectively with *T. castaneum* and *C. maculatus* being most susceptible. Also the plant powder was found to be toxic on all the beetles at 0.5 % treatment within 1 day of plant powder application except in *L. serricorne* where mortality was first recorded at 1.0 % g/g.

A. difformis powder concentration (% g/g) which caused 50 % and 90 % mortalities in five storage beetle population one day post application showed that there were significant differences in the mortality among the pest population with *S. zeamais* (LD_{50} = 45.83; LD_{90} = 82.83 %) having the highest resistance (Table 2). Four other beetles namely *T.castaneum, C.maculatus, O.mercator* and *L. serricorne* have LD_{50} s that are greater than the test dose range, this suggests that *A. difformis* powder is not an effective control agent against these species if applied only for one day.

Results also showed that *T. castaneum* (with LD_{50} = 1.81; LD_{90} = 3.26 %) is the least susceptible to *A. difformis* at two DAT followed by *C. maculatus* LD_{50} = 1.92; LD_{90} = 3.45 % (Table 2). *L. serricorne* (LD_{50}4.06; LD_{90} = 7.30 %), *S. zeamais* (LD_{50} 4.03; LD_{90} = 7.25 %) and *O. mercator* (LD_{50} = 3.56; LD_{90} = 6.40 %) with LD_{50} higher than the test dose range are resistant to the plant powder 2 days after treatment.

The LD_{50} values of *A. difformis* powder at 3 DAT showed that all the test beetles were susceptible to the plant powder treatment with *T. castaneum* being the most susceptible insects followed by *C. maculatus.* The least susceptible of the beetles was *L. serricorne* (LD_{50} = 2.42; LD_{90} = 4.35 %).

Rhizome powder of *A. difformis* provided good protection against all the test beetles at four days post - treatment. *Tribolium castaneum* was the most susceptible of five cereal beetles tested and showed the least LD_{50} value while *L. serricorne* powder with the highest LD_{50} is the least susceptible to *A. difformis* (Table 2). Since mortality increased as the exposure period increases, it shows that the toxic volatile components of *A. difformis* have some level of persistence.

Similarly, Chiranjeevi and Sudhakar (1996) reported that in many villages in Africa, farmers often mix plant materials with stored grains against pest infestation. Whole plants or parts of plant rather than

Table 1. Insecticidal effect of *Anchomanes difformis* (P.) powder in adult storage beetles

Insects	Powder Conc. (%)	Percentage Mortality at days post treatment 1	2	3	4
Sitophilus zeamais	0.0	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}
	0.5	1.25±1.25^{a}	3.75±2.39^{a}	16.25±3.75^{b}	17.50±2.50^{b}
	1.0	0.00±0.00^{a}	8.75±1.25^{a}	17.50±1.44^{b}	28.75±2.39^{c}
	1.5	3.75±1.25^{a}	20.00±2.04^{b}	33.75±3.15^{c}	48.50±2.50^{d}
	2.0	1.25±1.25^{a}	21.25±3.15^{b}	46.25±2.39^{d}	61.25±1.25^{e}
	2.5	2.50±1.44^{a}	35.00±2.89^{c}	67.50±1.44^{e}	90.00±2.04^{f}
T. castaneum	0.0	0.0±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}
	0.5	1.25±1.25^{a}	7.50±1.44^{a}	11.25±1.25^{b}	20.00±2.09^{b}
	1.0	6.25±1.25^{a}	21.25±2.39^{b}	28.25±2.50^{c}	38.75±1.25^{c}
	1.5	17.50±1.44^{b}	32.50±2.50^{c}	41.25±4.73^{d}	61.25±2.39^{d}
	2.0	25.00±2.04^{c}	51.25±2.39^{d}	73.70±2.39^{e}	92.50±1.44^{e}
	2.5	38.75±2.39^{d}	81.25±2.39^{e}	100.00±0.0^{f}	100.00±0.0^{f}
C. maculatus	0.0	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}
	0.5	0.00±0.00^{a}	8.75±1.25^{a}	13.75±1.25^{b}	22.50±3.23^{b}
	1.0	5.00±2.04^{ab}	10.00±2.89^{a}	15.00±3.53^{b}	22.50±3.23^{b}
	1.5	0.00±1.44^{bc}	27.50±3.23^{b}	40.00±3.53^{c}	57.50±3.54^{c}
	2.0	16.25±1.25^{c}	43.75±3.14^{c}	67.50±3.23^{d}	88.75±2.39^{d}
	2.5	27.50±4.79^{d}	86.25±4.73^{d}	100.00±0.0^{e}	100.00±0.0^{e}
O. mercator	0.0	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}
	0.5	0.00±0.00^{a}	2.50±1.44^{a}	5.00±2.04^{a}	13.75±2.39^{b}
	1.0	2.50±1.44^{ab}	12.50±2.50^{b}	27.50±3.22^{b}	37.50±3.23^{c}
	1.5	8.75±2.39^{bc}	18.75±1.25^{b}	35.00±2.04^{b}	48.75±1.25^{d}
	2.0	11.25±3.14^{cd}	28.75±1.25^{c}	53.75±4.26^{c}	73.75±3.14^{e}
	2.5	16.25±1.25^{d}	37.50±3.23^{c}	65.00±2.24^{d}	88.75±2.39^{f}
L. serricorne	0.0	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}
	0.5	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}
	1.0	0.00±0.00^{a}	1.25±1.25^{a}	2.50±1.44^{a}	5.00±2.04^{a}
	1.5	8.75±1.25^{b}	17.50±1.44^{b}	25.00±4.08^{b}	36.25±2.39^{b}
	2.0	15.00±2.04^{c}	28.75±1.25^{c}	42.50±1.44^{c}	61.25±3.15^{c}
	2.5	15.00±2.04^{c}	33.75±1.25^{d}	63.75±2.39^{d}	81.25±2.39^{d}

Each value is the percentage mean ± standard error of four replicates. Mean followed by the same letter(s) are not significantly different at P? 0.05 using Tukey's mean separation Test.

Table 2. LD_{50} and LD_{90} of *A.difformis* rhizome powder on five coleopterous pests

	Days after treatment 1		2		3		4	
Insects	LD_{50}	LD_{90}	LD_{50}	LD_{90}	LD_{50}	LD_{90}	LD_{50}	LD_{90}
S.zeamais	45.83	82.83	4.03	7.25	2.03	3.66	1.50	2.70
T.castaneum	3.82	8.87	1.81	3.26	1.39	2.50	1.19	2.15
C.maculatus	5.67	10.21	1.92	3.45	1.47	2.65	1.26	2.26
O.mercator	8.73	15.71	3.56	6.40	1.95	3.51	1.41	2.54
L.serricorne	8.52	15.34	4.06	7.30	2.42	4.35	1.78	3.21

LD_{50} and LD_{90} measured in percentage g/g *A.difformis* powder

their powders are often used, presumably because they are easy to remove from the stored grains (Casewell, 1976; Delobel and Malonga, 1987).

This experiment shows that powders made from *A. difformis* significantly reduce the population of all the storage beetles used in this study. Though *A. difformis* powder showed no insecticidal activity at low concentration in some of the tests after one-day treatment, significant ($P<0.05$) mortality occurred 3 days after treatment in all the beetles. After 4 days, the 0.5 g powder /20 g grains resulted in 81.25 to 100 % adult mortality. The action of *A. difformis* on these beetles could be linked to contact toxicity of the plant to the beetles and stomach poisoning (Chander and Ahmed, 1985; Adedire and Lajide, 2000, 2001) while feeding on whole or fragmental grains, the beetles might pick up a lethal dose of the treatment thus resulting in stomach poisoning. Also the fine particles of *A. difformis* powder could block the spiracles of the beetles thereby impairing respiration and causing death. The result obtained from this study are in agreement with earlier reports (Ofuya, 1990; Niber, 1994; Lajide *et al.,* 1998; Adedire and Lajide, 2001) that powder of some tropical plants could be admixed with grains in storage in order to protect them from damage by storage beetles. Considering the ease of powder application by farmers, *A. difformis* rhizome powder could be admixed with maize grains or cowpea seeds in order to protect them against some of the most serious pests of stored products.

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