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EVALUATION OF SOME PLANT MATERIALS FOR THE CONTROL OF SMOKED FISH PEST, *Dermestes maculatus* DEGEER (COLEOPTERA: DERMESTIDAE) IN *Clarias gariepinus* BURCHELL (PISCES: CLARIIDAE)

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ABSTRACT

The efficacies of the powders of four plant materials, namely: *Dennettia tripetala* Baker, *Eugenia aromatica* Hook, *Monodora myristica* (Dunal) and *Piper guineense* (Schum and Thonn) at 2.5, 5.0, 7.5 and 10.0g/100g smoked *Clarias gariepinus* Burchell were evaluated for the control of dermestid beetle, *Dermestes maculatus*. Each of the four plant powders caused significantly high ($P<0.05$) mortality in both the adults and larvae of the fish beetle at all concentrations when compared to the control and was effective in inhibiting progeny development in treated fish. The four plant materials could play a major role in protecting one of the highly valuable commodities in the tropics and thereby prevent smoked fish losses, improve income generation and enhance socio-economic status of fish mongers.

Keywords: fish preservation, plant product, D*ermestes maculatus*, *Clarias gariepinus*.

INTRODUCTION

Fish is one of the cheapest animal protein sources and it is being used increasingly to correct protein deficiency in human diets in the tropics. According to Azam *et al.*, (2004) and Fasakin and Aberejo (2002) consumption of fish provides an important nutrient to a large number of people worldwide and thus makes a very significant contribution to nutrition. However, fish is highly susceptible to damage by insects and microorganisms as soon as it is caught. The African mud catfish, *Clarias gariepinus* (Burchell 1822) is the most popular, widely cultivated and mostly smoked fish in Nigeria (Aderolu and Akpabio, 2009). Losses in quality and quantity of smoked fish during storage have been attributed to *Dermestes maculatus* infestation. This pest accounts for about 71.5% of dried fish infestation recorded in most of the producing areas with a substantial loss in dry weights of about 43-62.7% from both larvae and adults (Osuji, 1974).

The realization of the serious limitations (for example health hazards, cost of purchase, development of highly resistant strains etc.) offered by the use of highly persistent chemicals, as fish protestants, had elicited interests on seeking alternative methods of controlling fish damage. One of such promising areas is in the use of plant-derived pest control agents. Many Nigerian medicinal plants and spices have been cited as pest control agents of stored agents of stored grains, legumes and smoked fish (Adedire and Lajide, 2000; Okonkwo and Okoye 2001; Fasakin and Aberejo 2002; Ofuya 2003).

The need to protect smoked fish from pests is imperative when the crucial role it plays in ensuring food security, income generation and employment opportunities are considered; hence the rationale for this study. In this study, the evaluation of the efficacy of four indigenous plant powders on the main pest of the one of the highly valuable smoked fish in Nigeria, *C. gariepinus,* are presented.

MATERIALS AND METHODS

Preparation of plant powders

Fresh and ripe fruits of four plant materials namely: *Dennettia tripetala* Baker, *Eugenia aromatica* Hook *Piper guineense* (Schum and Thonn) and *Monodora myristica* (Dunal) were purchased in local herbal stores at Erekesan Central market in Akure, Nigeria. Samples are either pepperish or have aromatic flavour or both and are used as food condiments or spice in human diets. Each of the plant materials was washed with clean tap water, dried in laboratory drying cabinet at 40^0C for 8hrs, ground thoroughly in an electric 1.5HP kitchen grinder and sieved through a 40 holes/mm^2 mesh screen. Each of the plant powders was kept in a separate plastic container with a tightly fitted lid and placed in a cooled incubator at 0^0C for use in the experiment.

Insect culture and fish collection

The initial source of culture was obtained from infested smoked *C. gariepinus* collected from a dried fish market in Akure, Nigeria. The cultures were maintained separately in Kilner jars covered with muslin cloth under laboratory conditions and kept at temperature $30+2^0$C and relative humidity 75+5%. All bioassay jars were disinfected using the standard procedure by heat treatment in a Gallenkamp drying cabinets at 70^0C for 1hr and allowed to cool at room temperature. New generations were prepared by removing adults of the insect species from a stock culture, placing them on fresh uninfected fish, then removing the parent adults after 2-3 weeks oviposition period. Water was supplied with pieces of soaked cotton wool. Samples of African mudfish *C. gariepinus* were obtained from a reputable dried fish

market in Akure, weighed and disinfected by heat treatment in the Gallenkamp oven at 60^0C for 1 hour and allowed to cool room temperature.

Effect of plant powders on *D. maculatus* adults

Six newly emerged adults (0-24hrs) or *D. maculatus* were introduced into separate plastic jars (80mm depth and 100mm in diameter) containing disinfested dried fish that had been thoroughly mixed with each of the plant powders at 2.5, 5.0, 7.5 and 10.0g per 100g of dried fish. Each experimental set - up was in triplicated and was carried out at the ambient temperature 28-32^0C and relative humidity 60-70%. Similar jars, also in triplicates, containing untreated adult fish and the beetle, were used as control experiments. The caps of the plastic jars were perforated and covered with muslin cloth so as to prevent escape of the beetle or entry of other insects while allowing aeration for the beetles. Adult mortality was recorded at 1, 3, and 7 days after treatment and the percentage mortality was calculated.

Effect of plant powders on *D. maculatus* larvae

Six third instar larvae of *D. maculatus* were introduced in to separate plastic jars containing 50g of disinfested dried fish muscles that had been thoroughly mixed with each of the plant powders at 2.5, 5.0, 7.5 and 10.0g concentrations. Tests were in triplicates for each treatment per insect species and were carried out at the ambient temperature 28-32^0C and relative humidity 60-70%. Similar jars, also in triplicates containing untreated fish muscles and beetles were used as control experiments. The caps of the plastic jars were perforated and covered with muslin cloth so as to prevent escape of the beetle or entry of other insects while allowing aeration for the beetles. Larva mortality was recorded at 1, 3, 7 and 21 days after treatment and expressed as a percentage.

Effect of plant powders on reproductive performance and immature forms of *D. maculatus*

Each of plant materials at concentration of 2.5, 5.0, 7.5 and 10.0g per 100g dried fish were placed in Kilner jars (300cm^3). Twenty newly emerged adults (0 - 24h-old) of *D. maculatus* were introduced into each jar and covered with muslin cloth. A wet cotton wool was introduced into the jar to induce oviposition. A control experiment consisted of same number of insects exposed to untreated dried fish. Each treatment was in triplicate. Eggs laid on the fish by the insects were counted every 24hrs for 18 days. Observation was made daily until adult emergence. The number reaching larva and adult stages was recorded and expressed as percentage larva emergence and adult emergence, respectively.

Data were subjected to analysis of Variance and where significant differences existed, treatments were compared at 0.05 significant level using Tukey's Test.

RESULTS AND DISCUSSIONS

The results of the toxicity bioassay of the powders of four plant materials against the adults of *D. maculatus* are shown in Table-1. Each of the plant powder treatments was toxic to the adult insects and there was a significant difference ($P < 0.05$) between the effect of each plant powder at each of the concentrations and the control. By the end of the experimental period (7^{th} day), a 100% kill had been recorded. The four plant powders significantly ($P < 0.05$) reduced the number of live larvae of the pest when compared with the untreated fish samples (Table-2). Each of the powder treatments showed a good activity against both the adults and larvae of the fish pest.

In this work, a concentration level of 10g/100g for a post treatment period of not less than 7 days was required for 100% kill of both adults and larvae. It is undeniable; however that each of the powders at the lowest concentration and at 7 days post treatment was capable of evoking more than 50% and 80% mortality in the adult and larvae respectively. Implicated in this regard are the powders of *D. tripetala* and *P. guineense*, which caused more than 80% mortality in the adult and a near 100% larval mortality at the lowest concentration. The results are similar to the findings Ofuya and Dawodu (2001) who reported the susceptibility of different ages of *Callosobruchus maculatus to P. guineense*. This is also in agreement to Okorie *et al*., (1990) who reported a 93% kill for *D. maculatus* larvae and total mortality of all adults, when treated with 2g of neem seed powder/25g Tilapia species.

The insecticidal activity of members of the Family Piperaceae, which *P. guineense* belongs, has been attributed to the presence of chavicine (Su and Sondengam, 1980) and piperine (Su, 1977). The effect of each of the powder treatments on progeny development of *D. maculatus* revealed significant difference ($P < 0.05$) compared to the control (Table-3). There were very low mean numbers of emergent larvae of the insects from the new copulating adults that were exposed to powder treatments. This suggests that very few eggs were laid and or developed. The scanty eggs laid on the treated smoked fish could be as a result of high mortality of the pest, thus disrupting mating and sexual communications (NRC, 1992). It could also be due to the deterrency and or repellency abilities of the plants materials. Egwunyenga *et al.*, (1988) rated *D. tripetala* as one of the promising repellents and attributed the repellency of *D. maculatus* from admixed fish to olfactory and gustory sensation.

Observations for possible F_1 adult emergency from the few larvae produced were impossible because all the emergent larvae died within 2 days after emergence. Gonzalez-Coloma *et al.*, (1994) linked reduced fitness of larvae and consequent suppression of adult emergence to stomach poisons after ingestion of the plant material.

Table-1. Effect of powders on percentage mortality of *Dermestes maculatus* adults.

Plant powder	Concentration (g/100g fish)	Mortality (%) days post - treatment		
		1	3	7
D. tripetala	0.00 (control)	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}
	2.50	27.78±5.55^{c}	27.78±11.11^{b}	38.89±5.56^{c}
	5.00	11.11±5.56^{b}	50.00±9.62^{c}	11.11±5.56^{b}
	7.50	22.22±5.55^{b}	66.67±0.00^{d}	11.11±5.56^{b}
	10.00	16.67±9.62^{c}	38.89±11.11^{b}	44.44±5.56^{c}
E. aromatica	0.00 (control)	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}
	2.50	33.33±9.62^{c}	22.22±5.55^{b}	22.22±5.55^{c}
	5.00	16.67±9.62^{b}	44.44±5.56^{c}	27.78±11.11^{c}
	7.50	44.44±5.55^{c}	22.22±11.11^{b}	5.56±5.56^{b}
	10.0	44.44±5.5^{c}	44.44±4.44^{c}	11.11±5.56^{b}
P. guineense	0.00 (control)	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}
	2.50	5.56±5.56^{a}	38.89±5.56^{b}	44.44±5.56^{d}
	5.00	44.45±14.70^{c}	22.22±5.55^{b}	27.78±20.03^{c}
	7.50	27.78±20.03^{b}	38.89±11.11^{c}	27.78±5.55^{c}
	10.0	61.11±5.56^{d}	33.33±0.00^{c}	5.56±5.56^{b}
M. myristica	0.00 (control)	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}
	2.50	11.11±5.56^{b}	22.22±5.55^{b}	22.22±5.55^{b}
	5.00	22.22±5.55^{c}	38.89±5.56^{c}	22.22±5.55^{b}
	7.50	27.78±5.55^{c}	44.45±14.70^{c}	27.78±20.03^{b}
	10.0	38.89±5.56^{d}	38.89±5.56^{c}	22.22±5.55^{b}

Values are means of triplicate samples followed by the standard error of mean. Mean in the same column with different superscripts for each plant materials are significantly different ($P < 0.05$) by Tukey's Test. Mean in the same row with different superscript at each concentration level are significantly different ($p < 0.05$) by Tukey's Test.

Table-2. Effect of plant powders on percentage mortality of *Dermestes maculatus* larvae.

Plant powder	Concentration (g/100g fish)	Mortality (%) days post- treatment			
		1	3	7	21
D. tripetala	0.00 (control)	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}
	2.50	38.89±5.56^{b}	38.89±14.70^{b}	27.78±5.56^{b}	0.00±0.00^{a}
	5.00	33.33±9.62^{b}	38.89±5.56^{b}	27.78±5.56^{b}	0.00±0.00^{a}
	7.50	38.89±5.56^{b}	44.44±5.56^{b}	16.67±9.62^{b}	5.56±5.56^{a}
	10.00	27.78±5.56^{b}	44.44±5.56^{b}	27.78±5.56^{b}	0.00±0.00^{a}
E. aromatica	0.00 (control)	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}
	2.50	16.67±0.00^{b}	33.33±9.62^{a}	33.33±9.62 ^{b}	6.67±1.96^{a}
	5.00	27.78±5.55^{b}	44.44±5.56^{b}	27.78±5.55^{bc}	0.00±0.00^{a}
	7.50	22.22±11.11^{bc}	44.44±11.11^{b}	33.33±0.00^{c}	0.00±0.00^{a}
	10.00	22.22±5.55^{bc}	44.44±5.56^{b}	27.78±5.55^{bc}	0.00±0.00^{a}
P. guineense	0.00 (control)	0.00±0.00^{b}	0.00±0.00^{a}	0.00±0.00^{a}	0.00±0.00^{a}
	2.50	22.22±5.55^{b}	55.56±5.56^{b}	22.22±5.55 ^{b}	0.00±0.00^{a}
	5.00	38.89±5.56^{cd}	44.44±5.56^{c}	16.67±0.00^{b}	0.00±0.00^{a}
	7.50	33.33±9.62^{bc}	44.44±5.56^{c}	22.22±11.11^{b}	0.00±0.00^{a}
	10.00	44.44±5.56^{d}	55.56±5.56^{b}	0.00±0.00^{a}	0.00±0.00^{a}
M. myristica	0.00 (control)	0.00±0.00^{a}	0.00±0.00^{b}	0.00±0.00^{c}	0.00±0.00^{a}
	2.50	27.78±5.55^{b}	44.44±5.56^{c}	27.78±5.56^{c}	0.00±0.00^{a}
	5.00	38.89±5.56^{c}	38.89±5.56^{c}	16.67±0.00^{b}	5.56±5.56^{a}
	7.50	22.22±5.55^{b}	27.78±5.55^{b}	44.00±20.03^{d}	0.00±0.00^{a}
	10.00	44.44±5.56 ^{c}	44.44±5.56^{c}	11.11±11.11^{bc}	0.00±0.00^{a}

Values are means of triplicate samples followed by the standard error of mean. Means in the same column with different superscripts for each plant materials are significantly different ($P < 0.05$) by Tukey's Test. Mean in the same row with different superscript at each concentration level are significantly different ($P < 0.05$) by Tukey's Test.

Table-3. Effect of plant powders on reproductive performance of *Dermestes maculates*.

Plant powder	Concentration (g/100g fish)	Mean No. of eggs laid	Mean % larva emergence	Mean % adult emergence
D. tripetala	0.00 (Control)	153.67±4.63^{c}	91.76	100.00
	2.50	0.33±0.16^{b}	0.22	0.23
	5.00	0.00±0.00^{a}	0.00	0.00
	7.50	0.67±0.32^{b}	0.00	0.00
	10.00	0.00±0.00^{a}	0.00	0.00
E. aromatica	0.00 (Control)	146.67±4.63^{d}	90.22	95.72
	2.50	3.00±0.27^{c}	0.68	0.25
	5.00	0.67±0.31^{ab}	0.00	0.00
	7.50	1.00±0.27^{a}	0.46	0.00
	10.00	0.33±0.16^{b}	0.00	0.00
P. guineense	0.00 (Control)	145.33±1.81^{c}	91.52	95.99
	2.50	0.33±0.15^{b}	0.00	0.00
	5.00	0.00±0.00^{a}	0.00	0.00
	7.50	0.33±0.16^{b}	0.00	0.00
	10.00	0.00±0.00^{a}	0.00	0.00
M. myristica	0.00 (Control)	147.33±3.54^{d}	90.73	97.75
	2.50	1.00±0.27^{c}	0.22	0.00
	5.00	0.33±0.16^{b}	0.00	0.00
	7.50	0.00±0.00^{a}	0.00	0.00
	10.00	0.00±0.00^{a}	0.00	0.00

Number of adults introduced per replicate = 20. Values are means of triplicate samples followed by the standard error of means. Means in the same column with different superscripts for each plant material are significantly different ($P < 0.05$) by Tukey's Test.

CONCLUSIONS

In view of the high mortality rates of the selected plant powders on both the adult and larvae of the fish pest, and their reproductive inhibitory effects, the use of the studied plant materials as smoked fish protectants is promising and could play a major role in post-harvest management strategies.

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