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Potential of Five Local Plant as Protectant against Hide Beetle, *Dermestes maculatus* Degeer Infesting Dry Cat Fish; *Clarias gariepinus* Burchell

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

Efficacy of varying amounts of five selected local plant namely : *Balanite aegyptiaca*, *Eugenia aromatica, Piper guineense, Ocimum gratisimum*, and *Ziziphus mauratania* against the mortality, oviposition, progeny emergence and weight loss of dried fish due to infestation by *Dermestes maculatus* was studied under ambient conditions. The plant were pulverised into powders and applied as 2.0, 4.0 and 6.0 g per 50 g of dried fish. Three pairs of newly emerged adults by were inoculated into each of the treated fish in a beaker, arranged in a Complete Randomized Design in the laboratory. The result showed all the plant powders tested evoked significant mortalities of adults at the highest concentration (6) after 3 and 7 days of post-treatment when compared with untreated control. The rate of oviposition was drastically suppressed by all plant powders, especially at higher concentration. The number of adults emerged were significantly lower than control at ($p>0.05$). Similarly, all the plant's powders significantly prevented weight loss at highest concentration after 12 weeks of post-treatment periods. These results have shown that tested plants demonstrated potential ability against adults hide beetle infesting dried fish.

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1. INTRODUCTION

The quantitative and qualitative loses of dried fish during storage, transportation and marketing by insect are due to infestation by beetles species of the genus Dermestes and Necrobia [1]. These cause losses ranging from 22-50% in Nigeria [2]. In addition, the fish are often rendered unfit for human consumption and aesthetically unacceptable to the buyers (Baba et al. [3]).

The control of this pest in Northern Nigeria is primarily dependent upon repeated application of synthetic chemicals such as chlorpyrifos, methyl, permethrin, cypermethrin, BHC, and "Otapiapia" (Locally formulated) onto fish carton for protection against insect pest (Igene et al. [4]; Agbolagba et al. [5]. Although synthetic chemical is effective to protect stored dried fish, the availability, cost and right application, constitute the major problems toward the use of synthetic pesticide by illiterate fish processors (Booke et al. [6]. The hazard associated with food can result in injury and harm to human health. Millions of people suffer from sort of food poisoning each year due to the uncontrolled application and abuse of synthetic chemical [7]. In recent days, with this demerit of synthetic chemical, worldwide interest has been developed in search for the alternative pesticide to the stored product by the use of the botanical pesticide.

Many Nigeria medicinal plants species have been cited as very important in pest control of stored grain, legumes and dried fish [8], Adebote et al. [9], Akinwumi et al. [10,11,12] and Baba et al. [3]. These provide a solution to the problem emanating from the use of synthetic chemical, thus, this study sought to search for natural preservation material that is cheap and consumers friendly. The present work is aimed at investigating the potential of five plants powders as protectant against *D. maculatus* adults.

2. MATERIALS AND METHODS

2.1 Preparation of Plant Powders

The samples of Balanite agyptiaca (K) and *Ziziphus mauratania* (L) were obtained within the main campus of Usmanu Danfodiyo University, Sokoto, the sample of *Ocimum gratisimum* (L.), *Piper guinense* and *Eugenia aromaticum* were bought from Sokoto Central Market, Sokoto. The samples were washed and dried under shade and milled into a fine powder using mortar and pestle. They were sieved through 0.2 mm mesh size. Each of the plant powders was kept in a separate plastic container with tightly fitted cover prior to the use.

2.2 Preparation of Fish Sample

The samples of dried *Clarias gariepinus* was purchased from fish mongers at Sokoto Central Market, the fish samples were disinfected by heat treatment in the laboratory drying cabinet at 60°C for 1 hour and allow to cool at room temperature as adopted by [8].

2.3 Collection of Hide Beetle and Maintenance of Insect Culture

Different stages of Hide beetle were obtained from naturally infested fish collected from Sokoto central market fish stalls. Several adults pairs of *D. maculatus* were obtained and kept in glass jars and fed with dried fish (Clarias species), the jars were covered with Muslin cloth and tight with a rubber band. Wet cotton wool was supplied in each jar to provide water requirements for oviposition as suggested by [13]. The adult laid eggs which hatched into larvae and change to pupae. The pupae were picked up and transferred in to separate jar to obtained newly emerged adult, which were used for the experiment. The culture maintained for the regular supply of newly emerged adults.

2.4 Effect of Plant Powders on Mortality, Progeny Emergence and Weight Loss of Fish by *D. maculatus*

Fifty gram (50 g) of dried fish was dusted with 0, 2, 4 and 6g of each plant powder. Corresponding amount dried fish was dusted with 0.5 g of cypermethrin (2.0%) powder. Six newly emerged adult (0-72 hrs) of *D. maculatus* were introduced into each of the beaker (500 ml), a cotton wool soaked in distilled water was provided to cope with the water requirement of adults, these beakers were covered with a muslin cloth to allow gaseous exchange and prevent the insect from escaping. There were three (3) replicates.

Mortality data were taken at one (1) three (3) and seven (7) days post treatment. After seven days both live and dead insect were discarded, eggs and larvae were counted. The set up was kept for the emergence of F1 adult from 35 days after treatment until all adult emerged. Weight loss due to *D. maculatus* infestation was determined at 4, 8 and 12 weeks of post-treatment. Percentage weight loss was calculated as the difference between the initial and final weight of fish divided by initial and multiplied by 100.

2.5 Data Analysis

Data obtained were subjected to analysis of variance (ANOVA) using general linear Model (Multivariate Produce of statistical package for Social Science [14] and means found to be significant were separated using Duncan Multiple range test at 5% level of significance.

3. RESULTS

Table 1, shows the mortality of adults *D. maculatus* recorded at 24 hrs, 48 hrs and 7 days intervals due to the effect of plant powder treatments. The result revealed the mortality increase with an increase in the amount of powder and length of exposure. There were relatively low mortality rates at 24 hrs and 72 hrs of post-treatment. Higher mortality were recorded at 7 days of post-treatment period by *E. aromatic* (61.11%) and *B. aegyptiaca* (44.44%) and *P. guinense* (33.33%) at application of 6g/50g of dried fish. These were statistically significant ($P<0.05$) compared to other test plant and control. Lower mortality of adult at highest concentration after seven days post-treatment was observed in *O. gratisimum* (27.77), and *Z. mauratania* (27.77).

Table 2, showed the effect of plant powders on the oviposition and adults emergence on treated dried fishes. All the plant powders tested at all concentrations inhibited the number of eggs laid by *D. maculatus* these were significantly different ($p<0.05$) compared with oviposition on untreated dried fish. The fewer number of eggs were deposited on fishes treated with *P. guinense* at all concentration and *E. aromatic* at 4.0 and 6.0 concentration. But higher number of eggs were observed on fish treated with *O. gratisimum*, *B. aegyptiaca* and *Z. mauratania* at all concentration.

It is also evident from Table 2, that percentage of larval and adult emergence in untreated dried fish was significantly higher ($p<0.05$) than percentage of larval and adult emergence in all treated dried fishes. There was the little emergence of adult (0.3%) at lower concentration (2.0g) and no emergence of adults on dried fish treated with *P. guinense* at 4.0 and 6.0g/50g of dried fish . But few emergence of adult were also observed on dried fish treated with *E. aromaticum*, *B. aegyptica*, *Z. mauratania* and *O. gratisimum* at all application rate compared with control.

Table 3, shows the weight loss of dried fish treated with plant powders, it is evident from the table that the weight loss of the treated dried fish with *P. guinense*, *E. aromaticum* were significantly lower ($P<0.05$) than control at all rate of application at 4, 8 and 12 weeks of post-treatment period, but there was no significant difference between the weight loss of dried fish treated with powder of *B. aegyptiaca*, *Z. mauratania* and *O. gratisimum* , at lower rate of application of 2.0 g/50 g of fish after 4, 8 and 12 weeks of post-treatment periods.

4. DISCUSSION

The result obtained in this study showed that the powder of *E. aromaticum* seem to be the most effective in killing adult especially at high doses, followed by *B. aegyttica* and *P. guinense* treatment and *O. gratisimum* and *Z. mauratania* produce moderate result when compared with other tested plant powders after 7 days of post treatment period. All the powder treatment caused significant mortality of *D. maculatus* (adult) compared with control. The effectiveness of *E. aromatica*, *B. aegyptiaca* and *P. guinense* could be attributed to the high toxicity of these plant powders, this is consistent with the finding of others workers who have reported the effectiveness of various plant powders as dried fish and grain protectant against various insect of stored product [15] reported that powders of *E. aromaticum* and *Z. officianle* were effective against the yam moth *Euzopherodes vapidella* at 0.5 g, 1.0 g and 1.5 g concentration within 72 hours of application producing 100% mortality of moths. Hoda et al. [16] reported the insecticidal activity of *Balanite aegyptiaca* and commiphora molmol against blowfly *Lucilia sericata* (Diptera: calliphoridae) [17]. Assessed toxic potential some plant powders on the survival and development of *C. maculatus*

Table 1. Mortality of adult *D. maculatus Fed* on dried fish treated with plant powders

Plant Powders	Amount of powder (g)/ (50 g fish)	Post treatment period in Days		
		1	3	7
B. aegyptiaca	2	$0.00^{c} \pm 0.00$	$5.55^{bc} \pm 5.55$	$11.11^{de} \pm 5.56$*
	4	$0.00^{c} \pm 0.00$	$11.11^{bc} \pm 5.55$	$11.11^{de} \pm 5.55$
	6	$0.00^{c} \pm 0.00$	$27.77^{bc} \pm 5.56$	$44.44^{bc} \pm 5.56$
E. aromaticum	2	$11.11^{bc} \pm 1.11$	$11.11^{bc} \pm 1.11$	$22.22^{cde} \pm 0.00$
	4	$16.66^{bc} \pm 0.96$	$22.22^{bc} \pm 1.11$	$27.77^{cde} \pm 0.00$
	6	$22.22^{b} \pm 5.5$	$33.33^{b} \pm 0.96$	$61.11^{ab} \pm 0.00$
O. gratisimum	2	$00.00^{c} \pm 0.00$	$00.00^{c} \pm 1.11$	$00.00^{c} \pm 0.00$
	4	$00.00^{c} \pm 0.00$	$00.00^{c} \pm 1.11$	$11.11^{de} \pm 5.55$
	6	$5.55^{b} \pm 5.55$	$16.66^{bc} \pm 0.96$	$27.77^{cde} \pm 5.56$
P . guinense	2	$00.00^{c} \pm 0.00$	$5.55^{bc} \pm 1.11$	$11.11^{de} \pm 0.00$
	4	$55.55^{bc} \pm 5.55$	$16.66^{bc} \pm 0.96$	$27.77^{cde} \pm 5.56$
	6	$16.66^{bc} \pm 0.96$	$16.66^{bc} \pm 0.96$	$33.33^{cd} \pm 9.6$
Z. mauratania	2	$5.55^{bc} \pm 5.55$	$5.55^{bc} \pm 5.55$	$11.11^{de} \pm 5.55$
	4	$5.55^{bc} \pm 5.55$	$11.11^{bc} \pm 5.55$	$16.66^{cde} \pm 0.00$
	6	$16.66^{bc} \pm 9.6$	$16.6655^{bc} \pm 9.6$	$27.77^{cde} \pm 5.55$
Cypermethrin	0.5 g	$55.53^{a} \pm 5.55$	$72.22^{a} \pm 4.69$	$72.22^{a} \pm 4.69$
Control	0.00	$0.00^{e} \pm 0.00$	$0.00^{e} \pm 0.00$	$0.00^{e} +0.00$

**Mean±SD; P<0.05*

Table 2. Effect of plant powders treatment on oviposition and emergence of F1 adult

Plant powders	Concentration (50 g fish)	Oviposition	Number of larvae emerged	F1 adults
B. aegyptiaca	2	82.33c ± 4.48	$65.53^{c} \pm 5.72$	$17.85^{ed} \pm 0.81$*
	4	53.33fgh±2.60	$43.12^{ef} \pm 2.01$	$14.15^{de} \pm 1.11$
	6	51.67gh±4.48	$41.88^{f} \pm 5.72$	5.53g±0.81
E. aromatica	2	$61.00^{efg} \pm 0.57$	$51.28^{de} \pm 1.99$	$11.38^{f} \pm 1.11$
	4	$16.33^{i} \pm 0.88$	$12.25^{g} \pm 0.49$	$3.08^{gh} \pm 1.63$
	6	$4.66^{ij} \pm 2.60$	$3.70^{gh} \pm 1.99$	$1.23^{gh} \pm 0.62$
O. gratisimum	2	$95.00^{b} \pm 1.52$	$79.76^{b} \pm 1.03$	$22.77^{b} \pm 24$
	4	$79.00^{cd} \pm 1.73$	$62.67^{e} \pm 3.21$	$14.15^{de} \pm 1.23$
	6	$42.67^{h} \pm 2.72$	$35.61^{f} \pm 2.48$	$13.54^{de} \pm 3.2$

Plant powders	Concentration (50 g fish)	Oviposition	Number of larvae emerged	F1 adults
P. guinense	2	10.33^{ij}±0.33	6.55^{gh}± 0.28	0.31 ± 0.31
	4	6.66^{ij}± 2.96	5.69^{gh}± 2.53	0.00^{h}± 0.00
	6	0.00^{j}± 0.00	0.00^{h}± 0.00	0.00^{h}± 0.00
Z. mauratania	2	70.00^{de}±1.15	56.98^{cd}±3.47	18.77^{bc}±1.34
	4	64.00^{de}± 3.00	52.71^{d}± 2.80	16.62^{cde}±3.70
	6	62.00^{ef}± 4.04	51.85^{de}± 1.02	112.92^{ef}± 1.59
Cypermethrin	0.5g	9.66^{IJ}± 7.31	4.7^{gh}± 3.6	0.00^{h}± 0.00
Control	0.00	117^{a}.00 ± 1.52	93.73^{a}±3.70	29.33^{a}± 0.33

**Mean±SD; P<0.05*

Table 3. Effect of plants powders on weight loss of dried fish due to *D. maculatus* infestations

Plant powders	Concentration/(50 g fish)	Post treatment Period (Day)		
		30	**60**	**90**
B. aegyptiaca	2	28.23^{e} ± 1.51	31.27^{ab} ± 1.44	31.97^{abc}±0.90*
	4	21.46^{cd} ±1.68	23.32^{de} ± 1.1	24.49^{de} ± 0.53
	6	18.82^{d} ± 6.1	22.05^{e} ± 1.08	23.04^{e} ± 6.4
E. aromaticum	2	22.27^{cd} ±2.29	26.97^{cde}±2.06	29.85^{abcd}±0.94
	4	12.65^{e}±1.97	13.65^{f}±2.60	14.34^{f}±2.06
	6	10.36^{e}±0.77	11.53^{fg}±0.62	27.89^{bcde}±2.52
O. gratisimum	2	22.27^{cd} ±2.29	26.97^{cde}±2.06	29.85^{abcd}±0.94
	4	12.65^{e}±1.97	13.65^{f}±2.60	14.34^{f}±2.06
	6	10.36^{e}±0.77	11.53^{fg}±0.62	27.89^{bcde}±2.52
P. guinense	2	11.44^{e}±0.54	12.9^{fg}±0.24	13.13^{f}±0.21
	4	8.77^{e} ±1.532	10.31^{fg}±1.06	12.50^{f}±0.42
	6	7.89^{e}.0.33	8.06^{g}±0.26	8.11^{F}±0.21
Z. mauratania	2	29.27^{ab}±0.22	32.44^{a}±1.01	32.84^{ab}±0.48
	4	26.51^{abc}±2.61	26.42^{cde}±2.32	28.51^{abcde}±2.74
	6	23.32^{bcd}±0.57	25.00^{cdc}±0.46	26.31^{cde}±0.63
Cypermethrin	0.5	8.15^{e}±0.86	11.07^{fg}±0.57	11.14^{e}±0.60
Control	0.00	29.22^{ab} ± 1.50	32.29^{a} ± 2.28	34.58^{a} ±2.03

**Mean±SD; P<0.05*

and recorded 100% mortality after 8 days post treatment when *P. guinense* powder was used at the rate of 1g/50g cowpea seed. Similarly, [18] also reported the susceptibility of different ages of *Callosobrunchus maculatus* and *D. maculatus* respectively to at all rate of application. The observed low mortality of *O. gratisimum* and *Z. mauratania* could be due to low toxicity, differences in test insect, geographical location as well as an environmental condition at which the study was carried out. Which correspond with report of [19] who reported effectiveness of botanical insecticide varies with species of insect, with percentage adult mortality of *C. maculatus* ranging from 83.3 to 93.4% for *Azadrachta indica ;* 86.7 to 90% for *O. gratisimim,* 93.4 to 96.6% for *Hyptis suavelons* , while *S. zeamaise* recorded mortality of 13.3 to 50% for *A. indica*, 26.7 to 50% for *O. gratismum* and 13.3 to 30% for *H. suaveolens* powders at rate of 1.5, 2.5 and 3.5/80g cowpea seed after 7 days of post treatment. Maud et al. [20] reported weak oral acute toxicity test of *O. gratisimum* aqueous extract on Wister mice.

It is observed from the result of the study that oviposition and percentage of adult emergence by *D. maculatus* were significantly lower in powder treated fish against untreated fish. Few number of eggs were oviposited by each of the beetle on treated fish and consequently low larvae and adult emergence were observed; this could be as a result of high adult mortality caused by the treatment before oviposition or plant powder had deleterious effect on mating, egg laying, repellence or development of immature stage which in turn result in lower adult emergence. This is agreement with findings of [21] who reported that the orange peel powder reduced progeny development of *D. maculatus*. [22] reported that 0.1 g of *P. guinense* powder at 50g of maize grain result in significant reduction of adult emergence. [23] had reported when *P. guinense* powder was applied at five rate (0.1, 0.2, 0.3, 0.4, and 0.5g/20g of cowpea seeds) results in significant reduction in oviposition and adult emergence of *Callosobrunchus maculatus*. [24] reported plant product obtained from clove (*S. aromatica*), West African black pepper *(P. guinense*), alligator pepper (*Aframom melegueta*). Ethiopian pepper (*X. aethiopica*) and dried rhizome of ginger (*Z. officinale*) plant powder significantly reduce oviposition of *S. zeamaise* compared with control and the power of West African black pepper and clove at all dosage rate completely inhibited progeny emergence.

The result of the investigation reveals all the plant powder used at different amount cause considerable reduction in weight loss of dried fish infestation. There was significant ($p<0.05$) reduction in percentage weight loss of smoked fish treated with powder of *P. guinense* and *E. aromatic* compared to other plant powder tested and untreated fish. The reduction in weight loss reflects the number of surviving larvae and adult emerged from respectively treated fish. The highest weight loss was recorded in untreated (control) this could be as a result of feeding activities of *D. maculatus* larvae, on the fish which subsequently cause highest weight loss. The result confirmed the earlier report of [25], that ash and some bioactive plant species cause oviposition deference or ovicidal action resulting in reduced progeny production of stored product insect that reduces seed damage(weight loss). [26] observed percentage weight Loss of smoked fish Infested by *D. maculatus* was significantly reduced in fish treated with oil extracts from *A. melegueta, P. guinense* and *M. myristica* to 4.43, 3.72 and 8.46% respectively. Adesina et al. [27], reported that treatment of maize with *Secamone afzellii* Plant powder against *Sitophilus zeamais* at 2.0 g/ 20 g seeds significantly suppress Adult emergence and percentage weight Loss was significantly reduced at all level of application i.e 0.5/20 g, 1.0/20 g, 1.5 g/20 g 2.0 g/ 20 g of maize seeds.

5. CONCLUSION

A study was conducted to evaluate the effect of five plant powders on mortality of adults, oviposition, adult emergence and weight loss of the treated fish infested by *D. maculatus*. The five plant species, namely*; Balanite agyptiaca, Eugenia aromatic, Piper guinense, Ocimum gratisimum* and *Ziziphus mauratania*. The result of the study revealed that all the plant powders tested were effective in control of *D. maculatus*. The powder of *Eugenia aromatica, Balanite agyptiaca* and *P. guinense* recorded the higher mortality of adult and the powders of *O. gratisimum* and *Z. mauratania* gave the least mortality of adults. However, the powdered of *P. guinense* and *E. aromatica* were found to result in the lowest rate of oviposition, adults emergence and weight loss of the treated fish. The above-mentioned results revealed that powders of *P. guinense* and *E. aromatica* could be used as fish protectant against *D. maculatus.*

Therefore, it is recommended the use of these powder for control of *D. maculates* infestation during processing, storage; transportation and market of smoked dried fish.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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