EFFECT OF SWEET ORANGE PEEL POWDER ON *Dermestes maculatus* IN SMOKED-DRIED AFRICAN CATFISH *Clarias gariepinus* (BURCHELL, 1822)

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Abstract
Application of synthetic insecticides results into toxicity. However, use of organic wastes will proffer solution to insect's infestation in stored fish. This study therefore, aimed at effect of sweet orange peel powder against Dermestes maculatus on smoked-dried Clarias gariepinus. Fresh Clarias gariepinus was purchased from Baga road, in Maiduguri, Nigeria and orange peels was collected free from sellers and dried under shade. The efficacy was assessed using two treatments. Treatment A had 15g while B had 20g of smoked fish, in a completely randomized design, in triplicate. Orange peel powder at different concentration levels of 1g, 2g, 3g, 4g and 0g as control for A while B was 5g, 6g, 7g and 8g. The results showed that, 4g and 8g sweet orange peel powder had the highest larval mortality of 30.03% and 20.17%, while 1g and 5g had the least values of 0.00%, respectively. Percentage adult emergence reduction was significantly different in all the treatments, highest value was in 4g and 8g with 83.17% and 67.00%, respectively. Weight loss was highest in 0g, with value of 23.97% and lowest in 8g with 0.67%. Conclusively, the sweet orange peel powder can be used in protecting smoked-dried fish against D. maculatus.

Keywords: Food security, Economic loss, *Necrobia rufipes*, Microbial load, Post-harvest losses

Introduction

Food security exists when people have both physical and economic access to basic food they need at all times (Adewolu and Adoti, 2010). Fisheries make an important contribution to the animal protein supplies of many communities both in the industrialized and developing world (Adewolu and Adoti, 2010). These communities encounter post-harvest fish losses, due to insect infestation which accounts for 10 to 12 million tons per year and 20 million tons are discarded at sea yearly (Kumolu *and* Ndimele, 2011). However, smoking is the most commonly used method for fish preservation in the tropics (Ames, 1992). Smoke has been reported to impact some characteristics aromatic flavour on cured fish (Clucas, 1982) which is highly relished by the people in the tropics. Often, smoke-dried fish are eaten without further cooking (Asita, 2000).

In spite of the desirable effects of smoke on fish quality, infestation of insect pest has been reported to cause substantial losses in the nutritive value of fish during storage (Fasakin and Aberejo, 2002). Fish beetles, *Dermestes maculatus* and *Necrobia rufipes* are common insects in the tropics (Osuji, 1985). *Dermestes maculatus* is widely recognized as a cosmopolitan pest of stored commodities especially those containing animal proteins. The beetle feeds on hides, skins, feathers, horns and also a known pest of dried fish (Cohen, 1974). Efforts to reduce losses through insect infestation by the use of insecticides and pesticides have not been fully adopted due to the hazardous nature of those chemicals to health and toxicity at high doses to consumers (Balogun, 1992). In order to eliminate much of these problems, plant derived pest insecticides which are biodegradable, environment friendly, cheap, available and affordable to fish farmers and processors have been proposed (Lale, 1995; Adedire and Lajide, 1999). This approach could be of tremendous benefit in enhancing fish utilization in the tropics.

Orange peels has the potential of been used as insecticides because, is a rich source of flavanone and many polymethoxylated flavones, which are rarely found in other plants (Ngele *et al*., 2014). It can also be used as antimicrobial, antifungal, antioxidant, carminative, antiviral, antimicrobial, anti-yeast, anti-hepatotoxic and anti-mutagenic agent. Citrus peels exhibit antifungal, antibacterial, antiviral and anti-parasite properties (Ngele *et al*., 2014). Dipping of fish in crude orange peel extract concentration had acceptable proximate composition, anti-microbial properties, reduced microbial load and acceptable flavour on *Clarias gariepinus* (Bello and Hadison, 2017). This study therefore, aimed at the effect of sweet orange peel powder on the insect (*Dermestes maculatus*) in smoked-dried African catfish (*Clarias gariepinus*).

Materials and Methods

The study was conducted at the fish processing unit Department of Fisheries, Faculty of Agriculture, University of Maiduguri, Borno state, Nigeria. Freshwater catfish (*Clarias gariepinus*) was purchased from Baga road, fish market in Maiduguri, Nigeria. The freshwater catfish (*Clarias gariepinus*) was washed to remove external dirt, bent with the tail into the mouth and toothpick was used to hold it firm and was allowed to drip for 40minutes. The orange peel was collected free from the orange sellers in the market and dried under the

shade at ambient temperature. The dried peel was grinded into powder using hammer miller and sieved using 1mm^2 mesh size sieve. The fish was randomly allocated into two treatment group. Treatment A consists of 15g, while treatment B had 20g of fish, which was conducted, in a complete randomized design and in triplicate. Orange peel powder was used to mix both treatments at different concentration levels of 1.0g, 2.0g, 3.0g, 4.0g and treatment B was admixing with 5.0g, 6.0g, 7.0g and 8.0g while 0g served as control. *Dermestes maculatus* used in this study was obtained from infested smoked catfish (*C. gariepinus)* at Baga road, fish market Borno state, Nigeria. The insect was cultured in bottle jar with muslin cloth under laboratory condition of 30 ^oC temperature, relative humidity of 65% and was kept undisturbed. Adult female of *Dermestes maculates* laid eggs within 24h of first mating and hatched within 3-4 days, which serves as new generation and was prepared by removing newly emerged F1 generation larvae from the stock culture and placed on fresh uninfected smoked fish in the bottle jar for the experiment. Ten newly emerged larva of 3-5 days, *D. maculatus* was randomly introduced into each treatment and control dish and covered with muslin cloth. All bioassay (bottle) jars was disinfected in an oven at 80 ^oC for I hour and were allowed to cool at room temperature prior to use. The larvicidal effect of sweet orange peel powder on *Dermestes maculatus* larvae was determined using bottle Kilner jar. The containers were gently shaken for 2min to ensure homogeneous mixing of the smoked fish and orange peel powder. Each treatment was in triplicate. Larvae mortality was counted every 24hours for 5days. The mortality of the larva, was confirmed when there was no respond to probing sharp pin on the abdomen. Daily observation was recorded until emergence of the adult. The number that reached the adult stages was recorded and the percentage weight loss. The experiment was conducted for three weeks. The dry orange peel was tested for its phytochemical constituents using standard procedures. Data obtained were subjected to analysis of variance (ANOVA) in a completely randomized design using software statistix 8.0 version and the means were separated using Least Significance Difference (LSD).

The percentage reduction in adult emergence of F1 was calculated using the formula;

i. $\text{Percentage Adult emergence reduction} = 100 \times \frac{\text{Ac} - \text{At}}{At}$

Where,
Ac = No. Of adult insect emerge in control
At = No. Of adult insect emerge in treatment

ii. $\text{Percentage weight loss} = 100 \times \frac{W_1 - W_2}{W_1}$

Where,
W_1 = initial weight of fish sample
W_2 = final weight of fish sample

Results

Table 1: Percentage Larval Mortality of *D. maculatus* Treated with Different concentration of Orange Peel Powder in Hours after Infestation

	Treatment A				
Concentrations	**Hours After Infestation**				
15g/fish	**24h**	**48h**	**72h**	**96h**	**120h**
0g	0.00^a	3.33^a	3.33^a	6.67^a	6.67^a
1g	0.00^a	0.00^b	3.33^a	6.67^a	13.33^b
2g	2.00^b	0.00^b	3.33a	10.03^b	20.03^c
3g	3.33^{bc}	3.33^a	6.67^b	13.37^{bc}	26.73^d
4g	3.33^{bc}	6.70^c	10.00^c	16.67^{bc}	30.03^e
LSD	Ns	8.14	9.41	16.93	Ns

Key: Means followed by the same superscript(s) in the same column are not significantly different (P > 0. 05)

Table 2: Percentage Larval Mortality of *D. maculatus* Treated with Different concentration of Orange Peel Powder in Hours after Infestation

	Treatment B				
Concentrations	**Hours After Infestation**				
20g/fish	**24h**	**48h**	**72h**	**96h**	**120h**
0g	0.00^a	0.00^a	3.33^a	0.00^c	6.67^b
5g	0.00^a	3.33^{ab}	6.67^{ab}	10.03^{bc}	10.03^{ab}
6g	3.33^a	3.33^{ab}	6.67^{ab}	6.67^{bc}	13.40^{ab}
7g	3.33^a	3.33^{ab}	10.07^b	13.33^{ab}	16.77^{ab}
8g	6.67^{ab}	6.67^b	10.07^b	16.67^a	20.17^b
LSD	11.50	9.39	13.37	9.39	S

Key: Means followed by the same superscript(s) in the same column are not significantly different (P > 0. 05).

Table 3: Percentage Larval Mortality of *D. maculatus* Treated with Different concentration of Orange Peel Powder in Weeks after Infestation (Treatment A)

Treatment A		
Concentrations	**Weeks After Infestation**	
15g/fish	**1st**	**2nd**
0g	6.67[b]	10.00[a]
1g	10.00[c]	6.67[b]
2g	3.33[a]	3.33[ab]
3g	3.33[a]	3.33[ab]
4g	6.67[b]	6.67[b]
LSD	Ns	Ns

Key: Means followed by the same superscript(s) in the same column are not significantly different (P > 0. 05)

Table 4: Percentage Larval Mortality of *D. maculatus* Treated with Different concentration of Orange Peel Powder in Weeks after Infestation (Treatment B)

Treatment B		
Concentrations	**Weeks After Infestation**	
20g/fish	**1st**	**2nd**
0g	10.00[b]	16.67[b]
5g	16.67[ab]	10.00[a]
6g	13.33[ab]	13.33[ab]
7g	26.33[ab]	13.33[ab]
8g	16.67[b]	10.00[a]
LSD	Ns	11.51

Key: Means followed by the same superscript(s) in the same column are not significantly different (P > 0. 05).

Table 5: Percentage Adult emergence reduction of *D. maculatus* due to infestation on fish sample treated with different concentration of sweet orange peel powder

% Adult emergence reduction			
Treatment A Concentrations/15g		**Treatment B Concentrations/20g**	
0g	2.00[e]	**0g**	1.00[d]
1g	20.00[d]	**5g**	24.83[c]
2g	36.80[c]	**6g**	39.67[bc]
3g	62.53[b]	**7g**	51.67[ab]
4g	83.17[a]	**8g**	67.00[a]
LSD	15.6	**LSD**	15.8

Key: Means followed by the same superscript(s) in the same column are not significantly different (P > 0. 05)

.**Table 6: Percentage Weight loss due to infestation on fish sample treated with different concentration of sweet orange peel powder**

% Weight loss			
Treatment A Concentrations/15g		**Treatment B Concentrations/20g**	
0g	23.97[a]	**0g**	13.83[a]
1g	12.23[b]	**5g**	11.33[a]
2g	10.25[b]	**6g**	6.00[b]
3g	10.10[b]	**7g**	4.67[bc]
4g	9.26[b]	**8g**	0.67[c]
LSD	7.48	**LSD**	4.29

Key: Means followed by the same superscript(s) in the same column are not significantly different (P > 0. 05)

Table 7: Phytochemical constituent of sweet orange peel powder

Phyto-constituent	Orange peel
Saponnins	+
Tannins	+
Flavanoid	+
Salkawoskis (glycosides)	+
Kella-kellani (glycosides)	+

Phlabatannins	-
Alkaloids	-
Phenol	+
Terpenoid	+

Note: +presence of secondary metabolite; –Absence of secondary metabolite

The percentage larval mortality of *D. maculatus* treated with different concentration of orange peel powder, in hours after infestation for treatment A was presented in Table 1. The results in Table 1, showed that the highest larval mortality was recorded in 4g concentration (30.03%), while the least was in 0g (6.67%) all at 120h after infestation. The percentage larval mortality of *D. maculatus* treated with different concentration of orange peel powder for treatment B, in hours after infestation was presented in Table 2. The results in Table 2, showed that the highest larval mortality was recorded in 8g concentration (20.17%) at 120hour, while the least was in 0g (0.00%) at 24, 48, 96 hours and 5g at 24h after infestation. The percentage larval mortality of *D. maculatus* treated with different concentration of orange peel powder in weeks after infestation was presented in Table 3 (Treatment A). The result in Table 3 showed that, a week after infestation less mortality was observed in fish treated with 2g and 3g orange peel powder. The percentage larval mortality of *D. maculatus* treated with different concentration of orange peel powder in weeks after infestation as presented in Table 4 (Treatment B). The results in Table 4, showed that, there was significance difference at 1st week after infestation and at 2nd week there was no significance difference among the treatment. The percentage adult emergence reduction of *D. maculatus* due to infestation on fish sample treated with different concentration of sweet orange peel powder as shown in Table 5. The results obtained from Table 5, revealed that, the highest adult emergence reduction was recorded in 4g concentration (83.17%) in treatment A, while the least was in 0g (1.00%) in treatment B. The percentage weight loss due to infestation on fish sample treated with different concentration of sweet orange peel powder as shown in Table 6. The results in Table 6, revealed that the highest percentage weight loss was recorded in 0g concentration (23.03%) in treatment A, while the least was in 8g (0.67%) in treatment B, respectively. Phytochemical constituent of sweet orange peel powder was as presented in Table 7. The results in Table 7 revealed that, orange peel powder possess the following phytochemical constituents: Saponins, Phlabatonins, Alkaloid, Phenol, Flavanoid, Terpenoids etc.

Discussion

The results in Table 1, was in agreement with the work of Adesina *et al*., 2014 which stated that, the fish treated with 3.0g of *Phyllanthus fratenus* had the highest larval mortality, while the least was in 0g. Also, Zewde and Jembere (2010), revealed that dosage and time was directly related to efficacy, between treatments as was shown in their mortality rate. Invariably, higher dosage is more efficient in management of pests. The results in Table 2, closely agrees with the finding of Zewde and Jembere (2010). They reported that, at 72h after infestation, the highest larval mortality was observed at dosage of 15g, while the least was at the concentration of 5g, this implies that, mortality rate was affected by the quantity of fish used. Owoade, (2008) also exposed *Dermestes maculatus* larvae to three different concentrations of *Piper guineense*, *Aframomum melequeta*, *Zingiber officinale* and *Capsicum annuum*, for over 25 days. Mortalities monitored for five days showed that 100% of the beetles exposed to *P. guineense* died at the end of 24 hours, and by the end of 72 hours, 100% mortality were recorded in all three concentrations in *P. guineense* and *A. melegueta* gave the second best result (53.3%). The spices were shown to have slowed down or extended time of development of the larvae to the adult, especially at the two concentrations of 20g and 25g. The results in Table 3 showed that, a week after infestation less mortality was observed in fish treated with 2g and 3g orange peel powder. This was in line with Adesina *et al*., 2014. Akpako and Agbor (2015) investigated the use of *Monodora myristica* as surface protectant against *Dermestes maculatus* on stored *Clarias gariepinus*, observed that that the plant powder at 1.5g caused 100% mortality of the beetle at 9 days after treatment, 3.0g of the plant powder caused 100% mortality at 7 days, while that of 5.0g and 10.0g caused total mortality of the insects at 5 and 6 days after treatment. The results in Table 4, agreed with the work of Adesina *et al*. (2014). They reported that, there was significance difference at 1st week after infestation and at 2nd week there was no significance difference among the treatment. The results obtained from Table 5, disagreed with the finding of Fasakin (2003). Who stated that, oil extract from *T. diversifolia* was least effective as surface protectant against larvae and pupae development of storage insect *Dermestes maculatus.* In an experiment to evaluate the insecticidal efficacy of *Piper guineense* on fish beetle (*Dermestes maculatus*), Nwogor *et al.*, (2015) observed that *Piper guineense* powder at 2.0g gave mortalities of 83.33% and 76.67% for larva and adult of *D. maculatus*. The results in Table 6, was in agreement with the finding of Nwankwo *et al*. (2011) who stated that, the higher percentage of weight loss recorded in untreated fish, indicates that the larval

stage of beetle was more destructive than the adult. The results in Table 7 was in line with the finding of (Adesina *et al*., 2014) who reported that, the larvicidal activity of *Phyllanthus fraternus* may be attributed to the presence of phytochemical constituent in the plant.

Conclusion

It can be concluded that, sweet orange peel powder, deterred feeding of *D. maculatus* in smoked fish. Also, the orange peel powder significantly reduced the F1 progeny and weight loss. The study showed the orange peel powder possessed some phytochemicals constituent which are characterized with larvicidal effect on *D. maculatus.* Conclusively, sweet orange peel powder is a very promising protectant of stored smoked-dried fish from damage cause by *D. maculatus*. Sweet orange peel powder should be used in protecting smoked *Clarias gariepinus*, other citrus peels should also be investigated.

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