

Full Length Research Paper

# The effect of preservation methods and *Dermestes maculatus* (DEGEER 1174) on smoked *Chrysichthys nigrodigitatus* and *Ethmalosa fimbriata* purchased from Ishiet market, Akwa Ibom State, Nigeria

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This study assessed the effect of preservation by oven drying and refrigeration on smoked *Chrysichthys nigrodigitatus* and *Ethmalosa fimbriata* infested by *Dermestes maculatus* over a period of six months. The results showed that *E. fimbriata* is a better fish than *C. nigrodigitatus* in terms of proximate composition and nutritive contents. Oven treatment gave a lower mean weight (261.85 g) as against refrigeration (265.55 g) for *C. nigrodigitatus*. Also, 70.62 g and 72.91 g mean weights were recorded for *E. fimbriata* preserved in oven and fridge respectively. The relationship between the weight loss in oven and fridge was not statistically significant ( $P>0.05$ ). The percentage composition of moisture (6.0%), lipids (46.50%), fibre (31.00%) and carbohydrate (13.35%) increased geometrically in *C. nigrodigitatus* after six months of infestation with *D. maculatus*. However, there was a consistent reduction in the value of protein content (36.05%), ash content (4.10%) and caloric value (234.50kcal) during the same period of infestation. *D. maculatus* infestation led to increase in the composition of moisture (9.79%), protein (17.40%), lipids (20.50%) and fibre (13.60%) of *E. fimbriata*. However, there was a decrease in the energy value (327.38kcal) of *E. fimbriata* after six months of infestation with *D. maculatus* although the differences were not statistically significant ( $P>0.05$ ). The use of aluminium foil in the preservation of smoked fish for a longer period was better than that of polythene papers and iron baskets. Therefore, strategic preservation practices are recommended for the control of pests of smoked fish.

**Key words:** Proximate composition, preservation methods, *Dermestes maculatus*, smoked fish.

## INTRODUCTION

In Nigeria, *Chrysichthys nigrodigitatus* is a highly valued food fish and, is among the dominant fishes of commercial catches as well as culturable fish species from the wild. It is the fish consumed by the rich and very expensive in International and Five Star Hotels in Nigeria. The *Ethmalosa fimbriata* on the other hand is a lowly valued food fish, and very common in the diet of the poor. *E. fimbriata* and *C. nigrodigitatus* are found spawning in inshore waters of Nigeria. They were chosen for this study because they are the second and third major component (12.2 and 10.8% respectively) of fisheries in

the Cross River Estuary after *Pseudotolithus elongatus* (66.5%) (Holzlohner et al., 1998).

Fish is a perishable biomaterial especially in the tropics where high temperature and humidity accelerate spoilage and biodeterioration of fish immediately after catch (Okonta and Ekelemu, 2005). As a result of this, efforts are primarily directed towards the preservation of fish for human food. However, poor handling, inadequate processing facilities, lack of ice or storage facilities, remoteness of the fishing villages to urban market centers, poor transportation system and poor distribution



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channels have drastically reduced fish utilization in the tropics (FAO, 1981; Doyle, 2007). The rate at which fish spoils does not only depend on microbes, enzymes and fat oxidation but also on insect pest especially in cured fish during storage. Often, smoke-dried fish are eaten without further cooking. Smoke has been reported to impart some effects on fish quality and high incidence of insect pest infestation has been reported to cause substantial losses on the nutritive value of fish during storage (Odeyemi et al., 2000; Ogonnaya and Ibrahim, 2009). Fish beetles, *Dermestes maculatus* and *Necrobia rufipes* are common insects in the tropics. 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 these chemicals to health and toxicity at high doses to users (Mohammed and Yusuf, 2001; Ayuba and Omeji, 2006). However, Ajao (2012) reported that the efficacy of Neem Seed Oil (NSO) extract for the control of *D. maculatus* in *Clarias gariepinus* is promising.

Smoking fish is an age long tradition of preserving fish from further deterioration after being caught and dried, especially for commercial purposes. Generally, fish is a perishable commodity. There has been large scale deterioration and losses in the quality of processed fish due to the combined effects of insect's infestation and other biological agents that flourish under hot and humid condition (Blasteford, 1992; Lale and Sastawa, 1996; Mohammed and Yusuf, 2001). Insects are the most serious pests of cured fish; about fifteen (15) species were recorded as major pests of cured fish, (Lale and Sastawa, 1996).

*D. maculatus* and *N. rufipes* eat the cured fish when they are stored for long periods. The problem of large scale infestation often results in more than 50% losses due to inadequate packaging and storage. The need to further investigate the extent and rate of damage of the nutritional quality of smoke fish products becomes pertinent (Osuyi, 1974).

These insect pests cause economic damage and losses to the cured fish (Taylor, 1998), and they play a very important role in fish spoilage and this depends on a number of factors such as temperature, moisture content, relative humidity, nature of feed physical and nutritional quality (Taylor, 1998). Insect's infestation causes fragmentation of cured fish (FAO, 1981) which can lead to quantitative loss of the smaller fragments and loss of values due to quality reduction, since a higher price is often obtained for intact fish. In addition, an insect pest often transmits mould spores, the heat and moisture produced by heavy infestation can create condition suitable for mould growth on fish that has previously been dried (FAO, 1981; Atijegbe, 2011).

Blatchford (1962) observed that insect infestation is more likely to occur on fish under the influence of warm temperature and high moisture content. The studies have been recorded mainly with the biology of *D. maculatus* as

a pest of smoked fish. Lale and Sastawa (1996) and Odeyemi et al. (2000) put the losses due to susceptibility to pest infestation and deterioration of smoked fish products at 50% during storage, leading to reduction of nutritive quality of smoked fish.

Eyo and Mdaihi (1997) stated the control measures against insect infestation of smoked fish which include preserving in the oven at a minimal temperature and also the use of harmful chemical insecticides such as heptachlor to keep away insects and other pests.

Spoilage is a metabolic process that causes food to be undesirable or unacceptable for human consumption due to changes in sensory nutritional characteristics (Doyle, 2007). Since fish is highly susceptible to deterioration immediately after harvest and to prevent economic losses, the processing and preservation of fish is of utmost importance (Okonta and Ekelemu, 2005). Odeyemi (2000) noted that smoke-dried fish is one of the highly digestible and respectable sources of proteins and essential minerals in the tropics but it is highly susceptible to insect pest infection. In recent years, there have been increasing and concerted efforts directed at developing natural pest management control agents that are relatively cheap, safe, biodegradable and environment friendly as alternatives to synthesized insecticides (Boeke, 2001). Ayuba and Omeji (2006) stated that the gap between demand and supply of fish is widened due to poor post-harvest handling, lack of processing and storage facilities.

The *Dermestes spp* eat away the muscles leaving the skeletons when cured fish are stored for long periods. Lale and Sastawa (1996) and Odeyemi et al. (2000) put the losses due to susceptibility to pest infestation and deterioration of smoked fish products as 50% during storage, leading to reduction of nutritive quality and market price of smoked fish. Oke et al. (2014) reported that the nutritive benefit of cat fish *C. gariepinus* (Burchell, 1822) are threaten by its infestation by *D. maculatus* (Degeer, 1774) during storage.

Certain factors affect the development of insect pests in smoked fish such as salt content, moisture content, temperature, etc. Temperature above 40°C can be used to disinfect fish or delay invasion by *Dermestes spp.* (Esser, 1986; Rattagool, 1988; Zakka et al., 2013).

In an experiment at 30°C, larval development took thirty seven (37) days on fish with three point five (3.5%) percent salt content compared with twenty one and a half (21 ½) days on unsalted fish, and mortality reached one hundred (100%) percent when the salt content was increased to nine point two (9.2%) percent by brining for one and a half (1 ½) hour (Osuji, 1975). In other words, salting also gives considerable protection against *N. rufipes*, because larval development is severely retarded (Osuji, 1974).

It is of great importance to note that the most important environmental factors that affect pest development are ambient temperature and humidity. These factors dictate

URUAN LOCAL GOVT. AREA

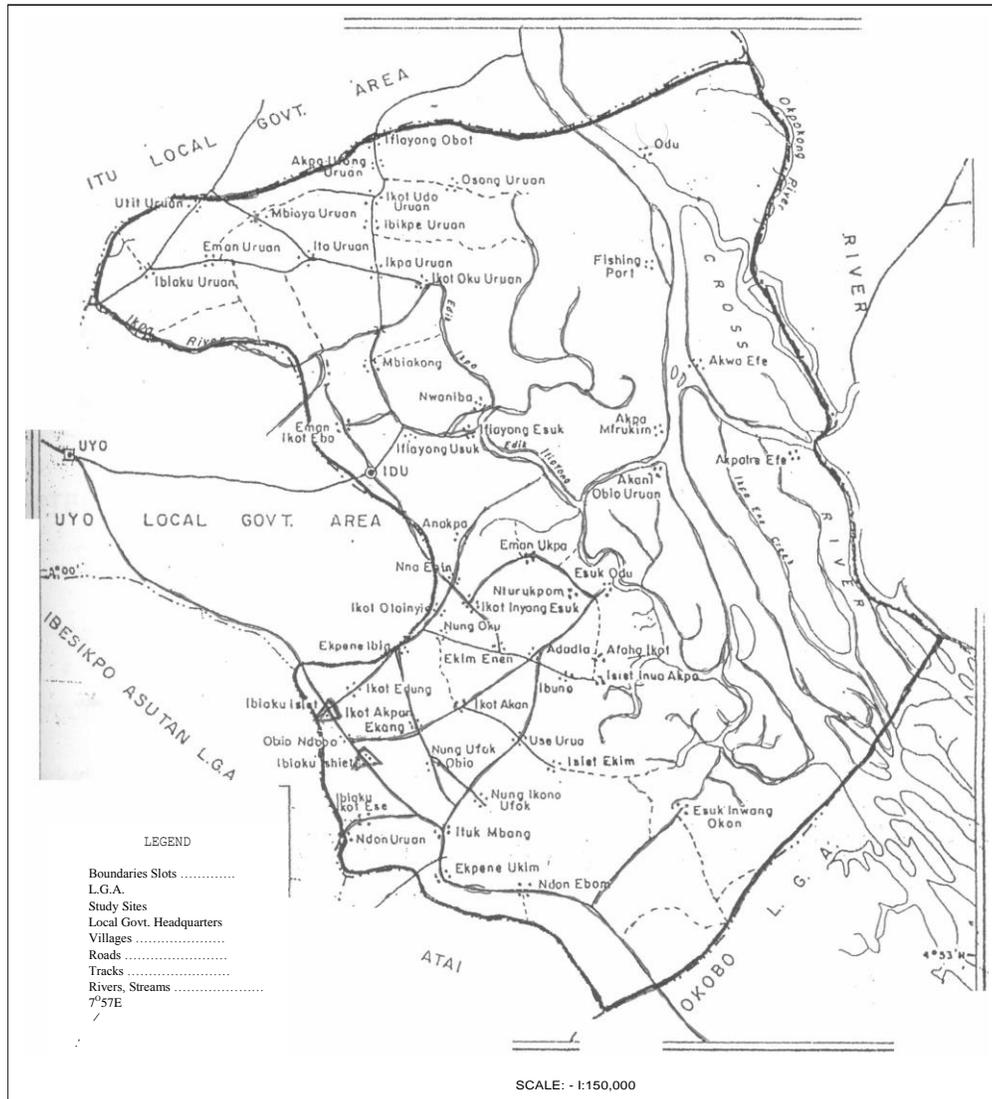


Figure 1. Map of study area.

the rate at which chemical changes take place (Marinetti, 1991; Zakka et al., 2013).

The objectives of the study were: to determine the proximate composition of smoked *C. nigrodigitatus* and *E. fimbriata*; to determine the effect of *D. maculatus* on the mean weight of *E. fimbriata* and *C. nigrodigitatus* and to examine the effect of *D. maculatus* on the proximate composition of *C. nigrodigitatus* and *E. fimbriata*.

**MATERIALS AND METHODS**

**Study location**

Ibiaku Ishiet is situated in Uruan, Akwa Ibom State,

Nigeria. Its geographical coordinates are 4° 57' 0" North and 8° 1' 0" East. The area is a highly commercial area that cuts across fishing, canoe/boat building, arts and crafts, etc. It has deposits of minerals such as clay deposit, crude oil and other natural resources.

**Sample collection**

Smoke-dried fishes (*E. fimbriata* and *C. nigrodigitatus*) were randomly sampled and purchased from main market, Ishiet in Uruan Local Government Area, Akwa Ibom State, Nigeria (Figure 1). The samples were brought to the Zoology laboratory of the University of Uyo for examination, identification and selection of



**Plate 1.** Larval stages of *Dermestes maculatus* with fish sample.

wholesome samples.

### Treatment of fish samples

The cured fish species were sterilized thermally by heating at 60°C for three days in a hot air oven in the laboratory in order to kill any insect pests that may be present. The second part of the samples was also collected into plain polyethene freezer bags, frozen for 72 h in order to kill any insect pest that may be present. Both samples were then stored at room temperature for acclimatization for 24 h.

The larvae of *D. maculatus* were placed in containers containing each of the fish substrates and maintained at controlled temperature 30°C and relative humidity (65%) conditions at the Zoology laboratory University of Uyo, Akwa Ibom State, Nigeria.

*D. maculateus* were obtained from a heavily infested dried *C. gariepinus* purchased from fish sellers at Akpanandem main market, Uyo, Nigeria. The larval and adult stages of this pest were disengaged from the tissues and placed in twelve transparent clean bottles (500 ml) with perforated covers. In the laboratory, the larval stages were sorted out and placed in another set of twelve clean reagent bottles (33 ml) whose open end were covered with nets.

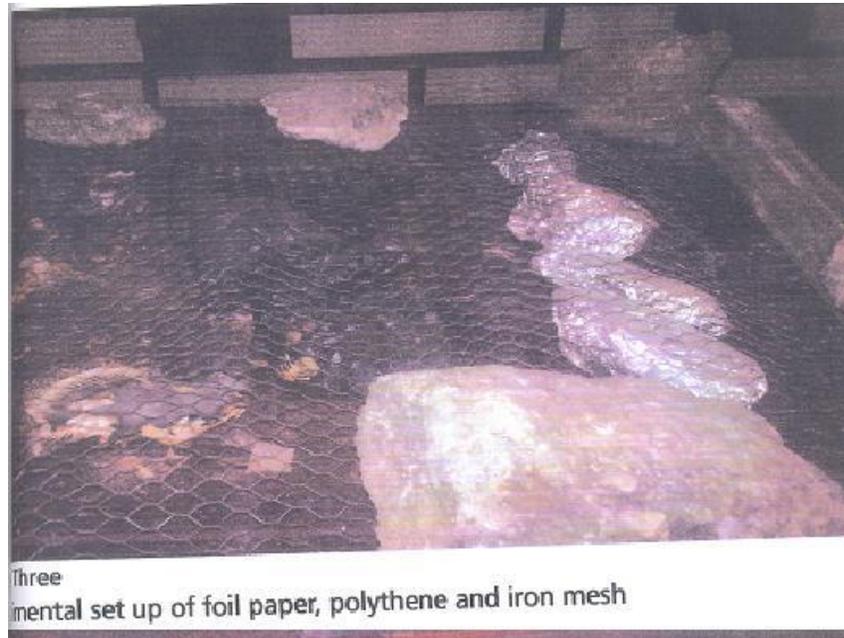
### Infestation of samples with *D. maculatus*

The study was designed to have smoked complete whole each of *E. fimbriata* and *C. nigrodigitatus* of different

weight grouped to a specific weight. The samples were subjected to four treatment groups (A, B, C and D) of pest infestation. Group A represented the control with no pest infestation, while B, C and D represented low ( $L_1$ ), were infested with eight larvae (four males and four females) of *D. maculatus*. Fish medium ( $M_1$ ) were infested with sixteen larvae of *D. maculatus* (eight males and eight females) and high ( $H_1$ ) were infested with thirty two larvae (sixteen males and sixteen females).

Smoked oven samples of *C. nigrodigitatus* were weighed with a weighing balance and randomly placed in clean transparent 500 ml bottles. The initial weight (a) of each of the 500 ml bottle was measured in grammes using an electronic weighing balance, thereafter placing the fish sample. The weight (b) of the fish sample was noted. The difference between the weights of the bottle with fish (b) and that of bottle alone (a) gave the initial weight (c) of the fish,  $c = b - a$ . The  $L_1$   $M_1$  and  $H_1$  treatment were replicated for the sample of *C. nigrodigitatus* from the fridge thus giving six experimental set up for *C. nigrodigitatus* (3-oven, 3 fridge). The initial group weight of each of the experimental set up was 280.45 g. The treatment was replicated for *E. fimbriata* but with an initial group weight of 80.25 g. Altogether twelve (12) experimental set up was put in place plus two (2) control making fourteen set up. All the bottles were tightly covered with mesh net that screens entry of any pest but allows free entry of air (Plate 1). Each group of bottles with infested fish samples was appropriately labelled according to treatment and left for investigation for seven months.

Fish samples with the pests and bottle were measured every month for a period of seven months and the



**Plate 2.** Experimental setup of method of preservation using foil paper, polythene and iron mesh.

gradual lost were recorded in weight. Before infestation, each of the smoke samples of *C. nigrodigitatus* and *E. fimbriata* without pest infestation were analyzed for proximate composition at the biochemistry laboratory for crude protein, free fatty acid, lipid content, Ash content etc, based on Marinetti (1991) and AOAC (2005). After seven months infestation, the H<sub>1</sub> sample of the oven smoke *C. nigrodigitatus* and *E. fimbriata* were again subjected to post infestation proximate analysis.

## Chemical analysis

### Proximate composition

The moisture content of each fish sample was estimated using the oven dry method as described by AOAC (2005). Weighing bottle was washed and dried in an oven at 80°C for some minutes, cooled and weighed. Two grams of the sample was weighed into the weighing bottle, new weight of the bottle and its content (sample) was taken.

The weighing bottle and its content was then dried in an oven at the temperature between 60-70°C for about 24 h after which it was cooled and weighed with a minimum exposure to the ambient temperature.

### Assessment of storage methods on the quality of dried smoked fish

The smoked sample of *C. nigrodigitatus* and *E. fimbriata*

which were dried in the electric oven for three (3) days at 60°C were presented in the following ways:

- (a) Ten (10) fish samples were each tightly wrapped with foil paper.
- (b) Ten (10) fish samples were each tightly wrapped with clean good quality sacks lined with polythene paper.
- (c) Ten (10) samples were kept inside 0.05 mm mesh iron basket on the laboratory table.
- (d) All the samples were caged with a strong 0.05 mm mesh size iron net to prevent rat and adult pest infestation and were kept for observation and assessment for six (6) months (Plate 2; Table 1). The extent of damage was assessed according to Esser (1986) and Ratta Gool (1988).

### Method of data analysis

The design was completely randomized. The mean losses in weight were replicated three times for each of the species treatment. The mean weight losses and the proximate composition analysis results were presented with mean value of each determination  $\pm$  standard deviation. Analysis of variance was performed using Duncan multiple range test.

Differences between mean values of the treatment were determined by the least significant difference (LSD) test and the significance was deferred at  $P < 0.05$ : correlation was also used in the analysis of the proximate composition.

**Table 1.** Assessment of damage.

Code	Observation
A	Appearance
O	No sign of damage
L	holes and canal on flesh
M	Flesh not completely eaten
H	Skeleton
F	Firmness

**Table 2.** Mean weight losses (G) of smoke *C. nigrodigitatus* infested with larvae of *D. maculatus* treatment.

Months of study	Mean weight in grammes (g)					
	Oven			Fridge		
	L <sub>i</sub>	M <sub>i</sub>	H <sub>i</sub>	L <sub>i</sub>	M <sub>i</sub>	H <sub>i</sub>
July, 2011	280.45	28.045	280.45	280.45	280.45	280.45
August	279.12	274.22	270.42	278.67	278.67	273.22
September	277.32	270.45	266.38	277.72	273.21	260.25
October	272.02	264.52	258.0	274.52	268.22	258.22
November	268.02	257.01	241.26	271.22	263.28	248.20
December	263.42	249.12	22.72	271.22	256.72	239.22
January, 2012	258.52	242.61	21.32	264.22	251.32	230.12
Total	1,898.85	1,838.8	1,71.55 (5498.78)	1,915.33	1,871.87	1,789.68 (5576.88)
X	271.26	262.63	251.65 (261.84)	273.62	267.41	255.67 (265.57)

N = total number of months = 7; R= 0.33, tr = 0.35, df = 1, p<0.05).

## RESULTS

The result in Table 2 indicates the mean weight loss of smoked *C. nigrodigitatus* infested with larvae of *D. maculates*. The mean weight decreased consistently between the treatment in oven (L<sub>1</sub> low infestation) = 271.26 g, M<sub>1</sub> (medium infestation) = 263.63 g), H<sub>1</sub> (high infestation = 251.65 g and fridge was L<sub>1</sub> = 273.62 g, M<sub>1</sub> = 267.41 g and H<sub>1</sub> = 255.67 g. However, the relationship between the mean weight of smoked *C. nigrodigitatus* treated with oven and fridge was not statistically significant (P>0.05), r=0.33, tr=0.35). But, it was observed that the treatment with oven recorded low mean weight (261.185 g) compared to the weight in the fridge (265.55 g).

Similarly, the result in Table 3 reported a relative decrease in the mean weight value of smoked *E. fimbriata* infested with *D. maculatus* treated with oven (L<sub>1</sub> = 74.19 g), M<sub>1</sub> = 71.33 g, H<sub>1</sub> = 68.77 g) and fridge (L<sub>1</sub> = 74.91, M<sub>1</sub> = 72.95 g and H<sub>1</sub> = 70.86 g). However, it was observed that the treatment with oven recorded low mean weight (70.62) compared to the weight in the fridge (72.91 g).

There was a statistically significant relationship between the mean weight of *E. fimbriata* infested with larvae of *D. maculates* treated in oven and in fridge

(P<0.05, R=0.801, tr=1.00, df=df=6). The result of Duncan multiple range test for the oven and fridge treatment of *C. nigrodigitatus* shows that there was no significant difference between the weight loss impact of low infestation (L<sub>1</sub>) and medium infestation (M<sub>1</sub>) of *C. nigrodigitatus* with *D. meculatus* whereas there was a significant difference in weight loss between the low infestation (L<sub>1</sub>) and high infestation (H<sub>1</sub>) of *C. nigrodigitatus* with *D. maculatus*. Similarly, Duncan's multiple range test for oven and fridge treatment of *E. fimbriata* with *D. maculatus* infestation reveals that there was no significant difference in weight loss between low infestation (L<sub>1</sub>) and medium infestation (H<sub>1</sub>) of *E. fimbriata* with *D. maculatus*.

The result in Table 4 shows the proximate analysis of the two samples examined which was *C. nigrodigitatus* and *E. fimbriata*. Data for the following was examined: moisture, protein, lipid, ash, fibre, carbohydrate contents (all in percentage) and caloric value (kcal). The result reveal that *C. nigrodigitatus* have higher values of ash content, fibre content, than that of *E. fimbriata* which in turn have better values of moisture content, protein content, lipid content, carbohydrate and caloric values than *C. nigrodigitatus*. Thus, *E. fimbriata* is a better fish than *C. nigrodigitatus* in terms of nutritive content.

Consequently, Table 5 compares the proximate

**Table 3.** Mean weight losses (g) of smoked *E. fimbriata* infested with larvae of *D. maculatus*.

Months of study	Mean weight in grammes (g)					
	Oven			Fridge		
	L <sub>i</sub>	M <sub>i</sub>	H <sub>i</sub>	L <sub>i</sub>	M <sub>i</sub>	H <sub>i</sub>
July, 2011	80.25	80.25	80.25	80.25	80.25	80.25
August	78.88	78.01	77.48	78.88	78.01	77.48
September	78.32	75.58	72.42	74.11	76.66	72.72
October	74.52	72.66	69.52	74.11	73.12	71.67
November	72.46	68.25	64.88	73.33	70.26	67.98
December	69.66	68.12	64.66	71.12	68.14	63.85
January, 2012	67.32	60.41	56.22	69.89	64.24	59.05
Total	519.41	499.28	481.43	524.36	510.68	496.00
X	74.19	71.33	68.77	74.91	72.96	70.86

R = 0.801, tr = 1.00, df = 6, p<0.05

**Table 4.** Proximate analysis of smoked *Chrysichthys nigrodigitatus* and *Ethmalosa fimbriata*.

Sample description	Moisture content (%)	Protein content (%)	Lipid content (%)	Ash content %	Fibre content (%)	Carbohydrate content (%)	Caloric value (kcal)
<i>C. nigrodigitatus</i> (A <sub>1</sub> )	0.91	5.80	12.23	17.38	11.58	4.59	391.63
<i>E. fimbriata</i> (B <sub>1</sub> )	1.4	67.55	12.57	8.63	5.75	11.25	428.33

**Table 5.** Proximate analysis of smoked *Chrysichthys nigrodigitatus* before and after six (6) months of *Dermestes maculatus* infestation.

Sample description	Moisture content (%)	Protein content (%)	Lipid content (%)	Ash content (%)	Fibre content (%)	Carbohydrate content (%)	Caloric value (kcal)
<i>C. nigrodigitatus</i> A <sub>1</sub>	0.91	65.80	12.23	17.38	11.59	4.59	391.3
<i>C. nigrodigitatus</i> (A <sub>2</sub> )	6.00	36.05	46.50	4.10	31.00	13.35	234.50

Tcal = 1.89, df = , (P<).05) MIS. *Chrysichthyes nigrodigitatus* A<sub>1</sub> (Before infestation) A<sub>2</sub> (After infestation). *Ethmalosa fimbriata* B<sub>1</sub>(before infestation) B<sub>2</sub> after infestation.

**Table 6.** Proximate analysis of smoked *Ethmalosa fimbriata* before and after six (6) months of *Dermestes maculatus* infestation.

Sample description	Moisture content (%)	Protein content (%)	Lipid content (%)	Ash content (%)	Fibre content (%)	Carbohydrate content (%)	Caloric value (kcal)
<i>E. fimbriata</i> (B <sub>1</sub> )	1.43	67.55	12.57	8.63	5.75	11.25	428.33
<i>E. fimbriata</i> (B <sub>2</sub> )	9.79	71.40	20.50	1.87	1.87	13.60	327.38

t-cal = 0.81, df = 6, (P<0.05).

analysis of *C. nigrodigitatus* after six months of infestation with *D. maculatus* respectively. Table 5 presents the proximate analysis of smoked *C. nigrodigitatus* before and after six months of *D. maculatus* infestation. It was seen that the moisture content increased from (0.91-6.00). Other content that showed geometric increases were lipid, fibre and carbohydrate contents (12.25-46.50, 11.59-31.00, 4.59-13.35) respectively. Whereas on the

other hand, some content showed a decrease during the period of observation and these were protein content (65.80-36.05), Ash content (17.38-4.100 and caloric value (391.63-234.50).

In Table 6, moisture, protein and fibre contents showed increase in the values while lipid, ash, carbohydrate contents and caloric values were reduced during period of observation in *E. fimbriata*. The differences between

**Table 7.** Assessment of storage/preservation methods. Quality attributes assessment for *E. fimbriata* and *C. nigrodigitatus*.

Method of preservation	O	L	M	H	A	Firmness
Foil paper	No sign of damage	No hole, no canal	Flesh intact, not eaten	Skeleton not exposed	Fair	Firm
polythene paper	Seventy five percent damage	Occasional holes and canals	Flesh seventy five percent eaten	Skeleton partially exposed	Unacceptable	Soft
Iron basket	Completely damaged	Complete holes and canals	Flesh completely eaten	Skeleton completely exposed	Unacceptable	Very soft

O =Sign of damage, L=Canal and holes on flesh, M=Flesh status, H=Skeleton, A=Appearance, F=Firmness.

the proximate value of *C. nigrodigitatus* and *E. fimbriata* before and after infestation with *D. maculatus* showed no statistical difference ( $P < 0.5$ ).

The result of the preservative methods of smoked dried fish in Table 7 indicates that use of foil paper can preserve smoke dried fish for a longer time while preservation in polythene paper and iron basket is unacceptable except as temporary measure.

## DISCUSSION

The degree of infestation of *D. maculatus* has shown a significant influence on the weight of *C. nigrodigitatus* and *E. fimbriata* respectively. However, influence of oven treatment leads to weight loss. This could be as a result of the increased intensity of heat in the oven which helps in dehydrating their proximate constituent resulting in weight loss of the fish. The fridge can lead to increase in weight by hydration at the initial stage.

Similarly, weight loss on smoked fish as a result of further preservation in oven has been reported by Ogbonnaya and Ibrahim (2009), Okonta and Ekelemu (2005) and Tayo and Linchun (2008). This study reported significant decrease in the weight of fish preserved in the fridge at different infestation level though the mean weight in fridge of *C. nigrodigitatus* (265.55 g) and *E. fimbriata* (72.91 g) was higher than that of the oven (261.85 g and 70.62 g) respectively. These is similar to previous report by Oke et al. (2014) who noted that weight of smoke fishes decreases as storage duration increases.

Generally, the relationship between the weight loss in oven and treatment in fridge was not significant. Okonta and Ekelemu (2005) recorded positive influence of fridge on the weight of fish infested with *D. maculateus* as there was a higher mean weight recorded (159.3) for *C. nigrodigitatus* in the oven (148.63 g).

This treatment medium (oven and fridge) has an effect on the proximate values of *C. nigrodigitatus* and *E. fimbriata* with *D. maculatus*. Some of the proximate

constituents, moisture (6.00%), lipids (45.50%), fibre (31.00%) and carbohydrate (13.35%) increase geometrically, whereas the protein (36.05%), Ash (4.10%) and caloric value (234.50kcal) decrease consistently. This is in contrast with the report of Tayo and Linchun (2008); they have however reported increase in protein content of smoke dried fish infested with *D. maculatus*. This work is in line with study of Ogbonnaya and Ibrahim (2009) as they recorded increase in the moisture and lipids and carbohydrate contents as well as decrease in protein and ash in smoke dry infested fish with *D. maculates*; the disparity may be attributed to the variation in Ash content of the species. Other earlier reports on the effect of *D. maculatus* on smoke-dry fish are Fawole et al. (2007) and Taylor (1998).

The initial higher levels in moisture, protein, lipid and carbohydrate contents of *E. fimbriata* than those of *C. nigrodigitatus* indicates that *E. fimbriata* is more in nutritive value than *C. nigrodigitatus* which is a more widely acceptable and highly sought for by the rich in the society.

Infestation of *E. fimbriata* by *D. maculateus* indicates decrease in the nutritional value of this fish, as previously reportedly by Oke et al. (2014). This study recorded increase in moisture content (9.79%), protein (71.40%), lipids (20.50%), fibre (13.6%) proximate values after six months of infestation with *D. maculateus* recorded increase in protein content in *E. fimbriata*, it decreases the protein value in *C. nigrodigitatus*. This increase in protein value was in accordance with the findings of Tayo and Linchun (2008). It is likely the skin of *E. fimbriata* is rich in protein, lipid and fibre.

The significant increase in the lipid content was in line with the study of Mendez (1996). Also, the increase in moisture content and fibre content recorded for *E. fimbriata* was not strange as Fawole et al. (2007) reported significant increases in smoke dry fish. This increase could be as a result of the nutritive content of the fish bones and flesh that remain as the corresponding removal of the flesh by *D. maculateus*.

However, ash content (1.87%), carbohydrate (6.23%) increase in six months of *E. fimbriata* infestation with *D. maculatus* indicates that the flesh of *E. fimbriata* is rich in Ash and carbohydrate. The degree of deterioration caused as a result of *D. maculatus* infestation on *C. nigrodigitatus* during the storage period is an indication that the nutrient value of *C. nigrodigitatus* are mostly stored in the skin and bone except for carbohydrate content. Sikorski et al. (1989) reported negative effect of smoke fish with low carbohydrate content to human content. Generally, the effect of this *D. maculatus* on smoke fish has indicated a serious concern on smoke fish storage strategy.

The result of the preservative assessment of smoke dried fish indicates that use of foil paper can preserve smoke fish (dried) for a longer period and this could be as a result of metal coating of the foiled paper which helps in heat maintenance and preservation of hydration. Whereas the iron basket sample was heavily infested by pest which laid their eggs on the body surface, their activities impart unsavoury odour and unacceptable appearance to the samples. The partial change observed in the samples preserved with clean quality sacks lined with polythene paper as a result of immigration of pest especially *Dermestes spp*, adult which can penetrate the polythene bag. However, the risk of such infestation can be reduced by improved hygiene and proper treatment with recommended insecticide

## Conclusion

Tissue degradation and weight loss of smoked fish sample was related to the infestation levels and exposure time. The longer the periods of storage of infested smoked fish, the more the tissues are degraded. There were significant influences of *D. maculatus* infestation of *C. nigrodigitatus* and *E. fimbriata* on their proximate compositions. Different nutritional compositions undergo different changes due to *D. maculatus* infestation. This research provides nutritional information on *C. nigrodigitatus* and *E. fimbriata* before and after infestation with *D. maculatus*. The present study also provides possible application of foiled paper in preservation of smoked fish for long time preservation and transportation.

## REFERENCES

- Ajao M (2012). Evaluation of the efficacy of Neem Seed Oil (NSO) for the control of *Dermestes maculatus* Degeer, 1774 (coleoptera: Dermestidae) in *Clarias gariepinus* (Burchell 1822) (pisces: claridae) *Munis*. Entomol. Zool. J. 7(2):188-194.
- Atijegbe S (2011). Infestation of smoke fish in Nigeria. Heineken Press, pp. 81-96.
- Ayuba V, Omeji N (2006). Effect of insect infestation on the shell life of smoked dried fish proceedings of the 21<sup>st</sup> Annual Conference of the Fishes Society of Nigeria (FISON), Calabar, 13<sup>th</sup> – 17<sup>th</sup> November, 357 – 359.
- Blatchford S (1962). Insects infestation problems with dried fish. University of Ibadan Press, pp. 212-224.
- Boeke S (2001). The use of plant material to protect stored dried fish against beetles. A Review. The Netherlands: Backhays Publishers, p. 108.
- Doyle E (2007). Microbial Food Spoilage, Losses and Control Strategies. Food Research Institute, University of Wisconsin-Madison, pp. 55-74.
- Esser J (1986). Evaluation of insecticides to protect salted-dried fish from insect infestation during processing and storage. Backhuys pp. 94-105.
- Eyo A, Mdaihi L (1997). Assessment of post-harvest losses in the Nigeria fishery. The Kainji Lake model report and papers presented at the seventh FAO Expert consultation on fish.
- FAO (1981). The Prevention of losses in cured fish. FAO Fish Technology No. 219:87.
- Fawole OO, Ogundisan M, Ayandiran A, Olagunju OF (2007). Proximate and Mineral Composition in some selected fresh water fishes in Nigeria. Internet J. Food Saf. 9:52-55.
- Holzlohner S, Enin UI, Nwosu FM, Abasi DE (1998). Stock assessment of fish and shell fish species in the Cross River Estuary. 1998 Annual Report for National Research Programme, Nigeria.
- Lale N, Sastawa B (1996). The effects of sun drying on the infestation of the African catfish by post harvest insects in the Lake Chad District of Nigeria. Int. J. Pest Manage. 42:281-283.
- Marinetti O (1991). Proximate composition of Raw and cooked Thai freshwater and marine fish. J. Food Compos. Anal. (12): 9 – 16.
- Mendez S (1996). Lipid content and fatty acid composition of fillets of six fishes from the Rio de Plata. J. Food Compos. Anal. 9(2):163-170.
- Mohammed A, Yusuf S (2001). Insect infestation and preventive measure in dry fish storage of Chit Tagong, Bangladesh. J. Biol. Sci. (1):963-965.
- Odeyemi OO, Owoade RA, Akinkulere BL (2000). Toxicity and population suppression effects of *Dermestes maculatus* and *N. rufipes*. Global J. Pure Appl. Sci. 6(2):191-195.
- Ogbonnaya C, Ibrahim M (2009). Effects of drying methods on proximate compositions of catfish. World J. Agric. Sci. 5(1):114-116.
- Oke OA, Ehien OO, Ademolu KO (2014). Effect of *Dermestes maculatus* Degeer, 1774 on Smoked African cat fish *Clarias gariepinus* (Burchell 1822) during storage. Afr. Entomol. 22(1):110-114.
- Okonta A, Ekelemu J (2005). A preliminary study of micro-organisms associated with fish spoilage in Asaba, Southern Nigeria. Proceedings of the 20<sup>th</sup> Annual Conference of the Fisheries Society of Nigeria (FISON) 557-560.
- Osuyi F (1974). Beetle infestation in dried fish purchased from Nigeria markets with special reference to *Demertes maculatus* and *Necrosia rufipes*. Niger. J. Entomol. 1:69-70.
- Rattagool P (1988). Evaluation of ineptitudes to protect salted dried fish from insect infestation during processing and storage. FAO Report No. 41:189-204.
- Sikorski ZE, Kolakowska A, Burt JR (1989). Post harvest biochemical and microbial changes sea food resources, nutritional composition and preservation Boca Rator Florida CRC Press MC.
- Taylor R (1998). The infestation of dried fish by *Dermestes spp*. In Africa and appropriate control measures. Paper presented at UNIDO Workshop on Appropriate Technology, Nairobi.
- Tayo W, Linchun M (2008). Influence of Hot air drying and microwave drying on nutritional and odorous properties of grass carp fillets. Food Chem. p. 110.
- Zakka U, Ayertey JN, Cobblah MA (2013). Development of *Dermestes maculatus* Degeer, 1774 (coleoptera Dermestidae) on different fish substrate. Jordan J. Biol. Sci. 6(1):5-10.