International Journal of Fisheries and Aquatic Research
ISSN: 2456-7248; Impact Factor: RJIF 5.44
Received: 08-08-2019; Accepted: 09-09-2019
www.fishjournals.com
Volume 4; Issue 4; October 2019; Page No. 38-41

Moisture content, weight loss and anti-oxidative stress enzyme activities in muscles of insect infested- smoked fishmeal compared with commercial fishmeal

Ezike CO[1*], Okechukwu GCE[2], Agbo AN[3]
[1] Department of Animal/Fisheries Science and Management, Enugu State University of Science and Technology Enugu Nigeria
[2] Department of Agronomy and Ecological Management, Enugu State University of Science and Technology, Nigeria
[3] National Open University of Nigeria

Abstract
The present research on pest infestation of smoked dried fishmeal's from catfish, croakers and tilapia compared to commercial fish meal were carried out to access the effect of exposed preserved fish product to adult *Dermestes maculatus*. The aim of the study was to determine the effects of the insect on smoked fish with respect to moisture content, weight loss and anti-oxidative enzyme activities of muscle tissue. The research was carried out at the Fisheries unit of ESUT Teaching and Research Farm, Agbani. The fish specimens used were gutted after which their carcass was washed and smoked in a kiln for 6 hours. Four treatments comprised of fish meal which served as control and fish meals of the 3 species were replicated three times. Five adult D*ermestid* beetles were introduced to each of the replicate and the experimental duration lasted for 3 weeks. Differences in moisture content were shown in week 2 and 3 between tilapia and control and the other 2 fishes with control on week 3. The weight loss recorded no significant difference ($P > 0.05$) among all the treatments and the control throughout the experiment but showed evidence of weight reduction with increase in exposure time. Superoxide dismutase (SOD) was significantly higher ($P < 0.05$) in all treatments compared to the control. The highest value of 1.8463 U mg protein $^{-1}$ was recorded in tilapia fish on the week 3 while the least value was recorded in croaker 0.7327 U mg protein $^{-1}$ on week 1. The LPO was significantly different ($P < 0.05$) in all the treatment weeks with highest value in catfish on week 3 (0.5020 mMole/TBARS/ mg protein). Catalase activity was significantly elevated ($P < 0.05$) in tilapia compared to the control. The highest value of CAT was recorded to be 0.6240 umol mm^{-1} mg protein^{-1} in tilapia on week 3, while the least value of 0.1050 umol mm^{-1} mg protein^{-1} was recorded in croaker on week 1. Differences existed between control and treatments in respect of the oxidative stress enzymes activities and showed evidence of elevation of LPO in catfish compared to the control. The results of this study showed that the weight loss of infested fish decreased with increase in storage time and did indicate that tissue moisture content and peroxidation of smoked fish samples was related to the infestation and exposure time. Thus, the longer the period of storage of infested smoked fish, the more the moisture and oxidative stress. Catfish, croaker and tilapia enhanced CAT and SOD levels when exposed to *Dermestes maculatus*. Storage of smoked Fish should be for a short period of time not longer than 2 weeks to avoid pest infestation which results to increased peroxidation and moisture. There is however the need for further studies to reveal the DNA damage, haematology and other biochemical effects.

Keywords: moisture content, weight loss, anti-oxidative stress enzyme activities, dermestes maculatus, smoked fish

Introduction
Insect infestation of cured fish by hide beetle *Dermestes maculates* is an important cause of post-harvest fish losses in many developing countries such as Nigeria. Fish are susceptible to attack by insect pests throughout the processing and storage time of which the commonest post-harvest fish preservation is smoking (Reed, 1997: Reed, 2009) [17, 18], which provides very little control against insect's attack (Okorie, 2003) [12]. Under prevailing conditions, it is estimated that between 25 - 75% of the nutritional value of fish is lost during attack by insect pests. The insect pests invade the fish at different stages of processing and storage during which time they attack the fish causing varying damages (Moses, 2006) [8].

The major challenge faced by fish farmers is that fish are perishable and easily infested by insect pests. It is in the light of this that most fish farmers have developed the use of the smoking method for the preservation of their fish. An estimated 95% of the total artisanal fish landings are smoked; the problem of large scale insect infestation often results in more than 50% losses due to inadequate moisture removal in the smoked fish, packaging and storage (Moses, 2006) [8]. The need to further investigate the exact nature and rate of damage (Ghaly *et al*., 2010) [4] caused by insect on smoked fish which impair its nutritional qualities is desirable to estimate the weight loss, moisture content and anti-oxidative enzyme activities of stored smoked fish. Species of *Dermestes* belong to the beetle family (Nduh, 2004) [9] and the feeding by their larvae and adults cause considerable quantitative loss of dried cured fish that often lead to fragmentation. The extent and value of quantitative losses in dried fish by *Dermestes spp*, have been assessed (Osuji, 2005; Proctor, 2007; Proctor, 2009) [13, 15, 16] whose estimates ranged from negligible to 50% reduction in weight which may be dependent on storage period (Mbunda, 2013) [6]. The aim of this study was to compare the effects of insect on moisture content, weight loss and anti-oxidative enzyme activities of smoked fish meals with those of commercial fish meal.

2. Materials and Methods

The experiment was carried out at the Fisheries Unit of Enugu State University of Science and Technology Teaching and Research Farm Agbani- Enugu, Nigeria. The area lies within Latitude 07° 4' North and 08° 2' South and Longitude 06° 8' East and 07° 6' West. It has a mean annual rainfall which ranges from 1600mm to 1800mm and a mean temperature of 30^0C during the hottest weather (February – April) and 22^0C during the coldest period of the year (December – January) Three (3) specimens of African catfish, tilapia and croaker fish were bought from Artisan market in Enugu. Fish specimens were gutted and washed thoroughly with clean water after which the carcasses were smoked over a smoking kiln for 6 hours. They were allowed to dry and mealed before the introduction of 5 adult Dermestid beetle per replicate group for 3 weeks.

2.1 Weight Loss and moisture content

Body weight of the fishes, moisture content and anti-oxidative stress enzymes were measured using standard procedures. The moisture content was determined after smoking samples at 105°C for 6hours with the use of automated oven.

2.2 Anti-Oxidative Enzymes Activities

Sample fishes exposed to the insects were assessed for the anti-oxidative enzyme glutathione peroxidase GPX according to the method of Sharma and Krishna- Muri, 1968[19] which involved H_2 O_2 breakdown, and was measured spectrophotometrically. Superoxide dismutase (SOD) activity was determined using the method of Misra and Fridovich (1972) [7]. Superoxide dismutase activity was assed spectrophotometrically at 420 nm and expressed as the amount of enzyme mg/L of protein required to give 50% inhibition auto-oxidation. Glutathione peroxidase (GPX) activities was measured according to Paglia and Valentine (1967) [14] which was based on the oxidation of gluthathione in the presence of NaN_3. The catalase (CAT) in the tissue was determined according to the method of Takahara *et al.*, (1960) [21] which involved H_2 O_2 breakdown, and was measured spectrophotometrically at 240 nm. Enzyme activity was expressed as nanomoles of H_2 O_2 decomposed min/L mg/L protein.

2.3 Experimental Design and statistical analysis

The experiment followed the completely randomized design (CRD) in which treatments fishmeals each replicated thrice were adopted. Treatment 1 was commercial fishmeal which served as the control, treatment 2 was smoked catfishmeal *Clarias gariepinus*, treatment 3 was smoked tilapiameal *Oreochromis niloticus* while treatment 4 was smoked croakerfishmeal *Micropogonias undulatus*. Data was collected using Statistical Package for Social Sciences (SPSS) computer package, version 20.0 and subjected to one-way analysis of variance (Steel and Torrie, 1990) [20]. Difference in means was separated using the Duncan multiple range test at ($P < 0.05$).

3. Results

The moisture content, weight loss and anti-oxidative enzyme activities of insect infested smoked fish is presented on tables below:

Table 1: Moisture content, weight loss and oxidative stress of smoked fish tissue

Fish	Week 1	Week 2	Week 3
Catfish	24.00 ± .00000^a	24.13 ± .03333^b	24.56 ± .03333^e
Croaker Fish	24.00 ± .00000^a	24.30 ± .05774^b	24.53 ± .03333^e
Tilapia Fish	24.00 ± .00000^a	24.10 ± .00000^a	24.70 ± .05774^f
Ctrl	24.00 ± .00000^a	24.00 ± .00000^a	24.00 ± .00000^a

Weight Loss (g)

Table 2

Catfish	0.00	0.13 ± .03333^b	0.53 ± .03333^c
Croaker Fish	0.00	0.17 ± .03333^b	0.70 ± .05774^e
Tilapia Fish	0.00	0.23 ± .03333^b	0.50 ± .05774^c
Ctrl	0.00	0.23 ± .03333^b	0.70 ± .05774^e

Superoxide Dismutase (SOD) U mg protein $^{-1}$

Table 3

Catfish	1.34 ± .00088^c	1.76 ± .00088^e	1.80 ± .00145^f
Croaker Fish	0.73 ± .00088^a	1.30 ± .00058^c	1.40 ± .00058^c
Tilapia Fish	1.09 ± .00058^b	1.81 ± .00088^f	1.85 ± .00088^f
Ctrl	1.55 ± .46448^a	1.62 ± .00058^d	1.71 ± .00404^e

Lipid Peroxidation (LPO) mMole/TBARS/ mg protein

Table 4

Catfish	0.39 ± .00088^e	0.44 ± .00133^h	0.50 ± .00058^i
Croaker Fish	0.33 ± .00058^b	0.37 ± .00115^d	0.39 ± .00231^e
Tilapia Fish	0.37 ± .00088^d	0.39 ± .00058^f	0.41 ± .00033^g
Ctrl	0.44 ± .00058^h	0.44 ± .00058^i	0.44 ± .00484^i

Catalase Activity umol mm^{-1} mg protein^{-1}

Table 5

Catfish	0.11 ± .00058^a	0.11 ± .00120^a	0.1210 ±.00058^a
Croaker Fish	0.11 ± .00058^a	0.11 ± .00033^a	0.2073 ± .00033^b
Tilapia Fish	0.49 ± .00033^f	0.50 ± .00058^f	0.6240 ± .00058^g
Ctrl	0.25 ± .00088^c	0.26 ± .00145^c	0.2943 ± .00088^d

GPX umol mm^{-1} mg protein^{-1}

Table 6

Catfish	nd	nd	nd
Croaker Fish	nd	nd	nd
Tilapia Fish	nd	nd	nd
Ctrl	nd	nd	nd

Nd= not detected in muscle tissue

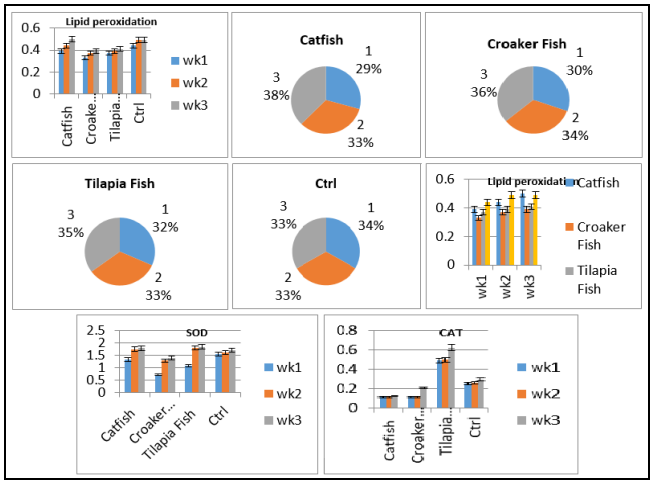

Fig 1: Lipid peroxidation compared in sample fish to control showed significant difference with greatest peroxidation in catfish 38%>croaker36%>tilapia 35% in time dependent manner

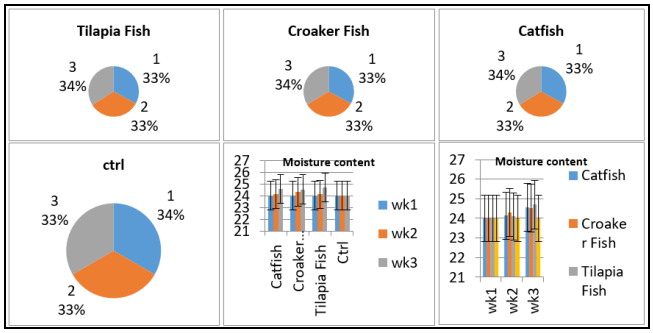

Fig 2: Moisture content varied with control in time dependent manner on week 3

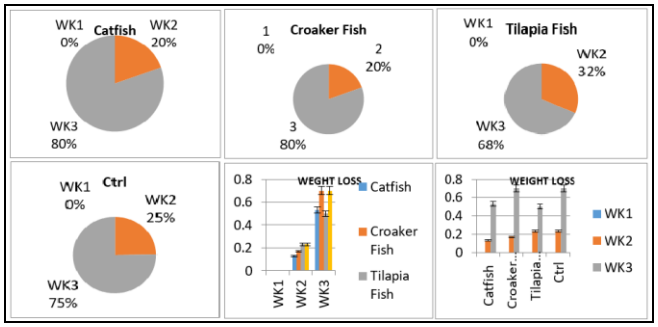

Fig 3: Weight loss did not differ with control but increased in time dependent manner with highest loss in catfish and croaker fish 80%>ctrl75%> tilapia68% on the third week

A difference in moisture content was shown in week 2 and 3 between tilapia and control and all 3 fishes with control on week 3. The weight loss recorded in the above showed no significant difference ($P > 0.05$) among the treatments and the control but recoded increases was shown along the period. Superoxide Dismutase (SOD) was significantly higher ($p < 0.05$) in all treatments compared to the control. The highest value of (1.8463 U mg protein $^{-1}$) was recorded in tilapia fish on the week 3 while the least value was recorded in Croaker (0.7327 U mg protein $^{-1}$) on week 1. There was significant difference ($p < 0.05$) in all the treatment weeks, but significant differences ($p < 0.05$) was shown to be higher in catfish on week 3 (0.5020 ± 0.00058 mMole/TBARS/ mg protein), thus Lipid peroxidation compared in sample fish to control showed significant difference with greatest peroxidation in catfish 38%>croaker36%>tilapia 35% in time dependent manner. Catalase activity was significantly elevated ($P < 0.05$) in tilapia compared to the control. The highest value of CAT was recorded to be 0.6240 umol mm^{-1} mg protein^{-1} in tilapia on week 3, while the least value of 0.1050 umol mm^{-1} mg protein^{-1} was recorded in croaker on week 1. The weight recorded in all the treatment did not show significant difference ($p < 0.05$) in all the weeks compared to control.

4. Discussion

Fish preservation is aimed at making the processed fish to be environmentally unfavourable for the growth of spoilage organisms. Fish however is an extremely perishable food item (Odeyemi *et al.*, 2000) [11] which soon after death, begins to spoil. In the healthy live fish, the complex biochemical reactions are balanced and the fish flesh is sterile but soon after death, irreversible changes results in fish spoilage, which begins with the effect on the decomposition of the fish muscle tissue (Odeyemi *et al.*, 2000; Mbunda, 2013) [11, 6]. The handling and the preservation practices after capture' affects the degree of spoilage of the fish (Bligh *et al.*, 2001). The quality of the freshly caught fish and its usefulness for further utilization and processing is affected by the fish capture and preservative method. Unsuitable fishing method does not only cause mechanical damage to the fish, but also creates stress and the conditions which accelerate fish deterioration after death. Fish is highly susceptible to deterioration without preservation or processing measures. Chen *et al.* (2001) [2] reported that immediately the fish dies, a number of physiological and microbial deterioration set in and thereby degrade the fish. FAO (2009) [3] reported different types of preservation methods including smoking of fish. The use of smoked fish as a source of foreign exchange is gradually losing ground, which can be adduced to the fact that exportation of processed fish to developed countries is becoming increasingly stringent because of high content of moisture and other emerging set of food safety and Agricultural health standard rules (Moses, 2006) [8].

Food lipids have specific roles such as the maintenance of quality of foods by influencing organoleptic characteristics of food and thus its desirability (Latour *et al.*, 2013) [5]. Lipid oxidation can occur enzymatically in presence of oxidative stress enzymes which try to modulate the associated peroxidation following exposure to insect infestation (Nguyen *et al.*, 2012) [10], which corroborated with the present findings. Catalase activity in smoked tilapiameal was significantly elevated when compared to the control and was followed smoked-catfishmeal and croakermeal, throughout the duration of the study. Dismutase superoxide SOD increased significantly among all the treatments compared to control but GPX was not detected in the muscles. Lipid peroxidation was shown to be highest in catfish and there was a significant difference in all the treatment weeks. The aforementioned gave suggestion that catfish, tilapia and croaker enhanced CAT and SOD levels when exposed to *Dermestes maculatus*.

5. Conclusion

The results of this study showed that the weight loss of infested fish decreased with increase in storage time and did indicate that tissue moisture content and peroxidation of smoked fish samples was related to the infestation and exposure time. Thus, the longer the period of storage of infested smoked fish, the more the moisture and oxidative stress. Catfish, croaker and tilapia enhanced CAT and SOD levels when exposed to *Dermestes maculates*. Storage of smoked Fish should be for a short period of time not longer than 2 weeks to avoid pest infestation which results to increased peroxidation and moisture. There is however the need for further studies to reveal the DNA damage, haematology and other biochemical effects.

6. References

1. Bligh EG, Dyer WJ. A rapid method of total lipid extraction and purification. Canadian Journal of Biochemistry and Physiology. 2001; 37:911-917.
2. Chen FC, Waren W, Levin RE. Identification of major high boiling volatile compounds produced during

Refrigerated storage of gaddock fillets. Applied Microbiology. 2004; 28:680-769.
3. FAO. Ice in fisheries. Food and Agricultural Organization. FAO Fisheries Report Series. 2009; 59:1-68.
4. Ghaly AE, Dave D, Budge S, Brooks MS. Fish Spoilage Mechanisms and Preservation Techniques: Review. American Journal of Applied Sciences. 2010; 7(7):859-877.
5. Latour MA, White HM, Richert BT. Impacts of Nutrition and Environmental Stressors on Lipid Metabolism, 2013. http://dx.doi.org/10.5772/51204
6. Mbunda AE. The quality changes in smoked and dried fresh water sardine (Rastrineobola argentea) and marine pelagic fish (caplin) as influenced by processing methods. [final project], 2013. http://www.unuftp.is/static/fellows/document/arnold12prf.pdf
7. Misra HP, Fridovich L. The role of superoxide anion in the autooxidation of epinephrine and a simple assay for superoxide dismutase. J Biol. Chem. 1972; 247:3170-3175.
8. Moses AG. Use of smoking to add value to Salmoned trout, Broz Arch Bio Technol. 2006; 49(1):57-62.
9. Nduh TA. Insect pests of died fish sold in Jos Metropolitan market. MSc. Thesis, University of Jos, Nigeria, 2004, 126 pp.
10. Nguyen VM, Thorarinsdottir KA, Thorkelsson G, Gudmundsdottir A, Arason S. Influences of potassium ferrocyanide on lipid oxidation of salted cod (Gadus morhua) during processing, storage and rehydration. Journal of Food Chemistry. 2012; 131(4):1322-1331.
11. Odeyemi OO, Owoade RA, Akinkarolere A. Toxicity and population suppression effect of Parkia cloppatoniana on dried fish pest (Dermestes macuatus and Necrobia rufipes) Global Journal of Pure and Applied Science. 2000; 6(2):191-195.
12. Okorie RA. Variation in Lipid and Fatty acid contents, Alantic Croakers. Stiped mullet and summer flounder; Transaction of the American fishing society. 2003; 120:614-619.
13. Osuji FUC. Recent studies on beetle infestation of dried fish in Nigeria with reference to Lake Chad district. Nigerian Journal of Entomology. 2005; 1:63-68.
14. Paglia DE, Valentine WN. Studies on the quantitative and the qualitative characterization of erythrocyte gluthathione peroxidase. J Lab. Clin. Med. 1967; 70:158-169.
15. Proctor DL. The protection of smoked dried freshwater fish from insect damage during storage in Zambia. Journal of Stored Products Research. 2007; 8:139-149.
16. Procter T. Effect of Smoking Drying on the Nutritive Value of fish; A review of Japanese studies in Fish smoking and unsmoking, 2009.
17. Reed ME. Properties of fish oils and the application to handling of fish and to nutritional and industrial use. Chemistry and Biochemistry of Marine Food Products. Ayi Publishing CO. Westport, 1997, Pp.15-92.
18. Reed W, Burchar J, Hopson AJ, Jonathan J, Ibrahim Y. Fish and Fisheries of Northern Nigeria. Government Press, London, 2009, 226 pp.
19. Sharma SK, Krishna-Muri CR. Production of lipid peroxides by brain. J. Neurochem, 1968; 17:147.
20. Steel RGD, Torrie JH. Principles and Procedures Statistics, Biometrical Approach. 2 nd edition, Mc Graw-Hill Books, Tokyo, Japan, 1990, 633 pp.
21. Takahara S, Hamilton HB, Neel JV, Kobara TY, Ogura Y, Nishimura ET. *et al*. Hypocatalasemia, a new genetic carrier state. J Clin. Invest. 1960; 39:610-619.