EFFECT of *Dermestes maculatus* INFESTATION ON SOME NUTRITIONAL COMPOSITION OF SMOKED AFRICAN CATFISH, *Clarias gariepinus* BURCHELL, 1822

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ABSTRACT

Studies on pest infestation of some nutritional composition of smoked-dried Clarias gariepinus were carried out, to assess the effect of exposing preserved fish products to different levels of infestation by Dermestes maculatus and the resultant effect on pH, crude protein (CP), free fatty acid (FFA) and tissue contents. Graded levels (5, 10 and 15) of larval and adult D. maculatus were used to infest pieces of C. gariepinus placed in 7 groups of 3 bottles per group. The experiment lasted 8 weeks (56days). There were consistent decreases in the pH and CP as well as the tissue contents of fish with storage time, although the CP content of the samples with the larval pests did not differ significantly from those without larval pests (P > 0.05). Fish samples exposed to adult pests showed significant variation (P < 0.05) in their pH and CP contents while the FFA content increased with storage time but was not significant (P > 0.05). The longer the storage periods of the infested smoked fish the more the tissue was degraded.

Keywords: *Dermestes maculatus, Clarias gariepinus* infestation

INTRODUCTION

The African catfish, genus *Clarias* has very high commercial value in Nigeria owing to its flavour and taste. The good quality coupled with its ability to feed on virtually anything makes the fish a highly recommended species for aquaculture development in Nigeria (Reed *et al.*, 1967; Bard *et al.*, 1976; Olatunde, 1983).

The phenomenon of fish preservation is enunciated by the simple principle of making fish unfavourable for the growth of spoilage organisms. In Nigeria, fish drying is the most adopted technique since it is within the socio-economic levels of artisanal fishermen contributing over 90% of domestic fish supply (Mabawonku and Ajayi, 1982). Many materials subjecting fish to different preservation techniques notably: traditional smoking, traditional solar drying, oven and Ife solar drying have been carried out (Afolabi *et al.*, 1984). Analyses of the preserved fish showed the occurrence of a high proportion of predominantly unsaturated fatty acids in oven and Ife solar-dried fish compared to the traditionally smoke-dried fish. In spite of the shortcoming, there is an insatiable market for dried fish products in the country.

An estimated 95% of the total artisanal fish landings are smoked or sun-dried; the problem of large scale infestation often results in more than 50% losses due to inadequate packaging and storage (Moses, 1983). The need to further investigate the extent and rate of damage of the nutritional quality of dried fish products becomes imminent. Studies on the action of *D. maculatus* as a pest of dried fish and meat in Nigeria and Zambia have been carried out (Osuji, 1975; Proctor, 1977). Although much work has been done on the prevalence and rate of degradation of this pest to host species, little has been done on the effect of pest infestation on nutritional quality of *Clarias gariepinus*. The objective of this study therefore was to determine the effect of varying levels of pest infestation on the crude protein, free fatty acid, pH and tissue degradation of smoked *C. gariepinus*.

MATERIALS AND METHODS

Fish Collection and Preservation: Twentyone (21) live specimens (450 ± 2.30g) of African

Clarias_gariepinus. (Viveen *et al.*, 1986) was used in the identification of the fish specimens. The specimens were later killed, gutted and decapitated. The carcasses were cut into small pieces, washed thoroughly with water and immersed in 20% saline solution for 10 minutes in accordance with the methods specified by Horn (1974). The immersion in salt solution was to reduce the water activity (A_w) in the specimens and retard microbial development. They were subsequently smoked over a smoking kiln for 48 hours at 87^0C, packed into small polythene bags and kept in the Research Laboratory of Enugu State University of Science and Technology, Enugu.

Collection of D. maculatus: *D. maculatus* were obtained from 10kg of heavily infested dried C. gariepinus purchased from fish sellers at Enugu main market, Enugu, Nigeria. The larval and adult stages of this pest were disengaged from the tissues and placed in 21 clean reagent bottles (500ml) with perforated covers. In the laboratory, the pests were placed in another set of 21 clean reagent bottles (50ml) whose open ends were covered with mosquito-mesh nets.

Infestation of *C. gariepinus* with *D. maculatus*: The study was designed to have smoked pieces of *C. gariepinus* (0.50 kg) subjected to four treatment groups (A, B, C and D) of pest infestation. Group A represented the control with no pest infestation, while groups B, C and D represented low (LI), medium (MI) and high (HI) infestations of both the adult and larval stages of *D. maculatus*. Both the control (A) and the pest infested treatments (B, C and D) were replicated thrice to give a total of 21 experimental replicates.

Smoked pieces of *C. gariepinus* (10.50 kg) were measured out with a chemical balance and randomly placed in 21 clean reagent bottles (500 ml) at 0.50 kg of fish per bottle. Fish samples contained in 3 bottles under group B were infested with 5 adult *D. maculatus* while the remaining 3 bottles (under the same group) were infested with 5 larval pests. This level of infestation was regarded as low infestation (LI). Fish samples under group C were infested with 10 adult pests (3 bottles) and 10 larval pests (3 bottles) and this was also regarded as medium infestation (MI). Fish samples in group D were infested with 15 adult pests (3 bottles) and 15 larval pests (3 bottles) regarded as high infestation (HI). Group A fish samples (3 bottles) were uninfested and served as the control. Each group of bottles with infested fish samples was appropriately labelled according to treatment and left for investigation for 56 days.

Fish samples from each bottle were disengaged from larval and adult pests every 2 weeks (14 days), weighed and analysed chemically for crude protein (AOAC, 1995), free fatty acid (Marinetti,1967) and pH using a pH meter.

Chemical Analysis: Fat contents of fish samples were extracted by Bligh and Dyer (1959) method. The fatty acids were determined by gas-lipid chromatography (GLC) through esterification by refluxing in 4% sulphuric acid (H_2SO_4) and methylation with methyl-hydroxide (MeOH) for 16h at 79^0C (Marinetti, 1967). Complete esterification was confirmed by thin layer chromatography (TLC) on silica gel G plates using a solution of petroleum ether, diethyl ether, and acetic acid (90:10:1) as solvent system.

Total nitrogen was measured by micro-kjeldahl method and the crude protein content determined by multiplying by 6.25 (AOAC, 1995). The pH was determined with a pH meter immersed in a suspension of finely ground fish samples. All the data obtained were subjected to analysis of variance to determine the levels of significance (Steel and Torrie, 1990).

RESULTS

The crude protein (CP) content of *C. gariepinus* exposed to larvae of *D. maculatus* decreased consistently from a pre-infestation protein value of 78.52% to a least value of 45.23 % (Table 1). This result varied with smoked fish sample exposed to adult pest and whose crude protein content decreased from 78.52 % to 38.10 % within 8 weeks (56 days) experimental period. The least CP content was found in the control experiment after 8 weeks (56 days). This was compared to the least CP value (45.23 %) for high larval infestation (HI) and 53.61 % for medium larval infestation (MI) (Table 1). There was no significant difference $F(4,8) = 1.36$ ($P > 0.5$) in the CP content between various levels of larval infestation. However, there was a significant difference $F(4, 8) = 9.84$ ($P < 0.05$) in CP content of smoked fish exposed to adult *D. maculatus*.

The greatest loss (21.99 %) in tissue weight was recorded in *C. gariepinus* infested with adult *D. maculatus* (Table 2). This value indicated that the adult pests were more destructive than the larval pests. In addition, the fast rate of loss in tissue weight could be due to increase in fat content of the fish sample. Two-way analysis of variance indicated a significant difference between periods of exposure of infested fish samples and levels of treatments ($P < 0.05$). The control experiment showed uninfested fish samples with a declining trend of protein values and there was a

Table 1: Percentage (%) mean crude protein of smoked *C. gariepinus* infested with *D. maculatus*

Treatments	Weeks of Study				
	0	2	4	6	8
Larvae					
L1	78.52 ± 0.14	72.62 ± 0.25	68.40 ± 0.24	66.40 ± 0.09	61.20 ± 0.39
M1	78.52 ± 0.13	70.32 ± 0.19	67.01 ± 0.32	55.78 ± 0.49	53.61 ± 0.59
H1	78.52 ± 0.35	71.20 ± 0.65	69.14 ± 0.47	48.10 ± 0.18	45.23 ± 0.16
		F (4,8) = 1.36 (P > 0.05)			
Adults					
LI	78.52 ± 0.18	61.22 ± 0.23	61.25 ± 0.18	58.46 ±0.28	55.03 ± 0.05
MI	78.52 ± 0.45	67.50 ± 0.37	60.02 ± 0.48	56.74 ± 0.66	43.72 ± 0.48
HI	78.52 ± 0.36	60.04 ± 0.36	46.02 ± 0.34	43.72 ± 0.44	38.10 ± 0.26
		F (4,8) = 9.84 (P < 0.05)			
CTRL	78.52 ± 0.12	66.04± 0.66	55.87 ± 0.45	52.81 ± 0.56	45.81± 0.27

LI= low infestation, MI =medium infestation, HI = high infestation, CTRL = control

Table 2: Mean weight losses (g) of smoked *C. gariepinus* infested with *D. maculatus*

Treatments	Weeks of Study				
	0	2	4	6	8
Larvae					
LI	15.46 ± 0.34	14.26 ± 0.41	13.06 ± 0.14	10.66 ± 0.31	9.47 ± 0.22
MI	15.46 ± 0.26	13.06± 0.47	10.86 ± 0.47	9.30 ± 0.27	6.80 ± 0.45
HI	15.46 ± 0.55	11.66 ± 0.24	9.86 ± 0.24	7.86 ± 0.47	4.68 ± 0.10
	F - value (treatment) = 5.91 (P > 0.05); F - value (period) = 82.92 (P > 0.01)				
Adults					
LI	15.46 ± 0.08	13.66 ± 0.27	11.94 ± 0.34	10.59 ± 0.31	7.38 ± 0.40
MI	15.46 ± 0.45	12.48 ± 0.36	10.81 ± 0.48	7.80 ± 0.41	5.39 ± 0.31
HI	15.46 ± 0.35	12.96± 0.23	10.10 ± 0.22	7.34 ± 0.51	3.40 ± 0.41
	F - value (treatment) = 132.97 (P < 0.01); F-Value (period) = 3.63 (P < 0.05)				
CTRL	15.45 ± 0.35	15.43 ± 0.54	15.37±0.41	15.32±0.35	15.32 ± 0.35
	F - value (treatment) = 4.63 (P < 0.05); F-value (period) = 135.97 (P < 0.01)				

LI = Low infestation, MI = Medium infestation, HI= High infestation, CTRL = control

Table 3: Free fatty acids (as % total fatty acid weight) of total lipids of smoked *C. gariepinus* subjected to various levels of *D. maculates* infestation.

Treatments	Weeks of Study				
	0	2	4	6	8
Larvae					
LI	8.42 ± 0.13	9.15 ± 0.16	12.17 ± 0.32	16.96 ± 0.07	18.36 ± 0.14
MI	8.42 ± 0.28	10.85 ± 0.18	12.43 ± 0.21	15.97 ± 0.17	18.01 ± 0.58
HI	8.42 ± 0.15	9.36 ± 0.18	14.60 ± 0.20	18.71 ± 0.35	20.87 ± 0.43
	F - value (treatment) = 1.23 (P > 0.05); F-Value (period) = 108.38 (P < 0.01)				
Adults					
LI	8.42 ± 0.32	9.14 ± 0.66	11.25 ± 0.40	15.64 ± 0.32	19.50 ± 0.19
MI	8.42 ± 0.11	10.20 ± 0.33	13.03 ± 0.58	16.58 ± 0.26	20.00 ± 0.59
HI	8.42 ± 0.21	10.35 ± 0.43	13.48 ± 0.57	1674 ± 0.35	21.78 ± 0.38
	F - Value (treatment) = 3.89 (P < 0.05); F - Value (period) = 398.25 (P < 0.01)				
CRTL	8.42 ± 0.05	9.00 ± 0.12	12.70 ± 0.10	16.30 ± 0.40	20.10 ± 0.30
	F - Value (treatment) =3.82 (P < 0.05); F- Value (period) = 39.4 (P < 0.01)				

LI = Low infestation, MI = medium infestation, HI = High infestation, CTRL = Control

significant difference between these values and storage period (P < 0.05). However, no significant difference was obtained for fish infestation levels (P > 0.05)

The quantity of free fatty acids in *C. gariepinus* in response to the period of exposure to infestation of larval and adult *D. maculatus* is presented in Table 3. The result of the control experiment is also presented. The highest mean value of 21.78 ± 0.43 % is obtained from larval infestation. Two-way analysis of variance revealed a significant effect (P > 0.05) of both larval and adult infestation levels over storage time. However, the different levels of larval treatment

Table 4: Percentage (%) total lipids of smoked *C. gariepinus* infested with *D. maculatus*

Treatments	weeks of study				
	0	2	4	6	8
Larvae					
LI	8.60 ± 0.12	8.69 ± 0.14	8.05 ± 0.29	8.40 ± 0.08	8.70 ± 0.16
MI	9.31 ± 0.16	8.71 ± 0.26	8.71 ± 0.22	8.61 ± 0.18	8.71 ± 0.56
HI	8.60 ± 0.15	8.60 ± 0.18	8.73 ± 0.21	8.70 ± 0.36	8.70 ± 0.45
	F - value (treatment) = 1.60 (P > 0.05); F-value (period) = 38.77 (P < 0.01)				
Adults					
LI	8.39 ± 0.32	8.64 ± 0.64	8.72 ± 0.38	8.59 ± 0.33	8.60 ± 0.18
MI	6.73 ± 0.43	6.88 ± 0.32	6.94 ± 0.56	7.02 ± 0.24	7.58 ± 0.57
HI	6.24 ± 0.54	6.64 ± 0.41	6.98 ± 0.58	7.07 ± 0.35	7.46 ± 0.30
	F-value (treatment) = 2.63 (P < 0.05); F-Value (period) = 49.79 (P < 0.01)				
CTRL	6.68 ± 0.44	6.96 ± 0.42	7.24 ± 0.36	7.13 ± 0.32	7.49 ± 0.31
	F-value (treatment) = 3.38 (P < 0.05); F- Value (period) = 37.45 (P < 0.01)				

LI = Low infestation, MI = medium infestation, HI= High infestation, CTRL= control

Table 5: Mean pH values of smoked *C. gariepinus* infested with *D. maculatus*

Treatments	Weeks of Study				
	0	2	4	6	8
Larvae					
LI	6.70 ± 0.01	6.55 ± 0.04	6.51 ± 0.04	6.47 ± 0.01	6.02 ± 0.04
MI	6.70 ± 0.03	6.66 ± 0.01	6.40 ± 0.05	6.14 ± 0.02	6.93 ± 0.02
HI	6.70 ± 0.10	6.54 ± 0.02	6.31 ± 0.04	6.17 ± 0.03	6.01 ± 0.08
	F-Value (treatment) = 1.25 (P > 0.05); F-Value (period) = 61.25 (P < 0.01)				
Adults					
LI	6.70 ± 0.50	6.42 ± 0.01	6.33 ± 0.15	6.04± 0.20	5.87 ± 0.07
MI	6.70 ± 0.60	6.54 ± 0.17	6.28 ± 0.12	6.17 ± 0.38	5.91 ± 0.28
HI	6.70 ± 0.37	6.41 ± 0.18	6.29 ± 0.32	6.00 ± 0.54	5.86 ± 0.45
	F-Value (treatment) = 1.00 (P < 0.01); F-Value (period) = 62.00 (P < 0.01)				
CTRL	6.59 ± 0.06	6.43 ± 0.23	6.27 ± 0.10	6.02 ± 0.12	6.02 ± 0.12
	F-value (treatment) = 3.00 (P < 0.05); F- value (Period) = 44 (P < 0.01)				

LI = Low infestation, MI = medium infestation, HI= High infestation, CTRL= control

did not effect any significant difference in the quantity of free fatty acid in the smoked fish (P > 0.05) (Table 3). The smoked *C. gariepinus* responded similarly to larval and adult infestations with regard to its percent total lipids content (Table 4). The values of the lipids were significantly different with storage period both for the larval and adult infestation (P < 0.01) (Table 4). The values of the total lipids were significantly difference with storage period both for the larval and adult infestations (P < 0.01) (Table 4). The values of the total lipids were not significantly affected by levels of larval treatments (P > 0.05) but by adult treatments (P < 0.05). Contrary to what obtained for the free fatty acids, the highest mean value of total lipids (9.31± 0.16%) was recorded with larval infestation (Table 4).

Table 5 which shows the mean variations in pH values of fish infested with larval and adult *D. maculatus* varied from a pre-infested value of 7.00 to a reduced value of 6.01± 0.08 (for larval infestation) and 5.86 ± 0.04 (for adult infestation). A least pH value of 6.02 ± 0.12 was recorded for fish under the control experiment. Both larval and adult infestations of the fish affected significantly the pH value of the fish with storage period (P < 0.01). The various levels of larval treatments did not significantly affect the pH values of the smoked fish (P > 0.05) whereas adult infestations significantly affected the pH values of the fish (P < 0.01).

DISCUSSION

The decreased crude protein (CP) content of fish samples within 8 weeks (56days) of this study (Table 1) contradicted an earlier report that pest infestations did not affect the nutritional quality (proteins, fatty acids) of smoked fish tissues (Nduh,1984). The decrease in the CP content of fish from 78.52 % to 45.81 % of the control experiment was a clear manifestation that the nutritional qualities of fish depleted where pest infestation was absent.

This result was probably due to fish spoilage and deterioration resulting from the combined activities of micro-organisms and tissue enzyme (Shewan, 1961; Frazier, 1976). Hydrolytic activities of fish tissue enzymes (cattepsins and glutamic dehydrogenases) have been known to

breakdown proteins into peptones, polypeptides and amino acids resulting in fish deterioration (FAO, 1968).

The result of fish tissue degradation led to loss in weight of smoked *C. gariepinus* (Table 2). *C. gariepinus* infested with adult *D. maculatus* suffered the greatest loss in tissue weight contrary to Osuji (1975) and Nduh (1984) views that the larvae of *D. maculatus* are the most destructive of dried stored fish products. The well-developed biting mouth-parts of adult *D. maculatus* in comparism with those of the larvae must have contributed to the rapid loss in tissue weight of fish samples infested with the adults in this study. The reason was that the well-developed mouth-parts of the adults conferred on them a more destructive tendency than the larvae.

The treatment of smoked fish samples to varying levels of larval infestation did not affect the free fatty acids (FFA) (Table 3) and percent total lipids (% TL) (Table 4) of the tissue. FFA and % TL of fish infested by both larval and adult pests increased with prolonged period of storage. These results compared favourably with the observations made by Olley and Watson (1962) and Nduh (1984) that attributed these increases to the hydrolysis of Phospholipids by lipases and also agreed with Chen *et al.* (1974) report that during storage, fats become rancid owing to peroxide formations at the double bond by atmospheric oxygen. The authors further stated that rancidity may also be as a result of hydrolytic breakdown by micro-organisms leading to the liberation of free fatty acids.

The pH of the infested fish samples and the control decreased with periods of storage (Table 5). This was probably due to variations in the storage medium, which enhanced fast activities and the release of metabolic by-products (CO_2, urea and uric acid) from the pests. This decrease in pH could have prevented the proliferation of pathogenic micro-organisms such as *Clostridium botulinum* and *Bacillius stearothermophilus*. The result was the abundance of pest food for healthy growth of the pests, as well as the gycolytic breakdown of fish tissue to give lactic acid. This assertion is in accordance with the views of Frazier (1976), who reported a decrease in pH post-mortem fish tissues owing to glycolysis. This study, however, varied with that of Emokpae (1978) who reported an increase in pH of smoked *C. gariepinus*: something he attributed to the breakdown of protein to amino acids and consequently to ammonia.

Conclusion: The results of this study showed that the crude protein contents of infested fish decreased with increase in storage time. This may be attributed to the activities of certain micro-organisms which facilitated enzymatic breakdown of proteins to amino acids. Storage time may be due to the oxidation of fats to fatty acids resulting in rancidity. In addition, the decrease in pH values of infested fish was attributed to the metabolic by-products (CO_2, urea and uric acid) by micro-organisms in the fish tissue. Tissue degradation of smoked fish samples was related to the infestation levels and exposure time. Thus, the longer the periods of storage of infested smoked fish the more the tissues are degraded.

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