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Determination of Physical and Nutritional Losses Caused by Pests on Selected Smoked Fish Families in Benue State, Nigeria

Animem, W. T[1], Annune P.A[2], Akombo P. M[1], Agim, M. C[1]

[1]Department of Biological Sciences, Benue State University, Makurdi, Nigeria.
[2]Department of Fisheries and Aquaculture, University of Agriculture, Makurdi, Nigeria.

Corresponding Author: Animem, W. T

ABSTRACT

The study determined the physical and nutritional losses caused by pests on selected smoked fish families in 3 agricultural zones of Benue state. The selected fish families were Clariidae, Protopteridae, Characidae and Mormyridae and were weighed before and after 3 months storage at the end of each quarter of the year for 2 years and were subjected to proximate analysis. In zone A, Claridae, Protopteridae, Characidae and mormyridae had weight loss of 39.00%, 32.00%, 22.00% and 15.00% respectively. In zone B Clariidae, Protopteridae, Characidae and mormyridae had 43.00, 35.50, 23.50 and 18.00% respectively while in zone C Clariidae, Protopteridae, Characidae and mormyridae had percentage weight losses of 43.00, 35.50, 25.00 and 17.50% respectively. There was no significant difference in weight loss to insect infestation for each family across the agricultural zones. For nutritional composition, infested Clariidae, Protopteridae, Characidae and mormyridae had lower protein and crude fat but higher ash and moisture contents. There was an increase in crude fibre for infested Clariidae and Characidae while uninfested and infested had Protopteridae and Mormyridae had no crude fibre. There were no significant difference, ($P > 0.05$) in the moisture and protein. The selected fish samples had weight loss and nutritional loss in all the agricultural zones of Benue state. In conclusion smoked fish are expected loss both physical and nutritional quantity and quality if infested. The study recommended that the smoked fish should be properly stored and handled to prevent pest infestation in order to help maintain the physical and nutritional quantity and quality.

Key words: Physical losses, Nutritional losses, Pests, Smoked fish, Storage, Proximate analysis

INTRODUCTION

Fish is one of the most important animal protein sources in the tropics and its nutritional value is well suited to human dietary needs and competes favorably with other sources of animal protein. [1] It is among the cheapest sources of animal protein in Africa. [2] Fish is however, one of the most perishable of all staple commodities in the tropical climates of most developing countries. According to, [3] fish is an extremely perishable commodity which begins to deteriorate as soon as it dies or is caught. Even after the fish has been processed, particularly if traditional methods have been used, the fish is still subject to many forms of loss and spoilage. [4]

Smoking is a traditional fish processing method and is one of the most important fish processing methods aimed at preventing or reducing post harvest losses. [3] It involves the application of heat to remove water and inhibits bacteria and enzyme actions on fish. [5]

Spoilage of locally dried fish can be as a result of insect pests' infestation such as blowflies which lay their eggs on exposed fish during the drying process. [6] There was a report by [7] and [8] that cured fish could

suffer considerable loss of weight due to feeding damage caused by insect pests. A reveal by [9] was that a high proportion of dried fish in Nigeria was usually infested by insect pests, such as *Dermestes maculates* and *Necrobia rufipes*.

Pests damage can cause fragmentation of cured fish; and this can lead to quantitative loss of the smaller fragments and loss of value due to quality reduction, visual quality loss due to contamination by live or dead pests, or by their cast skins. [8]

The main objective of this work was to investigate the post harvest losses in terms of weight loss and nutritional losses caused by pests on specific fish families.

MATERIALS AND METHODS

Sample Collection

One kilogramme (1Kg) of each of the four (4) most commonly smoked fish families in Benue state were purchased on each quarter of the year from the 6 selected fish markets (2 markets from each of the 3 agricultural zones) of Benue State for determination of physical and nutritional losses. The samples were stored in those markets using the method of the fish salers of those markets. The purchased smoked fish families samples were Claridae, Protopteridae, Characidae and Mormyridae.

Physical Losses

For determination of physical loss, 800g per family were used. The 800g per family were divided into 4 replicates of 200g. The replicates were weighed and stored for 3 months, four times per year in the selected fish markets of the 3 agricultural zones. At the end of each quarter of the year, samples were weighed. At the end of the work, the physical loss (weight loss) was calculated as:

$$\frac{\text{Mean finial weight}}{\text{Mean initial weight}} \times 100$$

Nutritional Losses

For determination of nutritional loss 200g per fish family were used four times per year. The 200g per family were divided into 4 replicates of 50g. Association of Analytical Chemists [10] method were used to analyze the proximate composition of the smoked fish before the commencement of the experiment. After the proximate analysis, the smoked fish were stored for the period of 3 months (quarter of the year). At the end of each quarter of the year samples were subjected to the [10] method again to determine proximate composition of the fish after storage. The proximate analysis was used to determine crude protein, crude fat, ash, moisture content and fiber. A comparison was made between the smoked fish that was not stored and not infested by pests and the smoked fish infested by pests during the 3 months storage to determine the nutritional loss caused by pest infestation.

Statistical Analysis

The physical loss (weight loss) was calculated using simple percentage formula. The data obtained from the proximate analysis in triplicate were expressed in means (±) standard deviation using Gen Stat Discovery Edition (Version 2012)

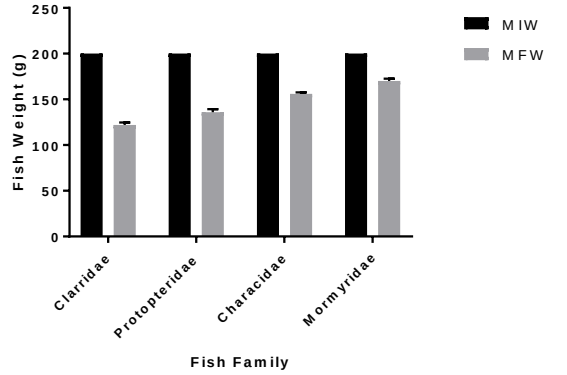
RESULTS

Physical losses caused by pests on individual smoked fishes

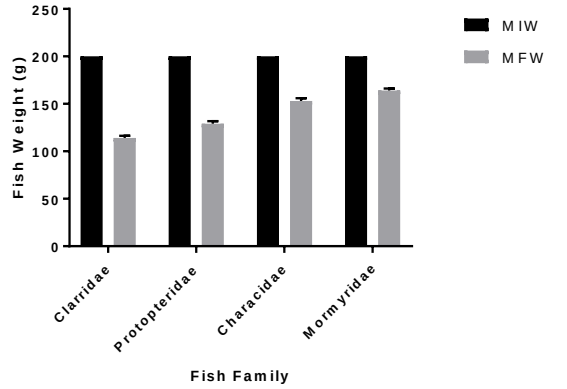
Figure 1 shows the initial weight, final weight and weight loss of all the fish family samples (Clariidae, Protopteridae, Characidae and Mormyridae) infested with pests in zone A. The initial weight of all the samples was 200.00g. Clariidae had a final weight of 122.00g and weight loss of 78.00g, Protopteridae had a final weight of 136.00g and weight loss of 64.00g, Characidae had a final weight of 156.00g and weight loss of 46.00g and Mormyridae had a final weight of 170.00g and weight loss of 30.00g.

Figure 2 shows the initial weight, final weight and weight loss of all the fish

family samples (Clariidae, Protopteridae, Characidae and Mormyridae) infested with pests in zone B. The initial weight of all the samples was 200.00g. Clariidae had a final weight of 114.00g and weight loss of 86.00g, Protopteridae had a final weight of 129.00g and weight loss of 71.00g, Characidae had a final weight of 153.00g and weight loss of 47.00g and Mormyridae had a final weight of 164.00g and weight loss of 36.00g.

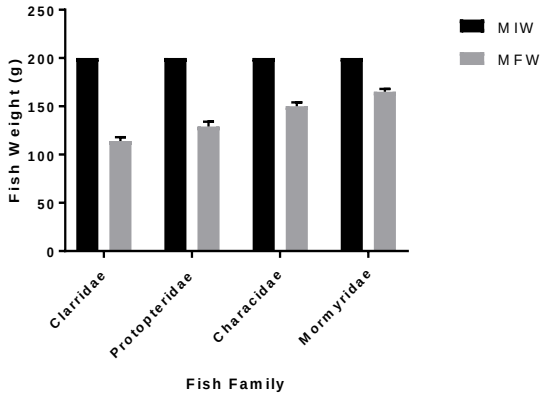


MIW=Mean initial weight
MFW=Mean final weight
Figure 1: Weight Loss Caused by Pests on Individual Fish Families in Agricultural zone A of Benue State



MIW=Mean initial weight
MFW=Mean final weight
Figure 2: Weight Loss Caused by Pests on Individual Fish Families in Agricultural Zone B of Benue State

Figure 3 shows the initial weight, final weight and weight loss of all the fish family samples (Clariidae, Protopteridae, Characidae and Mormyridae) infested with pests in zone C. The initial weight of all the samples was 200.00g. Clariidae had a final weight of 114.00g and weight loss of 86.00g, Protopteridae had a final weight of 129.00g and weight loss of 71.00g, Characidae had a final weight of 150.00g and weight loss of 50.00g and Mormyridae had a final weight of 165.00g and weight loss of 35.00g.



MIW=Mean initial weight
MFW=Mean final weight
Figure 3: Weight Loss Caused by Pests on Individual Fish Families in Agricultural Zone C of Benue State

Table 1 shows the percentage weight loss of infested fish families between the three agricultural zones of Benue State. In zone A Clariidae had 39.00% weight loss, in zone B 43.00% and in zone C 43.00%. Protopteridae in zone A had a weight loss of 32.00%, 35.50% in zone B and 35.50% in zone C. Characidae had a weight loss of 22.00% in zone A, 23.50% in zone while in zone C its weight loss was 25.00%. In zone A Mormyridae had a weight loss of 15.00±%, in zone B 18.00% while in zone C its weight loss was 17.50%. There was no significant difference in weight loss to pests infestation for each family across the agricultural zones.

TABLE 1: PERCENTAGE WEIGHT LOSS OF SELECTED FISH FAMILIES WITH PEST INFESTATION IN THE THREE AGRICULTURAL ZONES OF BENUE STATE

Agricultural zones	Percentage weight loss			
Zone A	39.00	32.00	22.00	15.00
Zone B	43.00	35.50	23.50	18.00
Zone C	43.00	35.50	25.00	17.50
p-value	0.132	0.346	0.403	0.249

Means % in the same column do not differ significantly (p>0.05)

Nutritional losses caused by pest infestation on individual smoked fishes

Table 2 shows proximate composition of Clariidae across 3 agricultural zones of Benue State. Uninfested protein content of the fish family (Clariidae) for zone A, B, and C was 63.38 ± 0.91^{a}, 50.88 ± 2.53^{b} and 49.92 ± 0.79^{b} while the one with pest infestation had 61.39 ± 1.44^{a}, 48.71 ± 3.07^{b} and 47.90 ± 0.45^{b} respectively. The highest protein content of uninfested fish was in zone A and the lowest in zone C while the highest protein content of fish with pest infestation was also in zone A and the lowest still in zone C.

TABLE 2: PROXIMATE COMPOSITION OF CLARIIDAE INFESTED WITH PESTS ACROSS 3 AGRICULTURAL ZONES OF BENUE STATE

Uninfested					
	Protein	**Crude Fat**	**Ash**	**Moisture**	**Crude Fibre**
Zone A	63.38	15.30	6.87	6.61	0.00
Zone B	50.88	11.70	14.23	9.80	0.06
Zone C	49.92	7.95	12.31	11.59	0.04
p-value	0.000	0.000	0.039	0.000	0.052
Infested					
Zone A	61.39	13.79	10.54	7.11	0.07
Zone B	48.71	10.16	17.47	10.45	0.10
Zone C	47.90	6.70	16.06	12.15	0.06
p-value	0.000	0.000	0.056	0.000	0.287

Means in the same column followed by different superscripts differ significantly ($p<0.05$)

For crude fat, uninfested Clariidae had 15.30 ± 0.66^{a}, 11.70 ± 0.88^{b} and 7.95 ± 1.55^{c} while the pests infested one had 13.79 ± 0.80^{a}, 10.16 ± 0.59^{b} and 6.70 ± 0.99^{c} in zone A, B and C respectively. For ash content, the uninfested Clariidae had 6.87 ± 1.07^{b}, 14.23 ± 2.48^{a} and 12.31 ± 2.04^{ab} while the pest infested one had 10.54±1.03, 17.47±2.58 and 16.06±2.10 in zone A, B and C respectively. The moisture content of uninfested Clariidae was 6.61 ± 0.66^{c}, 9.80 ± 0.47^{b} and 11.59 ± 0.19^{a} while the pest infested one had 7.11 ± 0.64^{c}, 10.45 ± 0.45^{b} and 12.15 ± 0.20^{a} in zone A, B and C respectively. Clariidae had no crude fibre content in zone A 00.00, 0.06±0.0.02 in zone B and 0.04±0.02 in zone C while pest infested one had 0.07±0.01, 0.10±0.01 and 0.06±0.02 in zone A, B and C respectively

Table 3 shows proximate composition of Protopteridae across 3 agricultural zones of Benue State. Protein content of uninfested Protopteridae for zone A, B,and C was 63.54 ± 1.64^{a}, 50.83 ± 2.50^{b} and 48.62 ± 0.96^{b} while the one infested by pests had 62.02 ± 1.45^{a}, 49.93 ± 2.50^{b} and 47.73 ± 0.96^{b} respectively.

TABLE 3: PROXIMATE COMPOSITION OF PROTOPTERIDAE INFESTED WITH PESTS ACROSS 3 AGRICULTURAL ZONES OF BENUE STATE

Uninfested					
	Protein	**Crude Fat**	**Ash**	**Moisture**	**Crude Fibre**
Zone A	63.54	16.37	7.44	6.91	0.00
Zone B	50.83	14.16	14.03	9.50	0.00
Zone C	48.62	10.15	12.24	11.29	0.00
p-value	0.000	0.000	0.073	0.000	-
Infested					
Zone A	62.02	13.47	10.26	7.21	0.00
Zone B	49.93	11.26	16.83	10.80	0.00
Zone C	47.73	7.22	15.12	11.63	0.00
p-value	0.000	0.000	0.074	0.001	-

Means in the same column followed by different superscripts differ significantly ($p<0.05$)

The highest protein content of uninfested Protopteridae was in zone A (63.54 ± 1.64^{a}) and the lowest in zone C (48.62 ± 0.96^{b}) while the highest protein content of infested Protopteridae by pests was also in zone A (62.02 ± 1.45^{a}) and the lowest still in zone C. For crude fat, uninfested Protopteridae had 16.37 ± 0.24^{a}, 14.16 ± 0.85^{a} and 10.15 ± 1.16^{b} while the pest infested Protopteridae had 13.47 ± 0.24^{a}, 11.26 ± 0.85^{a} and 7.22 ± 1.17^{b} in zone A,B and C respectively. For ash content, the uninfested Protopteridae had 7.44±1.00, 14.03±2.52 and 12.24±2.09 while the pest infested one had 10.26±1.00, 16.83±2.52 and 15.12±2.10 in zone A,B and C respectively. The moisture content of uninfested Protopteridae was 6.91 ± 0.73^{b}, 9.50 ± 0.51^{a} and 11.29 ± 0.27^{a} while the infested one with pests had 7.21 ± 0.73^{b}, 10.80 ± 1.04^{a} and 11.63 ± 0.28^{a} in zone A,B and C respectively. Both uninfested and infested Protopteridae by pests had no crude fiber content in all the zones.

Table 4 shows proximate composition of Characidae that had no pest infestation and the one infested by pests across 3 agricultural zones of Benue State. Protein content of uninfested.

TABLE 4: PROXIMATE COMPOSITION OF CHARACIDAE INFESTED WITH PESTS ACROSS 3 AGRICULTURAL ZONES OF BENUE STATE

Uninfested					
	Protein	**Crude Fat**	**Ash**	**Moisture**	**Crude Fibre**
Zone A	64.54	14.37	6.90	6.60	0.02
Zone B	56.36	7.57	13.30	3.57	0.03
Zone C	50.81	7.101	12.20	9.67	0.05
p-value	0.000	0.000	0.055	0.000	0.024
Infested					
Zone A	63.64	11.47	9.74	6.91	0.07
Zone B	55.44	4.64	16.16	4.32	0.08
Zone C	49.30	4.19	15.00	9.99	0.07
p-value	0.000	0.000	0.052	0.000	0.806

TABLE 5: PROXIMATE COMPOSITION OF MORMYRIDAE INFESTED WITH PEST ACROSS 3 AGRICULTURAL ZONES OF BENUE STATE

Uninfested					
	Protein	**Crude Fat**	**Ash**	**Moisture**	**Crude Fibre**
Zone A	63.91	13.95	6.90	6.36	0.00
Zone B	54.87	9.51	11.81	4.54	0.00
Zone C	49.99	7.82	11.78	9.89	0.00
p-value	0.000	0.000	0.064	0.000	-
Infested					
Zone A	63.01	11.05	9.82	6.67	0.00
Zone B	53.93	6.60	14.68	5.34	0.00
Zone C	48.48	4.92	14.54	10.19	0.00
p-value	0.000	0.000	0.068	0.000	-

Means in the same column followed by different superscripts differ significantly ($p<0.05$)

Characidae for zone A, B,and C was 64.54 ± 1.45^{a}, 56.36 ± 1.12^{b} and 50.81 ± 0.64^{c} while the pest infested was 63.64 ± 1.45^{a}, 55.44 ± 1.13^{b} and 49.30 ± 0.78^{c} respectively. The highest protein content of uninfested Characidae was in zone A (64.54±1.45) and the lowest in zone C (50.81±0.64). The highest protein content of infested was also in zone A (63.64±1.45) and the lowest still in zone C (49.30±0.78). For crude fat, uninfested Characidae had 14.37 ± 1.12^{a}, 7.57 ± 0.86^{b} and 7.10 ± 1.19^{b} while the infested one by pests had 11.47 ± 1.12^{a}, 4.64 ± 0.85^{b} and 4.19 ± 1.19^{b} respectively. For ash content, the uninfested Characidae had 6.90±1.11, 30.30±2.23 and 12.20±2.06 while the infested one by pests had 9.74±1.10, 16.16±2.20 and 15.00±2.06 respectively.

The moisture content of uninfested Characidae was 6.60 ± 0.58^{b}, 3.57 ± 0.31^{c} and 9.67 ± 0.27^{a} while the one with pests infestation had 6.91 ± 0.58^{b}, 4.32 ± 0.48^{c} and 9.99 ± 0.27^{a} respectively. For zone A, B and C uninfested Characidae had 0.02 ± 0.01^{b}, 0.03 ± 0.00^{b} and 0.05 ± 0.01^{a} crude fibre content while the one with pests infestation had 0.07±0.01, 0.08±0.01 and 0.07±0.01 respectively.

Table 5 shows proximate composition of Mormyridae across 3 agricultural zones of Benue State. The protein content of uninfested Mormyridae for zone A, B,and C was 63.91 ± 1.36^{a}, 54.87 ± 1.86^{b}

Means in the same column followed by different superscripts differ significantly ($p<0.05$)

11.78 ± 1.85 and 49.99 ± 0.34^{c} while the one with pest infestation was 63.01 ± 1.36^{a}, 53.93 ± 1.86^{b} and 48.48 ± 0.43^{c} respectively. The highest protein content of uninfested Mormyridae was in zone A and the lowest in zone C while the highest protein content of the infested one was also in zone A and the lowest in zone C. For crude fat, uninfested Mormyridae had 13.95 ± 1.18^{a}, 9.51 ± 0.34^{b} and 7.82 ± 0.55^{b} while the infested one had 11.05 ± 1.18^{a}, 6.60 ± 0.33^{b} and 4.92 ± 0.55^{b} respectively. For ash content, the uninfested Mormyridae had 6.90±1.18, 11.81±1.67 and 11.78±1.85 while the infested one had 9.82±1.18, 14.68±1.64 and 14.54±1.84 respectively. The moisture content of uninfested Mormyridae was 6.36 ± 0.70^{b}, 4.54 ± 0.42^{b} and 9.89 ± 0.55^{a} while the one with pests infestation had 6.67 ± 0.70^{b}, 5.34 ± 0.47^{b} and 10.19 ± 0.55^{a} respectively. The fish family of Mormyridae with pests infestation and without pests infestation had no crude fibre content in all the zones.

DISCUSSION

Physical Losses Caused by Pests on Individual Smoked Fish

The findings of the research revealed that all the selected fish samples had weight loss in all the agricultural zones of Benue state. This agrees with [11] and [12] who reported that both physical and quality losses are high in the fisheries sector due to pest infestation. Similarly [13] observed and

reported that insect infestation was the cause of most prominent losses in quality and quantity of stored dried fish in Nigeria.

The percentage weight loss of all the fish families in the study area ranged from 15.00±1.26 (Mormyridae in zone A) to 43.00±1.98 (Clariidae in C). This shows that Mormyridae has the least weight loss while Claridae has the highest weight loss in the study area. The lowest percentage loss observed on Mormyridae compared to other fish might be attributed to its stronger structure, low fragmentation and low moisture content.

When there is physical loss the people involved in fish marketing (and perhaps the fishermen) might have suffered a loss of potential income by not selling at the best possible price, but poor consumers of fish might have gained by having access to cheap fish. According to [14] physical loss can be regarded as a loss in value for the fishers or fish traders, but a social gain for very low-income groups**.**

Nutritional Losses Caused by Pests on Individual Smoked Fish

As shown in the study, pest infestation affected the nutritional composition of the fish samples (*Clariidae*, *Protopteridae*, *Characidae* and *Mormyridae*) used for the research. The study revealed that the protein content and crude fat of the uninfested *Clariidae* was higher in Zone A, followed by Zone B and lastly Zone C. The protein content was observed to be lower in infested fish samples compared to uninfested in all the zones (Tables 2, 3, 4 and 5).

The values of crude protein and crude fat composition of the samples were generally higher for uninfested fish samples compared to infested samples. There was rather an increment of moisture, fat and crude fibre in all the infested fish samples. The results of the present study corroborates with those reported by [15] who reported that the crude protein (CP) content of *Clarias gariepinus* exposed to larvae of *Dermestes maculates* decreased consistently from a pre-infestation protein value.

Nutritional losses can occur in uninfested smoked fish and some loss of nutrients is inevitable in all forms of contamination and deterioration. The result showing nutritional losses is also similar to [16] who reported that fish infestation by pests caused serious losses. These losses may not be significant if the people eating the infested fish have an adequate diet in other respects. Many people in various parts of the world eat only relatively small quantities of smoked fish, however many others are heavily dependent on smoked fish for their protein needs.

CONLUSION

The findings of the research revealed that all the selected fish samples had weight loss in all the agricultural zones of Benue state and the pest infestation affected the nutritional composition of the fish samples (*Clariidae, Protopteridae*, *Characidae* and *Mormyridae*) used for the research.

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