



INTERNATIONAL JOURNAL OF SCIENCE FOR GLOBAL SUSTAINABILITY
Studies on *Dermestes Maculatus* Infestation of Smoked - Dried Fish at
Uke Fish Market, Nasarawa State, Nigeria

Abdullahi, M. Mohammed^{1*} Akwe P. Joy², and Sani Z. Rabi³

^{1,2}Department of Zoology, Faculty of Natural and Applied Sciences, Nasarawa State University, Keffi, P.M.B 1022 Nigeria.

³Department of Biological Science, Federal University Gusau, P.M.B. 1001 Zamfara State, Nigeria

* Corresponding Authors Email Address: mairiga. nsuk.edu.ng@gmail.com, Phone: +234(0)8032243691.

Received on: January, 2020

Revised and Accepted on: March 2020

Published on: March 2020

ABSTRACT

Three smoke-dried fish, *Clarias gariepinus*, *Oreochromis niloticus* and *Protopterus annectens* were procured from Uke fish market to assess the effects of insect infestation. The fish samples were taken to the Department of Zoology Laboratory of Nasarawa State University Keffi. Percentage weights of the fishes were determined before and after insect pest infestations. The samples were stored in three different cartoons for a period of four weeks. Proximate analysis of the samples was carried out at the Animal Feed Analysis and Quality Control Laboratory Nyanya. The protein, moisture and fat contents for *Clarias gariepinus* before infestation were (73.40%, 9.70% and 15.70%), for *Oreochromis niloticus* (72.30%, 10.40%, and 11.60%), for *Protopterus annectens* (63.50%, 12.60%, and 8.30%). After infestation, the protein, moisture and fat contents for *Clarias gariepinus* were (72.50%, 6.00%, and 12.80%), for *Oreochromis niloticus* (71.90%, 5.80%, and 11.60%), for *Protopterus annectens* (60.80%, 10.30% and 7.70%). It was observed that insect pest infestation causes great loss and reduces the economic and market value of smoke -dried fish because it degrades and damaged the fish thereby reducing its protein, fat and moisture contents. The result of the study showed that *Dermestes maculatus* infestation was higher in *Clarias gariepinus* compared to *Oreochromis niloticus* and *Protopterus annectens* with the highest infestation rate of 35%, 30% and 30% respectively in the three species. However, there was no significant difference between the number of insect pests found in the fish samples at ($p > 0.05$), the proximate analysis shows that the data collected after insect infestation was significant at $p = 0.05$ with p value 0.00005.

Key Words: *Dermestes Maculatus*, *Clarias Gariepinus*, *Oreochromis Niloticus*, Protein, *Protopterus annectens*.

1.0 INTRODUCTION

Fish is one of the cheapest animal protein sources and is being used increasingly to correct protein deficiency in human diets in the tropics. The consumption of fish provides an important nutrient to a large number of people worldwide and thus makes a very significant contribution to nutrition (Moses, 2002). However, fish is highly susceptible to damage by insects and microorganisms as soon as it is caught Afolabi, *et al.*, (2000). Losses in quality and quantity of dry fish during storage have been attributed to *Dermestes maculatus* infestation. The processing and preservation of fresh fish prevents economic losses and deterioration of fish Okonta and Ekselemu, (2005).

A measure source of damage of smoked fish is insect infestation. About 15 insect pest species have been recorded in cured fish this pest account for about 71.5% of dried fish infestation recorded in most of the producing areas with a substantial loss in dry weights of about 43-62.7% from both larvae and adults (Emokpae, 1998). In Nigeria, dried fish is one of the cheapest sources of protein and essential minerals but highly susceptible to insect pest infestation. However, in recent years there have been increasing and concerted efforts directed towards developing simple and affordable smoking methods in preserving fish. Mabawonku and Ajayi, (2007). Processed fish are readily attacked by several species of insects

like *D. maculatus*, *D. frischi*, *D. attach*, and *Necrobia rufipes* (Don-Pedro 1989). In Nigeria, total loss of fish product during storage is about 50 % (Odeyemi et al. 2000). The life cycle of *D. maculatus* requires approximately 5 to 7 weeks under optimal conditions (Archer & Elgar 1998). Pheromones secreted by the males through a gland at the base of the abdomen are used to attract the females. Males and females mate multiple times and the female lays eggs within 24 hours of first mating (Jones et al. 2006). Larvae pass through 5–11 instars, the number of instars increase with unfavourable conditions. At the adult stage, the beetles can disperse to other food sources by flying (Jones et al. 2006). The adult beetles typically live between 4 and 6 months. Larval development in *D. maculatus* does not involve any visible morphological change but only increase in size from the previous instars. A

2.0 MATERIALS AND METHODOLOGY

2.1 Study Area

This study was carried out in Uke, Karu Local Government Area of Nasarawa State, Nigeria. Nasarawa State is situated on the North-central part of Nigeria (8° 32' N, 8° 18' E), located in the Guinea savanna of sub-humid climate with two distinct seasons. The rainy season starts in May and ends in October while the dry season is experienced between November and April. Annual rainfall ranges between 1100mm to about 2000mm with mean monthly temperature between 20°C and 34°C.

2.2 Smoked Fish Procurement

Three different fish species, *Clarias gariepinus*, *Oreochromis niloticus*, and *Protopterus annectens* were bought from Uke fish market and taken to Animal Care Feed Analysis and Quality Control Laboratory, Nyanya for proximate analysis and later taken to Zoology laboratory of Nasarawa State University, keffi for the determination of pest infestation.

2.2.1 Storage

The smoke-dried fish samples were stored in four different cartons labeled accordingly and kept in Zoology Laboratory of Nasarawa State

total developmental period of 31 days was observed on *C. gariepinus*, while average of 42.75 days was noticed on mixed substrates (Zakka et al. 2013). In a recent study by Zakka et al. (2009), *D. maculatus* infested and damaged four smoked fish species, namely *Clarias gariepinus*, *Oreochromis niloticus* and *Protopterus annectens*

There is dearth of literature on the extent of fish quality loss vis-à-vis nutritional deterioration during the period of infestation in the storage. Hence, the objective of this study is to evaluate the changes in *dermestes maculatus* infestation of smoked dried fish (*Clarias gariepinus*, *Oreochromis niloticus* and *Protopterus annectens*) sold at Uke fish market, Nasarawa State, Nigeria.

University, keffi for a period of four weeks to allow for the development and pest infestation.

2.3 Sorting and Identification

The insect pests collected, were placed in a petri-dish and carefully sorted to sub-orders, species and separately placed in separate specimen bottles containing 10% of formalin for preservation. The specimens were later mounted on temporary slide for taxonomic identification using identification guide under the supervision of the laboratory technician Mr. Sunday Dickson. Daily temperature readings were taken to determine its impact on the insect pest's development and infestation on the fishes.

2.4 Proximate Analysis

a. Determination of protein (crude protein)

The protein contents of the three samples *Clarias gariepinus*, *Oreochromis niloticus* and *Protopterus annectens* were determined by first analyzing the sample for the total nitrogen by Kjeldahl method, and crude protein in the sample was calculated by multiplying the total nitrogen by an empirical factor usually 6.25, a known weight of sample per heating with concentrated sulphuric acid and nitrogen was then converted into ammonium sulphate. The ammonia was estimated by distillation followed by titration with acid.

$$\text{Percentage (\% Crude Protein)} = \frac{\text{Sample Titre} - \text{Blank Titre} + 0.1 + 0.04 + 6.25 \times 100}{\text{Weight of Sample}}$$

2.4.1b. Determination of Lipid

The lipid contents of the three samples, *Clarias gariepinus*, *Oreochromis niloticus* and *Protopterus annectens* were determined by extracting the dried crude sample with a solvent (diethyl ether), weigh the sample powder into a thimble, which was then placed in a central siphon portion of extractor of soxhlet flask of known weight. The flask was connected to the siphon and condenser and the apparatus was heated on mantle the boiling solvent condenses in

the soxhlet siphon and by so doing dissolve the liquid in the sample. This was continued until extraction process was completed and then the mixed ether had evaporated. The flask was oven dried at a specific temperature usually 105^o C, cooled and weighed. The drying process was repeated until a constant weight was obtained. The lipid content was calculated from the weight of material in receiver flask.

$$\text{Percentage (\% crude fats)} = \frac{\text{Weight of Crude Fat} \times 100}{\text{Weight of Sample}}$$

2.4.2 c. Determination of Moisture Content

The water content of *Clarias gariepinus*, *Oreochromis niloticus* and *Protopterus annectens* were determined by weighing the fish sample in a petri dish and oven the content to a constant weight.

$$\text{Percentage (\% Water)} = \frac{\text{Original Sample Weight} - \text{Weight of Oven Dried}}{\text{Original Weight}} \times 100$$

3.0 RESULTS

Table:1 shows the mean weight of dried *Clarias gariepinus*, *Oreochromis niloticus* and *Protopterus annectens*. The result shows that *Clarias gariepinus*(002) has the highest weight (121.5, 10.0) followed by weight of 005

Clarias gariepinus(97.0, 84.0) before and after infestation. The mean of fish samples were not statistically significant (P>0.05).

Table 1: Mean Weight (G) Of Dried *Clarias gariepinus*, *Oreochromis niloticus* And *Protopterus annectens*/ Procured Samples Of Infested Fish

SNO.	<i>C. gariepinus</i>	<i>O. niloticus</i>	<i>P. annectens</i>	<i>C. gariepinus</i>	<i>O. niloticus</i>	<i>P. annectens</i>
001	90.0	33.7	50.6	74.0	29.0	43.0
002	121.5	29.1	29.6	110.0	20.0	20.0
003	26.4	31.7	22.3	20.0	26.0	19.0
004	34.0	15.1	24.9	28.0	10.0	22.0
005	97.0	34.0	70.0	84.0	25.0	60.0
Total	369.8	143.6	197.4	316.0	110.0	164.0

*Mean of fish samples were not statistically significant (P>0.05) $\chi^2 = 0.1161$ $\chi^2 = 0.1827$ $\chi^2 = 0.2264$

P = 0.9984 P=0.9961 P= 0.9941

Table:2 Illustrated the prevalence of insect pests in the three species of fishes. The result revealed that the prevalence was high in *clarias gariepinus*(40%) followed by

protopterusannectens (33.3%) and *oreochromis niloticus* (26.7%) respectively. No significant difference was observed (P>0.05)

Table 2: Prevalence of Insect Pests In The Three Species Of Fishes.

Fish samples	Number of insect pests	Prevalence of Pests (%)
<i>Clariasgariepinus</i>	60	40.0
<i>Oreochromisniloticus</i>	40	26.7
<i>Protopterusannectens</i>	50	33.3
Total	150	100

*not statistically significant (P>0.05) $f=1.1576$: $P= 0.5605$

Table: 3 Depicts the prevalence of infestation in *Clariasgariepinus*. The result indicate that infestation was high in *C. gariepinus*

(Dm₅) having (33.3%), Dm₂ (25.0%), Dm₃ and Dm₄ (16.7%) and Dm₁ (8.30%) respectively. No significant was observed.

Table 3: Prevalence of Insect Pests Found In Clarias Gariepinus (Catfish)

Sample ID	Insect pests	No. of insect pests in Catfish	Prevalence (%)
001	<i>Dermestesmaculatus</i>	5	8.30
002	<i>Dermestesmaculatus</i>	15	25.0
003	<i>Dermestesmaculatus</i>	10	16.7
004	<i>Dermestesmaculatus</i>	10	16.7
005	<i>Dermestesmaculatus</i>	20	33.3
Total		60	100.0

*not statistically significant (P>0.05), $f= 4.2334$: $P=0.3753$

Table: 4 shows the prevalence of insect pests in *Oreochromisniloticus*. The result indicate that the prevalence of insect pest (Dm₄) was high in *Oreochromisniloticus*(30.0%), Dm₃ (25.0%),

Dm₅ (20.0%), Dm₂ (15.0%) and Dm₁ (10.0%). No significant difference was observed (P>0.05).

Table 4: Prevalence of Insect Pests In Oreochromisniloticus

Sample ID	Insect pests	No. of insect pests in <i>O. niloticus</i>	Prevalence (%)
001	<i>Dermestesmaculatus</i>	4	10.0
002	<i>Dermestesmaculatus</i>	6	15.0
003	<i>Dermestesmaculatus</i>	10	25.0
004	<i>Dermestesmaculatus</i>	12	30.0
005	<i>Dermestesmaculatus</i>	8	20.0
Total		40	100

*not statistically significant ($P > 0.05$). $f = 61.3$: $P = 0.5953$

Table: 5 showed the prevalence of *Dermestes maculatus* found in *Protopterus annectens*. The result indicate that the insect pest Dm_5 has the highest occurrence

(30.0%) and Dm_3 (30.0%) followed by Dm_4 (20.0%), Dm_1 (12.0%) and Dm_2 (8.0%) respectively. No significant difference was observed.

Table 5: Prevalence of *Dermestes maculatus* Found In *Protopterus annectens*

Sample ID	Insect pests	No. of insect pests in <i>P. annectens</i>	Prevalence (%)
001	<i>Dermestes maculatus</i>	6	12.0
002	<i>Dermestes maculatus</i>	4	8.0
003	<i>Dermestes maculatus</i>	15	30.0
004	<i>Dermestes maculatus</i>	10	20.0
005	<i>Dermestes maculatus</i>	15	30.0
Total		50	100

*not statistically significant ($P > 0.05$). $f = 114.8$ $P = 0.247$

4.0 DISCUSSION

The result of the study revealed that insect's infestation on smoke-dried fish was influenced by moisture content, physical structures, nutrient availability, temperature and relative humidity. This agrees with the report of (Bala et al., 2000) who reported that in tropical climates under highly humid conditions, heavy infestation of smoke-dried fish by beetles may cause up to 30% loss of the product. The insect pests that infested smoked fish all the samples in this study were *Dermestes maculatus*. It was observed that the three smoked fish samples do not vary in their susceptibility to infestation by beetles. This was due to the physical structures, moisture content and nutritional composition and provision of conditions suitable for fish infestation.

This study indicates that improper handling of fish causes lots of damage which account for easy infestation of *Dermestes maculatus* on the smoked-dried fish which agrees with the result of (Ames et al., 1990) who reported that careless

handling can result in the fragmentation of fish, which might make the fish to become unsalable.

It was also observed that damaged of smoked-dried fish is caused as a result of insects' infestation which contributes to the economic losses and reduces the market value of the fish. This agrees with the report of (Ames 1990) who stated that damaged fish infested by insects are less attractive to consumers than undamaged fish and this will affect its market price.

5.0 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 much influences of *Dermestes maculatus* infestation of *Clarias gariepinus*, *Oreochromis niloticus* and *Protopterus annectens* on their proximate compositions. This research provides nutritional information on *Clarias gariepinus*, *Oreochromis niloticus* and *Protopterus annectens* before and after infestation.

REFERENCES

- Archer, M.S. & Elgar, M.A. 1998. Cannibalism and delayed pupation in hide beetle *Dermestes maculatus* DeGeer (Coleoptera: Dermestidae). *Australian Journal of Entomology* 37: 158–161.
- Afolabi, A.O., Omosola, A.A. and Oke, O.L. (1990). Quality Changes of Nigeria Traditionally processed freshwater, Fish specie. Nutritive and Organoleptic Changes. *Journal of Food Technology*, 19:333-340.
- Ames G.R. (1990). The kinds and levels of post-harvest losses in African inland fisheries. *Proceedings of the symposium on post-harvest fish technology*, October 21-22, 1990, FAO, Rome, Italy, pp: 1-10.
- Don-Pedro, K.N. 1989. Insecticidal activity of some vegetable oils against *Dermestes maculatus* (DeGeer) (Coleoptera: Dermestidae) on dried fish. *Journal of Stored Product Research* 25: 81–86.
- Emokpae, A.O. (1998). Organoleptic Assessment of the Quality of Freshwater Fish. Pages 12-15. In: 1998 Annual report of Nigeria Institute of Oceanography and Marine Research (NIOMR) Lagos, Nigeria.
- Jones, T.M., Mcnamara, K.B., Colvin, P.G.R., Featherston, R.D. & Elgar, M.A. 2006. Mating frequency, fecundity and fertilization success in the hide beetle, *Dermestes maculatus*. *Journal of Insect Behaviour* 19: 357–371.
- Mabwonku, A.F. and Ajayi, T.O. (2007). Economic Survey of Artisanal Fisheries in Bendel, Cross River, Lagos, Ogun, Ondo and River State. Pages 64-76. In: *Proceeding of the National Seminar on Integrated Development of Artisanal and Inshore Fisheries in Nigeria*, Federal Development of Fisheries, Lagos, Nigeria.
- Moses, B.S. (2002). Problems and Prospects of Artisanal fisheries in Nigeria, 76-90. In *Proceedings of second annual conference of the Fisheries Society of Nigeria (FISON)*. Calabar.
- Odeyemi, O.O., Owoade, R.A. & Akinkurule, O. 2000. Toxicity and population suppression effects of *Parkia clappertoniana* on dried fish pests (*Dermestes maculatus* and *Necrobia rufipes*). *Global Journal of Pure and Applied Sciences* 6: 191–195
- Okonta, A. and Ekelemu, J. (2005). A preliminary study of micro-organisms associated with fish spoilage in Asaba, Southern Nigeria. *Proceedings of the 20th Annual Conference of the Fisheries Society of Nigeria, (FISON)* 557-560.
- Zakka, U., Ayertey, J.N. & Cobblah, M.A. 2009. Suitability of four smoked fish species to *Dermestes maculatus* (DeGeer) (Coleoptera: Dermestidae). *Nigerian Journal of Entomology* 26: 35–39
- Zakka, U., Ayertey, J.N. & Cobblah, M.A. 2013. Development of *Dermestes maculatus* (DeGeer, 1774) (Coleoptera: Dermestidae) on different fish substrates. *Jordan Journal of Biological Sciences* 6(1): 5–10