



ORIGINAL RESEARCH ARTICLE

Evaluation of Insect Infestation on Commercially Smoked Fresh and Marine Water Fish in Mubi, Adamawa State, Nigeria

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ABSTRACT

The research was conducted to evaluate insect infestation on some smoked commercial fresh and marine water Fish in Mubi, Adamawa State of Nigeria. Fish species namely: *Clarias gariepinus*, *Oreochromis niloticus*, *Synodontis budgetti*, *Scomber scumbrus*, *Clupea harengus* and *Sardinella aurita* were obtained from Shagari low-cost fish market Mubi. The fishes were processed using Adamawa State University Smoking kiln (ADSU). The processed fishes were stored for six (6) months under room temperature and were examined virtually with hand magnifying lens for insects infestation count. Analyzed data showed no insect infestation count for the first two months December 2023 to January 2024. Monthly infestation count showed significant differences at $p < 0.05$ with highest values in February on *C. gariepinus* (16.83 ± 0.19), March; *S. scumbrus* (14.42 ± 0.25), April; *S. scumbrus* (95.00 ± 0.28), May; *C. harengus* (348.50 ± 0.29) with least values on fresh water fishes with *S. budgetti* throughout the month of storage February (0.83 ± 0.19), March (5.17 ± 0.25), April; (23.75 ± 0.28), May; (171.58 ± 0.29). Identified insect pest were *Dermestes maculatus* and *Necrobia rufipes* they lavish the fish product causing substantial damage to the stored fishes, with the highest infestation of *N. rufipes* observed in February on *C. gariepinus* (32.50 ± 0.27), *S. scumbrus*; March (79.80 ± 0.25), April (166.83 ± 0.29), May (495.17 ± 0.40), with least values on *D. maculatus* in February on *C. harengus* (0.83 ± 0.27), March on *S. budgetti* (1.17 ± 0.25), April on *O. niloticus* (13.50 ± 0.29), May on *S. aurita* (66.50 ± 0.40). The result obtained in the study clearly indicate that smoked fresh water fishes showed longer shelf life of 3-4 months while smoked marine fishes showed a shelf life of 1-2 months. Therefore it's recommended that fish should not be kept longer to avoid spoilage and unacceptability to consumers.

Introduction

Insect population count on smoked fish refers to the process of estimating the number of insects presents on or in the smoked fish products. Smoking provides very little control against

insect attack, it was estimated that between 25% and 75% of the nutritional value of fish is lost during attack by insect pests (Animem *et al.*, 2020). Iyabo (2015) reported that insects infest smoked dried fish during storage and causes

economic, qualitative and quantitative composition loss to fish (Ayeloja *et al.*, 2020). Infested fish attract lower price compared to intact whole smoked dried fish that will attract higher market price. Insects mainly known to infest dried smoked fish are beetles (*Necrobia* spp.) and bugs (*Dermestes* spp.) (Koru *et al.*, 2021). The characteristics of processed fish to be stored should ensure full health safety of the product, proper sanitary conditions as well as rendering it impossible for the development of harmful micro-organisms and toxins (Golon *et al.*, 2019). During storage of well processed and preserved fish, beetles of the family *Dermestidae* causes considerable damage to fish product (Abdullahi *et al.*, 2010). This leads to losses in weight, quality, visual appeal, market value, encourages growth of micro flora and reduces nutritive value (Akinwumi, 2011). Losses can also result from attack by animal pests which can gain access to the fish product (Flowara *et al.*, 2013), under these circumstances adequate attention must be paid to ensure protection of stored fish for availability of these vital products (Wahedi and Kefas, 2013). Shuaibu and Yahaya, (2018) When the moisture content of the fish is high, it provides suitable breeding ground for several species of flies (Koru *et al.*, 2021) and when the moisture content is low *Dermestes* spp beetles ravish the product causing severe loss (Adesina *et al.*, 2016). The eggs are laid on the dried fish during processing; consequently, the product is transferred to the storage with substantial level of infestation, especially the eggs and early larvae (Akpako and Agbor, 2015). This undergoes rapid development under the warm conditions while fish are still in storage system (Adesina *et al.*, 2014).

Akunne *et al.* (2014) observed 10-15% losses during fish drying and 12-20% during storage. The extent and value of quantitative losses

caused by dried fish insect pest (*Dermestes* species) have been assessed by various authors such as Ibrahim *et al.* (2015) and Anyanwu *et al.* (2016) estimated range from negligible up to 50% weight losses depending on length of storage, salt content, moisture content, climatic condition and general hygiene during processing and storage. The major pest to attack smoked dried fish, bones, hides and skin are *Dermestes maculatus degeer*, *Necrobia rufipes*, *Tribilium castellumand*, *Trogoderma grananum*, *Dermestes frischolkug* and *Dermestes ater* (Ebochuo and Oparaejiaku, 2017). Sani *et al.* (2016) reported that cured fish can suffer considerable loss of weight due to feeding damage caused by insect pests. Up to 50% loss can result due to beetle infestation over several months. From processing throughout storage shelf life, fish is vulnerable to insect pests belonging to 3 families, namely, *Calliphoridae*, *Sarcophagidae* (blowflies) and *Dermestidea* (beetle) (Jatau *et al.*, 2014). *Dermestes maculatus* is cosmopolitan and the most preponderant insect pest of dried fish (Akinwumi, 2011). Adesina *et al.* (2016) estimated 20 - 50% deterioration of smoked fish products during storage arising from microbial and insects' pest infestation in the tropics. More so, Akintola *et al.* (2013) put physical and financial losses at between 10 and 50% and 25 and 90%, respectively, for the fish species they investigated. Traditionally smoked-dried fish are stored in round smoking ovens and covered in polythene and jute sacks but occasionally, re-smoking is done to maintain dryness and ward insect pests and prevent mold attack (Golon *et al.*, 2019). Insect infestation is the most serious sources of losses in weight, quality and quantity of dried fish in Nigeria, which occurs due to high moisture content of fish providing a suitable breeding ground for several species of flies (Baba *et al.*, 2015). *Dermestes* beetle lavish the fish product causing substantial damage to the fish product (Akpotu

and Adebole, 2013). Oyedokun, (2020) stated that, smoking provides very little control against insect attack, he estimated that between 25% and 75% of the nutritional value of fish is lost during storage when attack by insect pests, which causes economic losses to the fish mongers. Omodara *et al.* (2012) stressed that beetles select fish with lower moisture content, traditionally addition of pepper prevent beetle infestation on fish, both blowfly and beetles do typically select specific ranges of conditions with higher temperature and relative humidity of tropical region (Akpako and Agbor, 2015).

Material and Methods

A total of 30kg each of fresh and marine water fish species of averaged weight of 0.5-0.80 kg were used for the research. Fresh 6 water fishes namely; *C. gariepinus*, *O. niloticus* and *S. budgetti* and Marine water fishes *S. scombrus*, *C. harengus*, and *S. aurita*. The Fish samples were smoked and kept in cartoon, and kept closed in a cupboard away from rodent in the laboratory for 6 months under room temperature. The insect infestation count was carried out at the end of every month. The fish samples were examined virtually, with hand magnifying lens to remove insect pests according to the standard methods (FAO, 2010). Insect pest from each fish sample were collected in separate labeled containers according to fish species. Hand lens was used to view each of the fish species in order to extract the pests with the help of forceps. The numbers and types of insect pest collected were noted. The insect pest collected were identified to taxonomic level in the laboratory using the identification manuals, vouchers and taxonomic keys. The identification was based on the morphological features of the insects; microscope was also used for proper

view in order to clearly identify their features. The different species of insect pests found were counted and recorded

Results

The result of the insect infestation count on the smoked stored fish samples is presented in Figure1. The result showed no insect infestation from the month of December 2023 to January 2024. Significant differences on the insect infestation count were observed on the smoked stored fishes. February showed highest insect infestation count on *C. gariepinus* (16.83±0.19) followed by *S. auriita* (14.42±0.19), *C. harengus* (12.58±0.19) and *S. scombrus* (14.17±0.19) while least value recorded on fresh water in *O. niloticus* (2.67±0.19) and *S. budgetti* (0.83±0.19). March showed significant difference at $p < 0.05$ on the insect infestation count with the highest value recorded in *S. scombrus* (41.42±0.25) followed *S. auriita* (24.08±0.25) but no significant difference were observed at $p < 0.05$ in *C. gariepinus* (20.50±0.25) *O. niloticus* (18.33±0.25) with least value of infestation recorded in *S. budgetti* (5.17±0.25). April showed significant difference at $p < 0.05$ on the insect infestation count with the highest value recorded in *S. scombrus* (95.00±0.28) followed *C. gariepinus* (58.08±0.28) *S. aurita* (47.67±0.28) *O. niloticus* (45.17±0.28) *C. harengus* (44.33±0.28) with least value of infestation recorded on fresh water fishes *S. budgetti* (23.75±0.28). May showed significant difference at $p < 0.05$ with the highest value recorded *C. harengus* (348.50±0.29) *S. scombrus* (301.50±0.29), followed by *S. aurita* (189.33±0.29) while value recorded in *O. niloticus* (239.83±0.29), *C. gariepinus* (187.67±0.29) with least value of infestation recorded on fresh water fish *S. budgetti* (171.58±0.29).

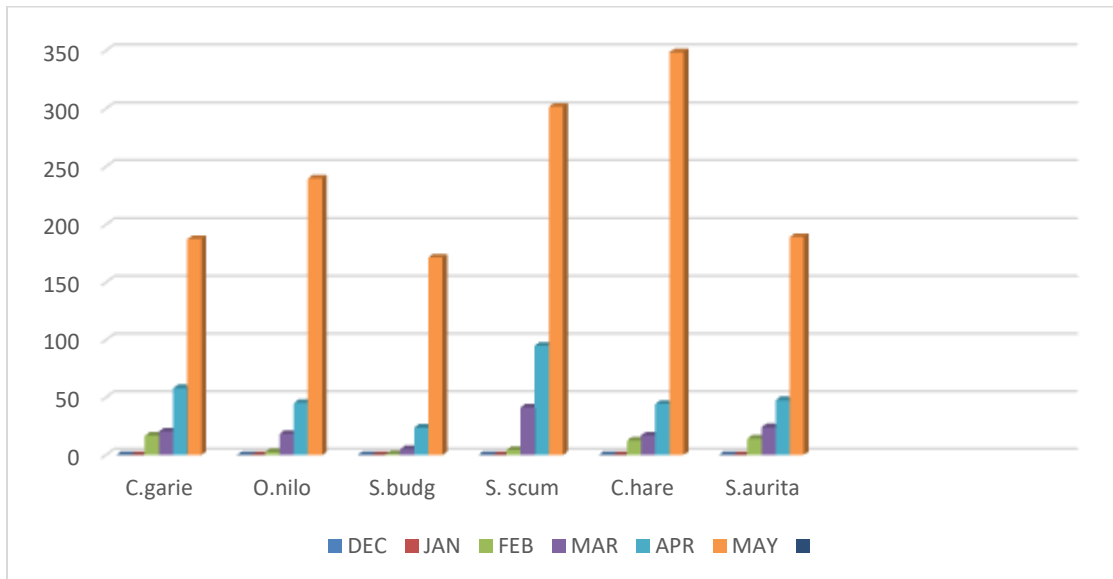


Figure 1: Insect infestation count on the smoked stored Fishes

Keys: C.garie- *Clarias gariepinus*, O.nilo- *Oreochromis niloticus*, S.budg- *Synodontis budgetti*, S.scum- *Scomber scumbrus*, C.hare- *Clupea harengus* and S.aurita- *Sardinella aurita*

Identified Insect pest Infestation count on the Smoked Stored Fishes

The major insects observed during the six month storage were *D. maculatus* and *N. rufipes*. Table 1: showed significant difference at $p < 0.05$ on the insect infestation count of the identified insect pest on the smoked stored Fishes. February; recorded highest infestation of *N. rufipes* on *C. gariepinus* (32.50 ± 0.27) followed by *N. rufipes* on *S. aurita* (27.67 ± 0.27). *N. rufipes* were observed on *C. harengus* (24.33 ± 0.27) *S. scumbrus* (7.17 ± 0.27) while *D. maculatus* showed no significant difference at $P < 0.05$ with same value on *S. scumbrus* (1.67 ± 0.27) *S. budgetti*. (1.67 ± 0.27) *C. gariepinus* (1.67 ± 0.27) and *S. aurita* (1.67 ± 0.27) with least value in *D. maculatus* on *C. harengus* (0.83 ± 0.27). March; showed significant difference at $p < 0.05$ on the insect infestation with the highest value recorded of *N. rufipes* on *S. scumbrus* (79.80 ± 0.25) followed by *N. rufipes* on *S. aurita* (36.17 ± 0.25) on *C. gariepinus* (32.50 ± 0.25) while no significant differences were showed *N. rufipes* on *O. niloticus*

(26.33 ± 0.25) *S. scumbrus* (79.80 ± 0.25) with least value on fresh water smoked fish in *N. rufipes* on *S. budgetti*. (1.17 ± 0.25). April showed significant difference at $p < 0.05$ on the insect infestation with the highest value recorded in *N. rufipes* on *S. scumbrus* (166.83 ± 0.25) followed by *C. gariepinus* (82.33 ± 0.25) with *N. rufipes* on *O. niloticus* (76.83 ± 0.25) *C. harengus* (63.84 ± 0.25) *S. aurita* (79.80 ± 0.25) no significant differences were showed at $P < 0.05$ in *D. maculatus* on *C. harengus* (21.83 ± 0.25) on *S. budgetti*. (23.17 ± 0.25) with least value on the fresh water smoked fish on *O. niloticus* (13.50 ± 0.25). *D. maculatus* were not significant on the fresh water smoked fish. May showed significant difference at $p < 0.05$ on the insect infestation with the highest value recorded in *N. rufipes* on *S. scumbrus* (495.17 ± 0.40) followed *O. niloticus* (397.83 ± 0.40) and *C. harengus* (63.84 ± 0.40). *D. maculatus* were not significantly different as showed on *O. niloticus* (81.83 ± 0.40) and *S. budgetti* (80.67 ± 0.40) with least value recorded in *D. maculatus* on *S. aurita* (66.50 ± 0.40).

Table 1: Identified Insect Pest Infestation count on the Smoked Stored Fishes

Fish species	Insect pest	December	January	February	March	April	May
<i>C.gariepinus</i>	<i>D. maculatus</i>	0.00	0.00	1.67 ^{fg}	8.50 ^{gh}	33.83 ^f	84.83 ⁱ
	<i>N.rufibes</i>	0.00	0.00	32.50 ^a	32.50 ^c	82.33 ^b	290.50 ^f
<i>O. niloticus</i>	<i>D. maculatus</i>	0.00	0.00	2.00 ^f	10.67 ^f	13.50 ^k	81.83 ^j
	<i>N. rufibes</i>	0.00	0.00	3.33 ^e	26.33 ^d	76.83 ^c	397.83 ^b
<i>S. budgetti</i>	<i>D. maculatus</i>	0.00	0.00	1.67 ^{fg}	9.17 ^g	28.83 ^h	80.67 ^j
	<i>N. rufibes</i>	0.00	0.00	0.00 ^h	1.17 ^j	18.67 ^j	262.50 ^g
<i>S.scombrus</i>	<i>D. maculatus</i>	0.00	0.00	1.67 ^{fg}	3.33 ⁱ	23.17 ⁱ	107.83 ^h
	<i>N. rufibes</i>	0.00	0.00	7.17 ^d	79.80 ^a	166.83 ^a	495.17 ^a
<i>C. harengus</i>	<i>D. maculatus</i>	0.00	0.00	0.83 ^{gh}	7.83 ^h	21.83 ⁱ	354.83 ^c
	<i>N. rufibes</i>	0.00	0.00	24.33 ^c	26.33 ^d	66.83 ^d	342.17 ^d
<i>S. aurita</i>	<i>D. maculatus</i>	0.00	0.00	1.67 ^{fg}	12.00 ^e	31.50 ^g	66.50 ^k
	<i>N. rufibes</i>	0.00	0.00	27.67 ^b	36.17 ^b	63.84 ^e	312.17 ^e
SEM		0.00	0.00	0.27	0.25	0.29	0.40

Values with different superscripts in the column indicate significant different at $P < 0.05$ while those with the same superscript are not significantly different.

Discussion

Insect identified during the storage period are *D. maculatus* and *N. rufibes* which are the major insect found to infest smoked fishes. This agreed with Ayetola *et al.* (2020) who stressed that *D. maculatus* and *N. rufibes* are insect found to infest smoked fishes and that cured fish can suffer considerable loss of weight due to feeding; up to 50% loss can result due to beetle infestation over several months. Ebochuo and Oparaejiaku, (2017) also reported that the major pest to attack smoked dried fish, bones, hides and skin are *D. maculatus* and *Necrobia. rufibes*, which infest smoked dried fish and causes economic, quantitative and qualitative losses to fish. The study revealed that from December 2023 to January 2024 which is the first and second month of storage there was no insect found in all the four (4) smoked fishes stored which may be due to the smoking process which reduced the moisture content on the fishes, as smoking provides control against insect attack, is in line with Akpako and Agbor, (2015) who stressed that beetles infest fish with lower moisture content and typically select specific ranges of conditions with higher temperature and relative

humidity. Marine water fish sample (*S. scumbrus* and *C. harengus*) had more infestation of *N. rufibes* thus suggesting that the beetle could preferentially select suitable substrate even when cues from different substrates abound proved to be a more suitable substrate for *N. rufibes* development.

Adeola *et al.* (2016) observed that *N. rufibes* is a pest that infests various substrates including fish and is attracted to dried fish rich in protein and moisture making it ideal substrate for infestation. However, when exposed to various animal steroid sources the insect tends to show preference to a particular species. *C. harengus* and *S. scumbrus* recorded higher number of insect infestation count, this may be due to the fact that marine smoked fishes typically have higher moisture content, oil contents and higher pH level. This is in line with the findings of Silva *et al.* (2019) who reported that smoked marine fishes are contains higher moisture and oil content creating an environment conducive to insect infestation. *O. niloticus* was observed to have low number of insect count during the course of the studies these may be due to the

type of fish species which has lower moisture content and less oily flesh making it less susceptible to insect infestation. These findings are in line with Animem *et al.* (2020) also reported that certain insect may be less attracted to some fish species due to its unique characteristics or chemical composition. *D. maculatus* and *N. rufibes* recorded higher number of insect infestation during the last month of storage which was May, the number of insect count keep on increasing during the storage period which may be due to environmental factors such as temperature and humidity. This agree with the findings of Adeola *et al.* (2016) who reported that temperature fluctuation and high relative humidity as well as adequate oxygen during storage can stimulate or create conducive environment for insect activity and increase population growth. Ayeloja *et al.* (2020) reported that poor storage facilities such as poor ventilation inadequate packaging contribute to increased insect infestation. The first two months of storage recorded zero as no insect was observed, this may due to the low moisture contents and the salt content which can inhibit insect growth and infestation. Koru *et al.* (2021) also stated that shorter smoked fish storage duration may be too short for significant insect infestation to occur. This is in line with Ngunte *et al.* (2022) who stressed that *D. maculatus* and *N. rufibes* are common insect of both the fresh and the marine fishes used for the study as both share the same insect type, they are the most preponderant insect pest of dried fish in sub-Saharan Africa. Koru *et al.* (2021) reported that insect pest damage can lead to quantitative, quality, visual and value loss due to contamination by live or dead pests, or by their cast skins and frass. Zakka *et al.* (2013) estimated 20 - 50% deterioration of smoked fish products during storage arising from insects' pest infestation. Weight loss incurred could partly be due to the differences in length of the

experiment, fish type and other factors. These also agrees with the findings of Golon *et al.* (2019) assessed fish loss and reported that during fish storage insect infestation exposed fishes and reduced it to mere frass and bones.

The study showed a considerable loss of both fish substrates leading to fragmentation and loss of quality. This is attributable to extensive feeding habit of *D. maculatus* and *N. rufibes* on fish substrates. Baba *et al.* (2015) stressed that high infestation rate (number of adults and larvae) of *D. maculatus* in both fish species is an indication that the insect constitutes serious threat to stored fish products leading to quality loss during storage. Lale and Sastas (2013) assessed the value and extent of quantitative losses of different fish species and reported 50-100 % quantitative and qualitative losses depending on storage length, salt content and climatic conditions.

Conclusion

In conclusion the result revealed that the number of insect counts increase with time during the storage months which may be due to environmental factors, poor storage condition and fish type. The highest count was recorded on Marine Fish and least on fresh water fishes which may be as a result of higher moisture and oil contents creating an environment conducive for insect infestation. The insect infestation causes economic, quantitative and qualitative losses to the fish therefore proper storage and effective pest management control measure should be done throughout the supply chain to prevent infestation and fish should not be kept for more than 3-4 months under room temperature to avoid infestation and losses.

References

Abdullahi, N. Auwal, F., Yushau, M. and Bello, B (2010). Efficacy of Nutmeg Powder

- (*Monodoramyristica*) against the Beetle *Dermestes maculatus* (Coleoptera: Dermestidae). *Bioscience Research Communications*, **22** (5): 279-282.
- Adeola, A.A., Ayegbokiki, A.O., Akerele, D., Adeniy, B.T., and Bamidele, N.A. (2016). Marketing Perspective of Smoked Catfish by Consumers. *Journal of Applied Tropical Agriculture*
- Adesina, J. M., Jose, A. R. and Rajashekar, Y. (2016) Bioefficacy of *Clerodrum capitatum* Willd) Schumacher, Thorn. (Lamiales: Verbenaceae) against *Dermestes maculatus* Degeer, 1774 (Coleoptera: Dermestidae) Larvae infestation on Smoked Catfish *Clarias gariepinus* (Burchell, 1822) (Siluriformes: Claridae). *Brazilian Journal of Biological Sciences*, **3** (5): 37-44
- Adesina, M., Jose, A. R., Adetuyi, O. O. and Olorunfemi, D. A. (2014). Larvicidal Activity of *Phyllanthus fraternus* Powder in Suppressing *Dermestes maculatus* Degeer (Coleoptera: Dermestidae) Infestation on Smoked African Cat Fish (*Clarias gariepinus*). *International Journal of Aquaculture*, **4** (11): 67-72.
- Akintola, A. J., Oyegoke, O. O and Lawal, O. S. (2013). Medical Implication of Bio-deterioration Agents in Stored Fish Sample in Nigeria. *African Journal of microbiological Research* **7** (26): 3429-3434.
- Akinwumi F.O and Fesobi M., E (2010). Effect of Some Plant Based Insecticides on the Nutritive Value of Smoked Catfish, *Clarias gariepinus* (Pisces: claridae). *African Journal of Food Science*, **4** (4): 143-147.
- Akinwumi, F.O (2011). Evaluation of some Plant Materials for the Control of Smoked Fish Pest, *Dermestes maculatus* DeGeer (Coleoptera: Dermestidae) in *Clarias gariepinus* Burchell (Pisces: Claridae) ARP. *Journal of Agricultural and Biological Science* **6** (7): 65-69.
- Akpako, E.C. and Agbor, R. B. (2015). Use of *Monodora myristica* as surface Protectant against *Dermestes maculatus* on Stored *Clarias gariepinus*. *Advances in Biochemistry and Biotechnology*, **1** (1): 1-6.
- Akpotu J. O, and Adebote D. A. (2013). Repellency Effect of Five Plant Extracts against the Larvae of *Dermestes maculatus* Larvae on Smoke-Dried *Clarias gariepinus* Fish. *Research Journal of Chemical and Environmental Sciences*, **1** (4): 1-4.
- Akunne, C. E., Ufele, A. N., Ozannadi, A. P., Mogbo, T. C. and Ononye, B. U. (2014). Evaluation of Piper guineense Fruit Powder as a Short Protectant against *Dermestes maculatus* (DeGeer) in Dry fish. *Journal of Entomology and Zoology Studies*, **2** (5): 373-375.
- Animem W. T., Annune P, A., Akombo P.M and Agim M., U (2020) Occurrence of Pests on selected Smoked Fish Families in Benue State. *Journal of Entomology and Zoology Studies*, **8**(4) 409-412.
- Anyanwu, C.N., Egbuche C.T, Osuigwe, D. I., Nwaihu E.C. and Anyachi, N. J. (2016). A Review on the Insecticidal Properties of Some Plant Materials used against *Dermestes maculatus* Infestation on Stored Smoked Fish in Nigeria. *Journal of Multidisciplinary Engineering Science Studies*, **2** (11).
- Ayeloja F.O.A., George W.A, Jimoh G.L, A. (2020). Effect of Insect Infestation on Economic Value of Smoked Fish Sold in Selected Markets in Nigeria. *Agricultural science and Technology*, **12** (1) pp 82-86.
- Baba, G. O., Ayarinde, F. A., Erhabor, T. A., Majolagbe, M. O., Sulaiman, Y.D., Fadoyin, A. S. and Kabiru, M. (2015). Potential of Neem Plant Products

- (*Azadirachta indica* A. Juss. Synonym *melia azadirachta*) as a Protectant against Adult Mortality, Rate of oviposition and Emergence of F1 Generation (Adults) of *Dermestes maculatus* DeGeer on Dried fish. *International Journal of Plant and Forestry Sciences*. **2** (3): 1-12.
- Ebochuo V., C and Oparaajiaku J (2017). Nutritive Value and Organoleptic Attributes of *Xylopiiaethiopica* Pre-treated Smoke Cured *Clarias gariepinus* (Burchell, 1822). *Direct Research Journal of Biology and Biotechnology Science*, **3** (3): 56-59.
- FAO (2010). Field Guide to the Type of Insect and Mite pp 1-25.
- Flowra F., A, Tumpa A., S, and Islam M.T. (2013). Insect Infestation of Dry Fishes at Singra. *Journal of the Asiatic Society of Bangladesh, Science*. **39** (2):273-277.
- Golon A.A., Niba A.T and Ngodiggha E.M, (2019) Insect Infestation and Damage to Dried Fish in Storage. *Journal of Food Science and Technology* 56(4) 1930-1938.
- Ibrahim, B. U., Salihu, I. M., Ndayako, H. H. and Idris, J. E. (2015) Study of the Insect Pests of Storage Fish in Lapai and Minna Metropolis, Niger State, Nigeria Research Paper.
- Iyabo, U. B. (2015). A Survey of Pest (*Dermestes maculatus*) Infestation of Dried Preserved *Clarias gariepinus*: its effect on Nutrient Quantity and Quality. *Continental Journal of Biological Sciences* **8** (1): 8 - 13.
- Jatau, A., Majeed, Q. and Bandiya, H. M. (2014). Effects of Five Local Spices on the Mortality and Development of Larvae of *Dermestes maculatus* De Geer (Coleoptera: Dermestidae) Reared on Dried Smoked Fish. *Intentional journal of fisheries and Aquaculture*.
- Koru J. Alagoa J., Akpodoite Y., and Felicity O. (2021) Abundance and Diversity of Insect Associated with Dry Fish Spoilage in 3 Selected Market in Yenegoa Bayelsa State. *Biological and Pharmaceutical Science* **16** (03) 222-228.
- Lale, N.E.S and Sastas, B. M. (2013). The Effect of Sun Drying on the Infestation of the African Cat Fish (*Clarias gariepinus*) by Post- Harvest Insect in the Lake Chad District of Nigeria.
- Ngunte T.H., Peyieno M.J, Yantcho T, L.F, Tamgno B, R., and Techoumboungang F. (2022). sSituation of Smoked Freshwater Fish Sold in the Markets of Yau'nde city (Center of Cameroon) and Evaluation of Control Methods against their Insect Pests during Storage. *African Journal of Tropical Entomology Research*, **2** (1): 14-25.
- Omodara, M. A., Olaniyan, A. M. and Afolayan, S. S. (2012). Effects of Drying Temperatures on the Drying Rate and Quality of African Catfish. *African Journal of Agricultural Research and Development*, **5** (2):52-60.
- Oyedokun J.O (2020). Proximate Composition of some Common Hot Smoked Fresh Water Fish Species using Different Packaging Materials, *International Journal of Fisheries and Aquacultural Research*, **6** (2): 29-39.
- Sani, F. M., Nasir, I. A. and Torhile, G. (2016). Mycological Evaluation of Smoked - dried fish sold at Maiduguri Metropolis. *European Journal of Health Sciences*, **2** (1):5-10.
- Shuaibu, T. and Yahaya, M. A. (2018). A Review on the Insecticidal Properties of Some Plant Materials used against *Dermestes maculatus* infestation on stored Smoked Fish in Nigeria Dutse. *Journal of Pure and*

- Applied Sciences* (DUJOPAS), **4** (2): 394 - 402.
- Silva S.A., Costa J. Albuguerera T.G., Costa H.S and Valente D. (2019) Insect infestation in Smoked Fish: effect of moisture content and oiliness. *Journal of Food Science and Technology*, 56(2) 851-858.
- Wahedi, J.A. and Kefas, M. (2013) Investigation of Insect Pests on Three Species of Smoked Fish in Mubi North-Eastern Nigeria *Global Journal Biological Agriculture and Health Services*. **2** (3):103-105
- Zakka, U., Ayertey, J.N. and Cobblah, M.A (2013). Development of *Dermestes maculatus* (DeGeer, 1774) (Coleoptera: Dermestidae) on Different Fish Substrates. *Jordan Journal of Biological Science*, **6** (1) 5-10.