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QUALITY ASSESSMENT OF SMOKE-DRIED CATFISH STORED IN DIFFERENT PACKAGING MATERIALS

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ABSTRACT

The perishable nature of fish necessitates its proper handling and preservation to increase its shelf-life and retain its desirable quality and nutritional value. This work aimed to evaluate the effects different packaging materials on the proximate and microbial analysis of smoked dried African Catfish (*Clarias gariepinus*). Freshly harvested fish was purchased from Zobe dam in Dutsin-Ma Local Government Area of Katsina State, Nigeria. A total of thirty (30) sample of *C. gariepinus* weighing 7.2kg were bought and divided into Ten (10) fish per treatment. The fish were smoked dried to a constant weight, packaged in three different materials and stored in the laboratory for six (6) weeks. Samples were then taken out from storage for further analysis biweek and finally concluded at six weeks. The analysis done was proximate composition, bacterial and fungal count. The result of the proximate assessment at the 6th week shows that the range for moisture was 10.1%-15.8%, protein, 51.1%-58.4%, 1.53%-2.40%, ash, 1.53%-2.40% and lipid, 19.6%-21.4%. Total viable count increased in week 6 with paper bag having the highest number of 9.3x10^5 cfu/g of bacteria and 8.4x10^5 of fungal. The least count for bacterial and fungal was recorded in transparent zip-lock bag and zip-lock aluminum foil bag. The results showed that the most suitable packaging material were both transparent zip-lock bag and zip-lock aluminum foil bag. This is because the preserved the quality of the fish hence the proximate composition of the fish was better than the fish kept in paper bag.

Keywords: Catfish, Packaging, Transparent zip-lock bag, Zip-lock aluminum foil bag, Paper bag

INTRODUCTION

Fish smoking is one of the traditional fish processing methods aimed at preventing or reducing postharvest losses. Smoking involves heat application to remove water and it inhibits bacterial and enzymatic actions of fish (Kumolu Johnson et al., 2009). Smoking lowers the moisture level and raises the protein content. It also improves the fish's sensory acceptability, which leads to value-added products (Akinwumi, 2014). Many fish processors favor smoking fish since it's a quick and straightforward way to extend its shelf life and increase its price (Magawata and Musa, 2015).

A properly dried fish product may undergo spoilage if not well packaged because of the hygroscopic nature and its ability to lose oil when exposed to the atmosphere. In Nigeria, smoked fish are not properly packaged and hence they are sold within a short period. This has made smoked fish business to remain at a small scale level in the country. Various types of packaging made up of different materials design and sizes are used all over the world on board vessels during processing, transportation, storage, retail and display. According to Olayemi et al. (2013), an efficient fish packaging material should be able to oxidation and dehydration, provide less bacterial and chemical spoilage, stop permeation, protect the product from physical harm. In Nigeria, jute bags, mat bags, baskets, sacks, paper cartons, wooden rackets, cane, and baskets are among the packaging materials for dried or smoked fish. According to Okonkwo et al. (1991), these materials provide minimal defense against microbial, chemical, dust, and insect attacks, and they only act to hold the products during handling, transportation, and storage. The principal requirement of packaging is to deny access to insect and to prevent rehydration and consequent increase in water activity leading to microbial spoilage. However, studies have revealed the materials used to package smoked fish in Nigeria provide little protection for the dried fish, which are vulnerable to nutrient loss, insect attack, and microbial infection (John, 2006).

Since processing agricultural products requires a lot of resources, including energy, time, and other inputs, it is imperative that adequate packaging materials be used.These resources differ from product to product and from process to process. Therefore, if any product is worth processing, then that product is worth packaging well. Therefore, the aim of this work is to examine the effects of transparent zip-lock bag, zip-lock aluminum foil bag and paper bag on the proximate and microbial load of smoked dried catfish (*Clarias gariepinus*)

MATERIALS AND METHODS

Collection of Fish Samples

A total of thirty (30) live sample of *C. gariepinus* weighing 7.2kg used for this investigation were purchased from Zobe dam Dutsin-Ma Local Government Area, Katsina State, Nigeria. The samples were carried in large plastic bowls, half filled with clean water and transported to the Biological laboratory Federal University Dutsin-Ma, Katsina State.

Fish preparation and smoking

Live fish samples purchased were sacrificed by clubbing on the head, gutted, thoroughly washed with clean water to remove slime and dirt and smoked with a traditional drum smoking kiln for 72hours according to the method described by Omojowo and Ibitoye (2005). During smoking, the fish samples were checked at intervals and turned over to avoid burning or charring. The hot smoked-dried fish were cooled for 30-40 minutes at ambient temperature.

Packaging methods and storage condition

The cooled smoked-dried fish were packed in different packaging materials and labels as T1 for fish samples packed

in a zip-lock aluminium foil bag (6.73W x 7.9H inches), T2 for sample packed in a transparent zip-lock bag (6.30W x 9.45H inches), T3 for fish sample packed in paper bag (7.00 H X 6.70W inches), acted as the control and stored for 6 weeks. Each packaging material had ten fish stored in them each at an average room temperature of 36ºC and humidity of 23%. During the storage period the proximate analysis, microbial analysis and sensory assessment were conducted at week 0, 2, 4 and 6. The packaging materials were obtained from the supermarket.

Proximate composition of fish

The proximate composition; crude protein, moisture, lipid, crude fibre and ash of the smoke-dried fish samples were determined in triplicate according to the AOAC (2010) methods while carbohydrate was calculated by difference.

Crude protein was determined using kjeldahl which involved digestion, distillation and titration. The percentage crude protein was obtained using the formula:

% Protein = N x 6.25, where N =NFE,

Fats were determined using Soxlet method. Percentage Fats was obtained by the formular:

% Fat = W0-WI /W0, where W0=Initial weight, WI=Final weight

Moisture was determined using an oven drying method. Percentage moisture was obtained by the formula:

%Moisture = W0 –WI /W0x100, where W0=Initial weight, WI=Final weight

Crude fibre was determined using trichloacetic acid. Percentage crude fibre was obtained using the formula:

% CF = W0 – WI x 100 / W0, where W0=Initial weight, WI=Final weight

The percentage carbohydrate (CHO) was calculated using the formula:

%CHO=100-% fibre+%fat+%crude protein

Ash was determined using an oven drying method. The percentage ash was obtained using the formula: %Ash=weight of fish+ ash-weigh of fish+100/ Weight of feed stuff used.

Microbial analysis of fish

Microbial analysis of fish Enumeration of bacterial load was done using plate count agar spread plate technique. Ten grams of the sample was mixed with 90 ml saline water; appropriate dilutions of fish homogenate were spread on plate count agar and incubated at 37°C for 48 hours. The colonies counted for total plate counts were expressed as Colony Forming Units per gram (CFU/g), bearing in mind the factors of dilution (Maturin and Peeler 2001). All media used for microbiological analysis were prepared as indicated by the manufacturer. Isolation and identification of *Staphyloccus aureus* were carried out by the method described by Gutierrez et al (2012) and *Bacillus subtilis* according to AOAC (1998) method. MacConkey agar media was used for Escherichia coli determination, the plates were incubated at 37oC for 24h. Colonies with pinkish red growth having a metallic sheen or reflection confirmed the presence of E. coli (AOAC 1998). Fungal analysis was done by using Rose Bengal Chloramphenicol (RBC) agar. Twenty-five grams of the sample was blended with 225 ml of 0.1% peptone water and 0.1ml of the appropriate dilutions of the sample was spread on the surface of the medium and incubated at room temperature (28±1°C) for 5 days (Immaculate et al (2013), then examined for fungi.

Statistical analysis

Data collected were in triplicates and subjected to analysis of variance test (ANOVA). Using statistical package for the social science (SPSS) computer software 1988 version 10.0 of the Chicago Illionis (USA). Comparisons among treatment was carried out by Duncan Multiple Range Test at a significance level of 0.05.

RESULTS AND DISCUSSION

Table 1: The results show total viable count of *Clarias gariepinus* package in different polythene

		Total Viable Count	
T1	Weeks	Bacteria (Cfu/g)	Fungi (Cfu/g)
	Week 0	1.02×10^2	2.7×10^2
	Week 2	2.11×10^2	3.7×10^3
	Week 4	4.1×10^3	4.7×10^3
	Week 6	8.9×10^5	6.1×10^5
T2	Week 0	1.28×10^2	1.26×10^2
	Week 2	1.48×10^2	2.3×10^2
	Week 4	1.69×10^5	7.2×10^5
	Week 6	6.9×10^5	8.0×10^5
T3	Week 0	1.06×10^2	2.9×10^2
	Week 2	1.09×10^3	6.1×10^3
	Week 4	4.1×10^5	7.9×10^5
	Week 6	9.3×10^5	8.4×10^5

T1=Aluminum bag, T2=Transparent Ziplock and T3=Paper bag

Table 2: Proximate Analysis of Stored Smoked Dried Fish

	Initial Week 0						Final Week 6					
Sample	**Moisture (%)**	**Ash (%)**	**Crude fiber (%)**	**Crude lipid (%)s**	**Protein (%)**	**Carbohydrates (%)**	**Moisture (%)**	**Ash (%)**	**Crude fiber (%)**	**Crude Lipids (%)**	**Protein (%)**	**Carbohydrate (%)**
T1	9.10±0.01[a]	3.10±0.23[a]	16.20±0.39[a]	14.20±0.64[a]	59.10±3.32[b]	9.10±0.01[a]	14.20±0.03[b]	1.53±0.18[a]	0.89±0.00[a]	19.60±0.01[a]	51.1±0.07[a]	12.68±2.07[b]
T2	9.50±0.01[a]	7.10±0.70[c]	9.60±0.73[b]	12.10±0.05[b]	61.10±2.80[a]	9.60±0.01[a]	10.10±0.02[c]	2.40±0.46[b]	0.66±0.00[a]	21.40±0.02[b]	58.4±0.01[a]	7.04±0.05[a]
T3	6.2±0.01[b]	4.20±0.02[b]	19.50±0.25[a]	6.50±0.04[c]	67.40±1.98[a]	7.10±0.01[b]	15.80±0.01[a]	1.62±0.03[a]	1.04±0.01[a]	19.80±0.01[a]	54.7±0.03[a]	7.66±1.02[a]

T1=Aluminum bag, T2=Transparent Ziplock and T3=Paper bag

Discussion

The moisture content of catfish is important in preserving the fish. It is a precursor of the relative content of protein, lipid and energy (Msuku and Kapute, (2018). The percentage moisture and carbohydrate increased with increase storage time (Table 1) while the percentage crude protein and ash reduced with increase storage time. Mosarrat et al. (2016) observed similar trend in their study of shelf-life quality of smoke-dried freshwater SIS fish stored at laboratory condition (26°-31°c) where it was observed that during storage period, the percentage of moisture increased whereas protein, fat and ash contents considerably decreased. Moisture content is an important attribute in food processing and preservation because many biochemical and physiological changes depends very much on it (Ndife et al., 2022).The increase in the moisture content of the smoked samples in week 6 in comparison to the samples in week 1 is as a result of environmental factors. The moisture contents of the dried catfish stored in the paper bags increased compared to other packaging materials. This is in line with the findings of Elijah et. al. 2023, who recorded highest moisture content of *Clarias garipenus* stored in paper material. The increase in moisture is due largely to environmental effect which is also in line with the findings of Daramola et. al.(2007). It was found that most of the packaging material behaves differently because of their peculiar characteristics with respect to the environment in which they were exposed. Since moisture absorption is major determinant of growth of microorganism which can cause spoilage, it was used to assess their performance. From the analysis it was found that both zip-lock aluminum foil bag (14.2%) and transparent zip-lock (10.1%) bags had the least amount of moisture absorption whereas paper bag (15.8%) had the highest amount of moisture absorption, as shown on Table 1, hence the are both better storage material for dried catfish given the prevailing condition of the storage environment.

The value of the crude protein content also shows the inverse relationship between the protein and moisture contents. Usman (2017) opined that the protein content of fish may be influenced by size, sexual maturation, water quality as well as feeding ration and frequency. From the result the protein content of the stored fish generally decreased with storage time but there was not much loss in the protein content for all the packaging materials. The range of the values recorded for protein in this study agreed with the observation (33.66 – 66.04) of Adebowale et al., (2008). The observed reduction in crude protein and lipid content during storage may be attributed to leaching out of some extractable soluble protein fraction and hydrolysis of some of the lipid fractions (Daramola et al., 2007).

The total viable counts (TVC) (Table 2) of the prepared smoked fishes shows fish stored in all the packaging material having microbial and fungal growth at week 0, which might be as a result of post processing contamination during cooling and packaging (FDA, 2000). Bacterial and fungal growth increased in all the packaging material as the week progressed with the highest bacterial growth recorded for fish stored in Paper bag (9.3×10^5 Cfu/g) at week 6 and transparent zip-lock bag(6.9×10^5 Cfu/g) and zip-lock aluminum foil bag (8.9×10^5Cfu/g). At the 6th week, all the samples recorded growth of both bacteria and fungi with an increase in bacterial and fungal load. These high total bacterial count of the fish samples were higher than the maximum recommended value of bacteria counts for good quality fish products, which is 5×105 cfu/g according to International Commission on Microbiological Specifications for Foods (ICMSF 2002) and < 10 cfu/g by the Microbiological Guideline for Ready-to-eat-Food (2007).

The increase in TVC during storage period might be attributed to multiplication of microorganisms as a result of changes in environment and temperature during storage. Smoked fish samples may have a relatively low water activity level which is a prerequisite for fungal growth. The increase in TVC of the sample is in agreement with (Dutta, et al., 2018) who worked on bacterial and fungal population assessment in smoked fish during storage period.

The levels of microbial contamination in the fish samples are minimal, therefore, are fit for consumption, as it is below the tolerable limit for bacteria (2.5×10^5 -1.0×10^8 cfu/g) growth in meat products (F.A.O, 2024 and P.H.O, 2024) The low microbial loads could be attributed to the actions of salt, heat and smoke.

CONCLUSION

The study demonstrated the effectiveness of different packaging materials in nutrient retention and control of microbial population in smoked dried fish. There were changes in the proximate and microbial quality during the storage period. The results showed that the most suitable packaging material were both transparent zip-lock bag and zip-lock aluminum foil bag which could store smoked dried fish up to a period of 6week. This is because the quality of the fish, proximate composition and microbial load were better than the fish kept in paper bag. There was no insect infestation throughout the experimental period. Therefore, hygienic processing, proper packaging and storage will improve the quality and safety of smoked fish. Local fish processors should also be trained in good manufacturing practices so that quality fish products will be available for consumers.

REFERENCES

Adebowale, B. A., Dongo, L. N., Jayeola, C. O. and Orisajo, S. B. 2008. Comparative quality assessment of fish (Clarias gariepinus) smoked with cocoa pod husk and three other different smoking materials. Journal of Food Technology, 6:5-8.

Akinwumi FO.2014. Effects of Smoking and Freezing on the Nutritive Value of African Mud Catfish, Clarias gariepinus Burchell, 1822. Journal of Agricultural Science. 2014;6(11):143-149. https://doi.org/10.5539/jas.v6n11p143

Bouzgarrou, O. and Sadok, S. 2017. Determination of Potential Health Hazards and Nutritional Attributes of the Fresh and Smoked Freshwater Thin-Lipped Grey Mullet (Liza Ramada). IOSR Journal of Business and Management (IOSR-JBM) 19(5): 60-73 e-ISSN: 2278- 487X, p-ISSN: www.iosrjournals.org https://doi.org/10.9790/487X-1905066073.

Byett, A. (2006). Fish packaging. International Trade Centre, UNCTAD IWTO.

Daramola J. A., Fasakin E. A. and Adeposi E. O. 2007. Changes in Physiochemical and Sensory Characteristics of Smoked Dried Fish Stored at Ambient Temperature. African Journal of Food Agriculture Nutrition and Development; 7:6.

Dutta,M., Majumdar,P.R., Rakeb-Ul- Islam,M. and Saha, D. 2018.Bacterial and Fungal Population Assessment in Smoked Fish during Storage Period.Journal of Food:Microbiology, Safety & Hygiene 3:1.

Elijah G. I., Mfrekemfon, G. A. and Uwem, I. J. 2023. The Effect of Pretreatment and Packaging Material on the quality of Stored Dried Catfish (*Clarias gariepinus*). International journal of research and scientific innovation (ijrsi) issn no. 231-2705 | doi: 10.51244/ijrsi | volume x issue vii july 2023 www.rsisinternational.org page 105

Eyo, A.A., (2001). Fish Processing Technology in the Tropics.National Institute for Fresh Water Fisheries Research (FIFR), New Bussa, Nigeria.

FAO, F.A.O.(2024): Microbiological Requirement for Food Group 1. 2024.

FDA (Food and Drug Administration),(2000): Conference on mycotoxins in animal feeds, grains and food related to human and animal health. Rockville: Maryland.

Ikrang, E. G., and Umani, K. C. (2019). Optimization of process conditions for drying of catfish (Clarias gariepinus) using response surface methodology (RSM). Food Science and Human Wellness, 8(1), 46–52.

International Commission on Microbiological Specifications for Foods (ICMSF) (2002). Microorganisms in foods. Microbiological testing in Food Safety Management. Kluwer Academic/Plenum Publishers, New York, 199pp.

Daramola, J.A., Fasakin, E.A., Adeparusi E.O.(2007): Changes in physicochemical and sensory characteristics of smoke-dried fish species stored at ambient temperature Afr. J. Food Nutr. Sci., 7 (6) (2007), pp. 1-1.

John, B. (2006):Fish Packaging, International Trade Center. UNCTAD/ WTO, 2006, 19-34.

Kumolu – Johnson, C. A.; Aladotohum, N. F. and Ndimele, P. E. (2009).The Effects of Smoking on the Nutritional Qualities and Shelf Life of Catfish.African Journal of Biotechnology 9.1: 73 -76.

Magawata, I. and Musa, T.(2015). Quality characteristics of three Hot-Smoked fish species using locally fabricated Smoking kiln. International Journal of Fisheries and Aquatic Studies. 2015;2(5):88-92. Available at: https://www.fisheriesjournal.com/archives/2015/vol2issue5/PartB/2-5-26.pdf.

Microbiological Guidelines for Food (2007). Ready-To – Eat-Food in General and Specific Food Items. Centre for Food Safety, Food and Environmental Hygiene Department, Hong Kong. 46.

Mosarrat, N.N., A.L. Gulshan, C.C. Subhash, B.F. Farzana, B Mohajira (2016): Shelf-life quality of smoke-dried freshwater SIS fish; Chapila (*Gudusia chapra*, Hamilton-Buchanan; 1822) Kaika (*Xenentodon cancila*, Hamilton-Buchanan; 1822) and Baim (*Mastacembelus pancalus*, Hamilton-Buchanan; 1822) stored at laboratory condition (26°-31°C). J. Agri. Vet. Sci., 9(3) (2016), pp.23-32.

Msuku, L. and Kapute, F. 2018. Effect of Smoking and Sun Drying on Proximate Composition of Diplotaxodon Fish Species (Ndunduma) From Lake Malawi, Malawi. Afr.J.Food Agric. Nutr. Dev. 2018; 18(1): 13009 – 13018 https://doi.org/10.18697/ajfand.81.16960.

Ndife, J., Onwuzuruike U. A., Ebeleagu, S. B. and Okwunodulu N. I. (2022). Influence of meat type on processed meat (Kilishi) quality. FUDMA Journal of Sciences, 6(2):160-168.

Okonkwo TM, Obanu ZA, Ogbonna I.(1991): Rapid Appraisal of Smoked Meat Production Problems in Nigeria: A Case Study of Tao Kara Smoked Meat Production Centre, Tarkare Keffi L. G. A. Paper presented at Rapid Rural Appraisal case study Workshop, Dakar Senegal, 1991, 6–8.

Olaniyi, W. A., Olukayode A.M and Omitogun, O.G. (2016). Comparison of proximate composition and sensory attributes of Clariid catfish species of *Clarias gariepinus*, *Heterobranchus bidorsalis*, and their hybrids. Food Science and Nutrition. 5(2): 285–291. https://doi.org/10.1002/fsn3.391.

Olayemi F. F, Raji A. O, Oyelese O. A, Oyewole S. N, Omodara M. A. (2013) Effective Smoking Kiln for Developing Country. International of Scientific and Engineering Research 2013; 4(1):847-853.

Olokor, J., Ihuahi, J., Omojowo, F., Falayi, B. and Adelowo, E. (2007). Handbook of Practical Fisheries Technology.Fisheries Technology Division, National Institute for Freshwater Fisheries Research (NIFFR), New Bussa.

Public Health Ontario, P.H.O.(2024): Food Sample Analysis; Bacteria indicator. 2024.

Sengor, G.F., Kalafatoglu, H and Gun, H. (2004). 27. Mepba, H.D., 2002. The Determination of Microbial Flora, water Activity and Chemical Analysis in Smoked Mussels (*Mytilus galloprovincialis, L.*) Turk J Vet Anim Sci., 28: 793-797.

Usman, I.B. (2017). Assessment of the Nutritional Quality of Smoked Catfish (*Clarias gariepinus*) In Lapai, Niger State, Nigeria Science World Journal Vol 12 (No 1) 2017 www.scienceworldjournal.org ISSN 1597-6343.