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PROXIMATE, MICROBIAL AND HEAVY METAL ANALYSIS OF FERMENTED AND SMOKED-DRIED *Brycinus nurse* AND *Oreochromis niloticus*

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ABSTRACT

The study was aimed at evaluating proximate, microbial, and heavy metals of processed *Brycinus nurse* and *Oreochromis niloticus*. Fresh *B. nurse* and *O. niloticus* weighing 16kg of 8kg per species were obtained from fishers at Gubi dam. They were washed and gutted. Each 8kg of fish species was divided into two equal parts of 4kg each. The fish samples were randomly allocated to four treatments in complete randomized design:*B. nurse* fermented with salt (BFS) and without salt (BFWS);*O. niloticus* fermented with salt (NFS) and without salt (NFWS). Fermentation of the fishes was carried out by splitting the 4kg of each fish species into 2kg and was placed manually into four airtight transparent glass bottles, buried in four holes of 1m deep in the soil for four weeks.*B. nurse*(SMB) and *O. niloticus*(SMN)samples weighing 4kg each were salted, dried, and smoked. The mean proximate analysis values were BFS had the highest moisture content (78.98%); BFWS had the least (55.10%); SMB had the highest crude protein (60.12%); NFWS had the least (4.66%). SMB had the highest 14.08%ash while NFWS had the least (3.65%). SMB had the highest 10.29% extract ether while NFS had the least (1.22%). NFS had the highest 1.40% crude fibre while SMBhad the least (0.29%). Fresh *B. nurse* recorded the highest 1.70 x 10^7 and 8.80 x 10^7cfu/g mean bacteria and fungi counts respectively. BFWS recorded the highest mean values of 2.05±0.05mg/kgand 0.88±0.02mg/kg for Zn and Pb respectively.

Keywords: Fermentation, Smoked, Proximate Analysis, *Brycinus nurse*, *Oreochromis niloticus*

INTRODUCTION

Large proportion of Nigerian population lives near water bodies such as lakes, reservoirs, swamps and coastal lagoons that are invaluable ecological resources that serving many human needs (Adeyemi*et al.*, 2010). Fish spoils easily after harvest due to the high tropical temperature which accelerates the activities of bacteria, enzymes and chemical oxidation of fat in the fish; however, processing and preservation of fish extends its shelf life either through moisture or pH reduction thereby retarding microbial activity (Ruddle and Ishige, 2010).Sanjeev*et al.* (1990) reported that fermented fish products are akin to staple foods in most parts of south-east Asia, generally as a condiment for rice dishes.Fish fermentation is a method that prevents spoilagethrough inhibition of microbial activities by making the fish muscle more acidic (Adeyemi*et al*, 2010).Bio-accumulation of heavy metals by aquatic organisms is through absorption or ingestion and when studied are bio-indicators of pollution (Ibemenuga, 2013; Ibemenuga*et al*. 2019).

Fish is a highly perishable food. There is need to process and preserve fish in order to maintain its quality using least cost and simple technology.The technology of chilling, freezing and caning fish are not common due to high cost of preservation materials. In urban areas most household owns a refrigerator for preservation of perishable food while majority of rural inhabitants do not have. Furthermore, fish smoking offers an alternative to fish processor but in recent time the price of wood has sky rocketed.This study is aimed at assessing the microbial, biochemical and heavy metals of *Brycinus nurse* and *Oreochromis niloticus*processed using fermentation and smoke-drying methods.

MATERIALS AND METHOD

Study Area

The study was conducted at Abubakar Tafawa Balewa University Research Farm Bauchi, Bauchi state.Bauchi State is located on latitude 10°17, and longitude 9°49, with a mean annual rainfall of 1099 mm and mean annual temperature of 25.4°C (FAO, 1998).

Fish Sampling and Experimental Design

Fresh *B. nurse* and *O. niloticus* weighing 16kg of 8kg per species were obtained from fishers at Gubi dam fishing settlement in Piro village. They were washed and gutted. Each 8kg of fish species was divided into two equal parts with each 4 kg. The fish samples were randomly allocated to four (4) treatments in a complete randomized design :*B. nurse* fermentation with and without salt; *O. niloticus* fermentation with and without salt.

Fish Fermentation Process

Fermentations of *B. nurse* and *O. niloticus* were carried out by splitting the 4kg of each fish species into 2kg and were placed manually into four airtight transparent glass bottles. Some salt of 5g was added to the 2kg of each fish species to be fermented with salt. Two bottles with salt and two without salt were buried in four holes of 1m deep in the soil for four weeks period of the experiment.

B. nurse and *O. niloticus* samples weighing four 4kg each also salted, dried and smoked.

proximate Analysis

Samples from fermentation with and without salt as well as smoked-dried fish for each species were obtained in three replicate per processing method per fish species and proximate composition for ash, moisture, fibre, crude protein and fat were determined according to AOAC methods (AOAC, 2000).

Microbial Analysis

Total plate count (TPC) of each sample was determined. Counts were expressed in 10g colony forming units (CFU) per gram of sample. Enumeration of lactic acid bacteria (LAB) in the samples were done by employing MRS agar. The dominant bacterial colonies were randomly selected by their similarity in morphological characteristics from the TPC plats and bio-chemically, characterized as per the protocol outline in Bergey manual of determinative bacteriology (Bergey*et al*, 2002).

Data Analysis

All data were subjected to analysis of variance (ANOVA) and means were separated using least significant difference (LSD) (Ogbeibu, 2005).

RESULTS AND DISCUSSION

Table 1: Mean Proximate Composition of Differently Processed Species of Fish (*Brycinus nurse* and *Oreochromis niloticus*)

Parameters	A1	A2	B1	B2	C1	C2	D1	D2	LOS
Moisture	65.1	69.22	55.10	58.10	78.96	62.37	70.13	71.42	NS
Ash	14.08^{a}	13.13^{a}	5.12^{b}	3.65^{b}	8.13^{b}	6.3^{b}	16.21^{a}	14.43^{a}	**
Crude Protein	60.12^{a}	58.61^{a}	6.18^{b}	4.66^{b}	9.12^{b}	7.33^{b}	62.74^{a}	59.70^{a}	**
Ether Extract	10.29^{a}	8.62^{a}	2.05^{b}	1.22^{b}	2.40^{b}	1.31^{b}	11.64^{a}	9.88^{a}	**
Crude fibre	0.29^{b}	0.38^{b}	1.04^{a}	1.40^{a}	0.61^{ab}	0.73^{ab}	0.11^{b}	0.20^{b}	**

Means within a row with different superscripts are significantly different (P<0.005); LOS= Level of significance; NS= Non-significant; ** = Highly significant; A1= Smoked-dried *B. nurse*; A2= Smoked-dried *O. niloticus*; B1= Fermented *B. nurse without* salt; B2= Fermented *O. niloticus* without salt; C1 = Fermented *B. nurse with* salt**;** C2= Fermented *O. niloticus* with salt; D1= Fresh *B. nurse*; D2= Fresh *O. niloticus*

Mean Proximate Composition of Differently Processed Species of Fish

The general trends in the proximate composition of the two fish species (Table1) were that the ash, crude protein and ether extract contents of the smoked and fresh fishes are higher than in the fermented fishes while the moisture and fibre contents of the fermented fishes were higher than those of the smoked and fresh fishes. Fermented *B. nurse* with salt (C1) had thehighest mean moisture content of 78.96% while fermented *B. nurse* without salt (B1) had the lowest value of 55.10%. However, thefindings of Ranendra*et al* (2015) recorded lower value of 43.48%. The low crude protein content in the fermented fishes might be due to degradation of protein during fermentation. The low ether extract in fermented fishes is an indication of low fat contents in fermented products. The mean value of ether extract (11.64%) of fresh *B. nurse* in this research corroborate with 11.57% reported by Abdulkarim *et al* (2017).

Table 2:Mean microbial load of variously processed fish species *B. nurse* and *O. niloticus*

Samples	Total Bacterial plate count	Total fungal count	Total Coliform count
Fermented *B. nurse without* salt	1.55×10^7	1.35×10^5	5.5×10^7
Fermented *O. niloticus* without salt	1.23×10^7	1.55×10^5	6.2×10^7
Fermented *B. nurse*with salt	1.27×10^7	1.1×10^5	6.35×10^7
Fermented *O. niloticus* with salt	1.36×10^7	2.35×10^5	7.15×10^7
Fresh *B. nurse*	1.70×10^7	1.40×10^5	8.80×10^7
Fresh *O. niloticus*	1.44×10^7	1.45×10^5	7.6×10^7
Smoked-dried *B. nurse*	1.22×10^7	8.6×10^5	6.35×10^7
Smoked-dried *O. niloticus*	1.17×10^7	9.6×10^5	6.95×10^7

Mean Microbial Load of Different Processed Fish Species

The highest bacterial total plate count was found to be 1.70×10^7 and lowest of 1.055×10^7Cfu/g for fresh *B. nurse* and fermented *B. nurse* without salt respectively. The highest bacterial count of 9.5×10^5Cfu/g was recorded in *B. nurse* smoked with firewood by Buba*et al* (2021) and the value fell within the acceptable limit of 1.0×10^6cfu/g for consumption.The highest fungal count of 9.6×10^5 and the lowest value of 1.1 were recorded in smoked *O. niloticus* and fermented *B. nurse* with salt respectively while Muzaddadi (2002) also reported a higher fungal count of 9.1 and 8.50log Cfu/g for shidal (traditional fermented fish product).

Table 3:Mean heavy metals of variously processed species of fish (*B. nurse* and *O. niloticus*)

Samples	Lead (Pb) (Mean ± SDmg/kg)	Zinc (Zn) (Mean ± SD mg/kg)
Fermented *B. nurse*without salt	0.88±0.02	2.05± 0.05
Fermented *O. niloticus* without salt	0.64±0.02	1.34±0.02
Fermented *B. nurse*with salt	0.65±0.01	1.77±0.02
Fermented *O. niloticus* with salt	0.35±0.01	1.88±0.00
Smoked-dried *B. nurse*	0.69±0.01	1.82±0.02
Smoked-dried *O. niloticus*	0.63±0.03	1.56±0.01
Fresh *B. nurse*	0.55±0.01	1.88±0.02
Fresh *O. niloticus*	0.55±0.01	1.55±0.01

Heavy Metals Content of Different Processed Fish Species

The highest mean values of lead of 0.88±0.02mg/kg and 2.05± 0.05mg/kg of Zn were recorded from fermented *B. nurse* without salt and the lowest values of Pb(0.35mg/kg) and 1.34±0.02mg/kg of Zn were also recorded in fermented *O. niloticus* without salt and all the values were higher than those reported by Abdulkarim *at al.* (2014) and Magaji*et al* (2020). The highest mean value of zinc is 2.05 ± 0.05mg/kg from fermented *B. nurse* without salt and the lowest value of 1.34 ± 0.02 from fermented *O. niloticus* without salt.

Zinc is a very important mineral that form an integral component in the formation of many enzymes including RNA and DNA polymerases (Rosa *et al*, 2007).

CONCLUSION AND RECOMMENDATIONS

Smoked *B. nurse* and smoked *O. niloticus* were more nutritive based on their chemical composition. All the bacterial counts from two fish species are within acceptable limits. Fermented *B. nurse* has the least microbial load; *B. nurse* is a good source of zinc components to *Oreochromis* niloticus. Further research should be conducted on fish fermentation in both wet and dry season to compare the effects of season on their chemical compositions.Fish species should be fermented and stored for at least 6-12 months to determine the storage quality of both fermented and smoked fish.

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