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Nutritive and sensory value assessment of smoked dried catfishes from two indigenous markets in Benue state, Nigeria

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Abstract Nutritional assessment of processed fish is needed to ensure that such products sold in the local communities are safe for human consumption. Present study aimed at evaluating the nutritional quality of selected catfishes, namely, *Clarias gariepinus*, *Heterobranchus* spp and *Synodontis* spp from Abinsi and Wadata fish markets in Benue State, Nigeria. Samples of smoked catfish each weighing approximately 500 g were sourced from Abinsi and Wadata fish markets, and packaged using foil paper and polythene bags. The smoked fish samples were analysed to determine organoleptic qualities, proximate and mineral composition. The results of the study revealed a significant ($p<0.05$) variation in proximate and mineral composition of the three smoked catfishes between the two markets. The percentage moisture content for the three species of catfish ranged from 8.19 ± 0.031 to 10.34 ± 0.035%. *Synodontis* spp. from Abinsi market had the least moisture content (8.19 ± 0.031%) while *Heterobranchus* spp. from Wadata market had the highest moisture content (10.34 ± 0.035%). Protein content of the three species ranged from 55.80 ± 0.060 to 68.97 ± 0.125%. *C. gariepinus* from Wadata market had the highest protein content (68.97 ± 0.125%). The lipid content of the fish ranged from 10.37 ± 0.023 to 22.68 ± 0.035. The most abundant mineral was Potassium (K) and was more abundant in *C. gariepinus* from Wadata market which had the highest K content (410.15 ± 0.895 mg/100 g). *Heterobranchus* spp. had the highest Calcium (Ca) content (395.48 ± 0.499 mg/100 g), Sodium (Na) (39.84 ± 0.045 mg/100 g) and Zinc (Zn) (0.80 ± 0.015 mg/100 g) while the highest concentration (12.0 ± 0.093 mg/100 g) of Iron (Fe) was recorded in *Synodontis* spp. The concentrations of Cu, Zn, and Fe in the three species across the markets were well above WHO permissible limits of 20-30 ppm, 30-100 ppm and 50-100 ppm respectively. The smoked catfishes retained good scores for taste, appearance, texture, and odour. However, there was significant ($p < 0.05$) differences in taste, appearance, texture, and odour for *Heterobranchus spp.*, *C. gariepinus* and *Synodontis spp* in Abinsi and Wadata markets.

Keywords: Mineral composition, organoleptic qualities, proximate analysis, smoked fish

1 Introduction

Fish and seafood products are very essential commodities in the international trade market. They constitute an essential part of a healthy meal due to their high protein content, low fat content and the presence of omega-3 fatty acid- an essential amino acid (Rhea 2009, Pal 2010). About two-third of the world's protein is derived from fishes and seafood products (Emikpe *et al*. 2011).

Processing of fish and seafood products aims at inhibiting the growth of microorganisms, extending product shelf-life, and ensuring that these products have acceptable quality. Several methods such as refrigeration, salt curing or smoking have gained wide application in preservation of fish and sea products. In Nigeria, smoking is the oldest and commonest method of preservation, especially by rural inhabitants. It is a simple and affordable preservation method. It reduces the fish moisture content and inhibits microbial activity. Smoke-drying technology gives fish a characteristic colour and flavour (Alasalvar *et al*. 2011). It also extends the shelf life of the fish (Eyo 2000, Kumolu-Johnsoh *et al*. 2010).

The type of wood used during the smoke drying of fish is very important as this affects the quality of the fish (Huong 2014). The main objective of food processing is to meet safety and acceptability standards, especially for consumers (Pal 2012). To actualize this, high-level hygienic practices during processing and preservation are very essential. Nutritional assessment of fish is an integral part of the fish industry and should be routinely carried out to meet the quality demands of fishmongers. Most countries have quality standards that meet their local market needs. Nutritional assessment of fish products will ensure that only smoke-dried fish of good quality is marketed to consumers.

Smoking of fish possibly elevates mineral compositions in the fish to beneficial or toxic levels. The method of smoking and length of exposure to the smoking process have been identified as essential factors that affect the quality and acceptability of the product (Indranesa *et al*. 2000). Hence, the need to access not only the physical properties (taste, odour, flavour etc.) of the fish product but also the mineral and proximate composition to ensure overall product quality. The aim of this study is to carry out a nutritional assessment of some selected catfishes, namely, *Clarias gariepinus, Heterobranchus* spp. and *Synodontis* spp. from Abinsi and Wadata fish markets in Benue state Nigeria.

2 Materials and Methods

2.1 Sample collection

Smoked dried catfish samples were randomly purchased from three different locations at Abinsi and Wadata markets. A total of eighteen samples were collected, six samples from each species of *Clarias gariepinus, Synodontis* spp. *and Heterobranchus* spp.

weighing approximately 500 g were sourced. The samples were collected and packaged separately using foil paper and polythene bags. Thereafter, they were taken to the laboratory for analysis.

2.2 Proximate analysis

The proximate composition of the samples was determined according to Association of Official Analytical Chemists methods (AOAC 2010). These analyses were conducted at Nigeria Stored Product Research Institute (NSPRI) Ilorin Kwara state, Nigeria.

2.3 Organoleptic assessment

A panel of Ten (10) judges was selected from Centre for food technology and Research (CEFTER) community at random to assess the smoked dried catfish samples. A 9-point hedonic scale ranging from 1(Dislike extremely) to 9 (Like extremely) was used (Olayemi *et al*. 2011) for the assessment. The qualities assessed were appearance, odour, texture, and taste.

2.4 Mineral determination

For wet digestion of samples, the powdered sample was weighed (1 g) into a digesting glass tube, 12 ml of HNO_3 was then added and the mixture was left to stand overnight at 25 – 30 $^{\circ}$C. Perchloric acid (4 ml) was added to this mixture and then digested in the fume block. The temperature was gradually raised from 50°C to 300°C. The appearance of white fumes after about 90 min of digestion, brought the digestion to an end. After cooling, the digested samples were transferred to 100 ml volumetric flasks and made up to 100 ml with distilled water. This was then used for mineral determination.

2.5 Determination of mineral elements

Determination of Minerals by Atomic Absorption Spectrometry (AAS) was carried out at University of Ilorin Central Research Laboratories using model BUCK scientific ACCUSYS-211-AAS. The standards for each element under investigation were prepared in parts per million (ppm) and the limit standard concentration for each element was carefully followed according to the standard operating procedure. The standard solutions were aspirated, and the graph was obtained. The concentrations of various metal elements in the samples were read and calculated using the equation below.

Concentration of element= $\frac{concentration\ of\ sample(ppm)}{Weight\ of\ sample} \times dilution\ factor\ (100)$

2.6 Statistical analysis

The data were subjected to analysis of variance (ANOVA) using Genstat (Discovery version) and a significant test for differences between samples means was done using Duncan multiple range (DMRT) test at 5% level of significance.

3 Results and Discussion

3.1 Proximate compositions

The highest moisture content (10.34 ± 0.035%) was recorded in *Heterobranchus* spp. The highest protein (68.97 ± 0.125%) and lipid content (22.68 ± 0.035%) were recorded in *Clarias gariepinus* and *Synodontis spp* respectively (Table 1). Significant ($p<0.05$) differences between the two markets occur in *C. gariepinus* for moisture contents, in all three species for ash content and lipid content, in *C. gariepinus* for protein content, and in *Heterobranchus* spp. for carbohydrate content. The protein content values of the *Heterobranchus* spp. *C. gariepinus*, and *Synodontis* spp. from both markets showed high values and variation in the markets (Table 1).

Table 1: Proximate compositions (%) of smoked catfish obtained from Abinsi and Wadata markets in Benue State, Nigeria

Market	Sample	Moisture	Ash	Protein	Lipid	Carbohydrates
Abinsi	*Heterobranchus spp.*	10.16 ± 0.012^{d}	12.74 ± 0.049^{d}	58.98 ± 0.110^{b}	16.42 ± 0.081^{d}	1.71 ± 0.018^{b}
	Clarias gariepinus	9.09 ± 0.015^{c}	10.10 ± 0.029^{a}	66.11 ± 0.029^{c}	13.94 ± 0.041^{b}	0.76 ± 0.041^{a}
	Synodontis spp	8.19 ± 0.031^{a}	11.07 ± 0.035^{b}	55.80 ± 0.060^{a}	22.68 ± 0.035^{f}	2.27 ± 0.054^{cd}
Wadata	*Heterobranchus spp.*	10.34 ± 0.035^{d}	11.89 ± 0.055^{c}	59.48 ± 0.067^{b}	15.71 ± 0.029^{c}	2.59 ± 0.032^{d}
	Clarias gariepinus	8.88 ± 0.049^{b}	11.39 ± 0.032^{b}	68.97 ± 0.125^{d}	10.37 ± 0.023^{a}	0.38 ± 0.015^{a}
	Synodontis spp	8.36 ± 0.026^{a}	12.19 ± 0.061^{c}	56.35 ± 0.033^{a}	21.30 ± 0.044^{e}	1.81 ± 0.041^{bc}

Means ± Standard Error on the same column with different superscripts differs significantly at $p < 0.05$ level.

3.2 Elemental composition of smoked catfishes from Abinsi and Wadata markets

Significant ($p<0.05$) difference was recorded for K, Ca, Zn and Fe content of *Heterobranchus spp*, *Clarias gariepinus* and *Synodontis spp* across the two markets (Table 2). The highest potassium content (410.15 ± 0.895) was recorded in *C. gariepinus* from Wadata market while the least potassium content (240.33 ± 0.050) was recorded in *Heterobranchus spp* from Abinsi market. *Heterobranchus spp* from

Abinsi market had the highest calcium content (395.48 ± 0.499) while the same species from Wadata market had the lowest calcium content (127.88 ± 0.792) (Table 2). The highest Fe content (12.0 ± 0.093) was recorded in *Synodontis* spp from Wadata market while the least Fe content (4.95 ± 0.052) was recorded in *Heterobranchus* spp from Wadata market.

Table 2: Elemental composition of smoked fish species obtained from Abinsi and Wadata fish markets, Benue State, Nigeria

Market	Sample	Mineral Concentration in mg/100g					
		K	Ca	Na	Cu	Zn	Fe
Abinsi	*Heterobranchus* spp	240.33 ± 0.050^{a}	395.48 ± 0.499^{e}	32.44 ± 0.035^{a}	0.03 ± 0.009^{a}	0.80 ± 0.015^{e}	5.37 ± 0.021^{a}
	Clarias gariepinus	270.30 ± 0.240^{c}	278.05 ± 0.954^{d}	32.14 ± 0.113^{a}	0.21 ± 0.012^{b}	0.30 ± 0.012^{a}	5.06 ± 0.055^{a}
	Synodontis spp.	330.05 ± 0.421^{e}	257.78 ± 0.093^{c}	34.24 ± 0.032^{c}	0.24 ± 0.017^{bc}	0.40 ± 0.029^{b}	6.98 ± 0.058^{c}
Wadata	*Heterobranchus* spp	250.30 ± 0.643^{b}	127.88 ± 0.792^{a}	39.84 ± 0.045^{d}	0.39 ± 0.186^{d}	0.68 ± 0.030^{d}	4.95 ± 0.052^{a}
	Clarias gariepinus	410.15 ± 0.895^{f}	159.33 ± 0.891^{b}	33.03 ± 0.064^{b}	0.22 ± 0.015^{b}	0.60 ± 0.023^{c}	5.96 ± 0.070^{b}
	Synodontis spp.	300.45 ± 0.480^{d}	295.48 ± 1.24^{d}	33.93 ± 0.057^{c}	0.30 ± 0.038^{c}	0.71 ± 0.029^{d}	12.0 ± 0.093^{d}

Means ± Standard Error on the same column with different superscript differs significantly at $p<0.05$ level

3.3 Organoleptic Assessment

From the organoleptic scores, *Heterobranchus* spp. and *Clarias gariepinus* from Wadata market were preferred over *Heterobranchus* spp. and *C. gariepinus* from Abinsi market while *Synodontis* spp. from Abinsi were preferred over *Synodontis* spp. from Wadata market (Table 3).

Table 3: Sensory Evaluation of Smoked-Dried Catfish from Abinsi and Wadata markets, Benue State, Nigeria

Market	Samples	Taste	Appearance	Texture	Odour
Abinsi	*Heterobranchus* spp.	6.23 ± 0.032^{c}	6.67 ± 0.021^{c}	6.97 ± 0.040^{c}	6.43 ± 0.032^{c}
	Clarias gariepinus	5.38 ± 0.020^{a}	6.22 ± 0.053^{b}	6.92 ± 0.024^{bc}	6.23 ± 0.032^{b}
	Synodontis spp.	8.50 ± 0.026^{f}	7.67 ± 0.020^{e}	7.52 ± 0.031^{e}	6.93 ± 0.052^{e}
Wadata	*Heterobranchus* spp.	7.63 ± 0.046^{e}	7.33 ± 0.035^{d}	7.43 ± 0.035^{d}	6.92 ± 0.053^{e}
	Clarias gariepinus	7.38 ± 0.021^{d}	7.63 ± 0.050^{e}	7.33 ± 0.047^{d}	6.77 ± 0.040^{d}
	Synodontis spp.	5.73 ± 0.050^{b}	5.58 ± 0.032^{a}	6.63 ± 0.041^{a}	5.92 ± 0.367^{a}

Means ± Standard Error on the same column with different superscript differs significantly at $p < 0.05$ level.

A significant ($p<0.05$) difference occurred between *Heterobranchus* spp., *C. gariepinus* and *Synodontis* spp. in Abinsi and Wadata for taste, appearance, texture, and odour and this might be due to variations among individuals in responding to the same level of stimuli such as appearance and taste.

4 Discussion

The percentage moisture content of *Synodontis* spp. from Abinsi market had the least value of moisture content while *Heterobranchus* spp. from Wadata market had the highest moisture content. The lower moisture content recorded in *Synodontis* spp. shows that it may have a good keeping quality, as a study on the influence of traditional smoke drying on the quality of fish by Ali *et al*. (2011) revealed that smoked fish with good keeping quality had the least moisture content.

Fish is an essential part of a balanced diet because it contains complete protein and some vital polyunsaturated fatty acids (Polak-Juszczak and Adamczyk 2009, Polak-Juszczak and Komar-Szymczak 2009). Protein content was slightly higher in *Clarias gariepinus* from both markets, each recording 66.11 ± 0.029% and 68.97 ± 0.125% respectively. These values are higher than the value of 53.10% reported by Ogbonna and Ibrahim (2009) but concur with 68.40% reported by Olayemi *et al*. (2011).

The fat content values of the fishes were within the range of 10.37 ± 0.023 to 22.68 ± 0.035% and this concurs with the findings of Ogbonna and Ibrahim (2009), and Olayemi *et al*. (2011). These values indicate that smoking had no adverse effect on the fat content of the catfish species examined for the study. The relatively high ash content values of the fishes could be because of the high drying temperature and enclosed system of drying which is associated with high ash values (Olayemi *et al*. 2011). This can also reflect the high mineral constituent of the fish (Liu 2019). Very low carbohydrate content was recorded in the fishes, with *Heterobranchus* spp. having the highest value of 2.59 ± 0.032% and *Clarias gariepinus* having the least value (0.38 ± 0.015 %), both from Wadata markets.

The significantly high composition of certain minerals (K, Ca, Na) reveals that these smoke-dried fishes are a very good source of these vital minerals. These results concur with the findings of Adewoye and Omotosho (1997), Prapasri *et al.* (1999), and Ricardo *et al*. (2002) who also reported high concentrations of these minerals in fish. Generally, varying concentrations of minerals in fishes have been reported in similar studies and this could be because of differences in chemical characteristics of water from which the fishes were sampled, rate of absorption, the season in which the studies were conducted as well as different dietary patterns (Yilmaz 2003, Papagiannis *et al*. 2004, Ahmed *et al*. 2010, Opaluwa *et al*. 2012, Emurotu *et al*. 2014, Mohammed and Osman 2014).

Freshwater fish is a valuable source of Iron, Copper, and Zinc (FAO 2014). The concentrations of Cu, Zn and Fe in the three fishes were well above WHO permissible limits of 20-30 ppm, 30-100 ppm and 50-100 ppm respectively (FAO/WHO 1989,

WHO 2000, European community 2005, Mokhtar 2009). However, the concentration of Cu in *Heterobranchus* spp from Abinsi market was within FAO/WHO acceptable limit. Excess copper in the human blood causes hematemesis, hypotension, melena, coma, jaundice, and gastrointestinal distress (Oti-wilberforce *et al*. 2016). Zinc although essential for normal growth and development can be deleterious at high concentrations (Oti-wilberforce *et al*. 2016). High toxicity of this element in the blood can lead to gross deficiencies in copper and iron, abdominal pain, bloody enteritis, paralysis of extremities, and lowered leukocyte count (ATSDR 1994). Excess iron in human blood may lead to hemochromatosis which increases the susceptibility of the individual to cancer and heart disease (ATSDR 1999). This raises alarm as regards the potential danger of continual consumption of these fishes without proper screening by relevant stakeholders in the aquatic industry.

Reports of sensory evaluation from the panelists revealed that the smoked catfishes from both markets retained very good scores for taste, appearance, texture, and odour. This shows that the products were accepted or liked, since the least score for all the organoleptic indices examined was $\geq$ 5.38. However, there was a significant difference between taste, appearance, texture, and odour of the smoked catfish samples that were subjected to organoleptic assessment. The preference in taste, texture and appearance could be attributed to the processing method (smoking). The result of the sensory evaluation reveals that high concentrations of Cu, Zn and Fe in the fishes may not have affected the sensory properties of the fishes. This makes it more dangerous to the consumer as elevated levels of these minerals are not easily noticed by the sensory organs, albeit very dangerous to human health when ingested.

5 Conclusions

The proximate and mineral composition of the smoked catfishes showed variations from market to market, however, the three catfish species from this study were found to be rich in protein, Potassium, Calcium, and Sodium with low presence of lipid and carbohydrate contents. High concentrations of copper, zinc and iron was recorded in all three species across the markets, revealing the potential risk of these products to consumers. The sensory evaluation of *Hetrobraunchus* spp, *Clarias gariepinus* and *Synodontis* spp from both markets had acceptable quality from the panelists. Key stakeholders in the aqua feeds industry should constantly screen fishery products sold in local markets to ensure that these products meet international standards and are safe for consumption.

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