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Comparative Evaluation of Nutritional Composition and Organoleptic Analysis of *Oreochromis niloticus* and *Chrysicthys nigrodigitatus* from the Tombia segment of the New Calabar River, Port Harcourt, Nigeria

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ABSTRACT

Proximate composition is a critical parameter in evaluating the nutritional quality and suitability of fish for various applications, such as human consumption, aquaculture, and industrial processing. Nutritional composition and organoleptic analysis of *Oreochromis niloticus* and *Chrysicthys nigrodigitatus* from the Tombia segment of the New Calabar River, Port Harcourt were studied between March and May, 2023 using a total of 180 fresh specimens collected for three months and analysed following standard of Association of Official Analytical chemistry (AOAC) was evaluated. Organoleptic evaluation was conducted using twenty panelists based on taste, texture, flavour, colour and overall acceptability of the smoked fish products. The moisture and protein contents of *C. nigrodigitatus* (76.822±2.71%,17.528±0.61%) differed significantly from that of *O. niloticus* (67.217±1.32%, 13.472±0.710%) respectively unlike the fat contents (1.303±0.17%, 1.710±0.13%). Average organolepticc scores showed that there was significant difference in consumer preference between *O.niloticus* and *C. nigrodigitatus* at $p<0.05$ with respect to taste and flavor. The result also showed that both species of fish studied contain essential nutrient like protein with *O. niloticus* having higher consumer preference compared to *C. nigrodigitatus* with respect to taste and flavor. More awareness should be created by carrying out research of this nature on fish for patronage.

Keywords: Comparative evaluation, Nutritional Composition, Organoleptic analysis, *Oreochromis niloticus, Chrysichthys nigrodigitatus*, Tombia Segment

INTRODUCTION

Fish and fishery products are important sources of high-quality protein, essential fatty acids, vitamins, and minerals in the human diet (Ackman, 1989). The Niger Delta region of Nigeria especially the New

Calabar River is renowned for its rich fisheries resources, which include diverse species such as tilapia (*Oreochromis niloticus*) and silver catfish (*Chrysichthys nigrodigitatus*). These fish species are widely consumed and play a significant role in the livelihood and food security of the local population (Abowei and Tawari, 2011).

The proximate composition, which includes moisture, crude protein, crude fat, and ash content, is a critical parameter in evaluating the nutritional quality and suitability of fish for various applications, such as human consumption, aquaculture, and industrial processing (Zuraini *et al.*, 2006). Understanding the proximate composition of fish species from different regions or water bodies is essential for making informed decisions about their utilization and for comparing the nutritional profiles with other fish species or published data.

Olopade *et al*.,(2016) reported that proximate composition comprises the estimation of moisture, protein, fat and ash contents of a fresh fish body. Otene *et al*.,(2023) opined that composition of a particular species usually varies from a fishing ground to another, season to season and age but that the basic causes of change in composition are variation in quantity and quality of food consumed and the amount of movement made by the fish. Edun (2012) disclosed that fish processing processes alters its composition and general characteristics depending on the used method. According to Silver and Chamul (2000) nutritional composition of fishes and their products change from time to time with respect to age, sex, species, food intake, sexual changes, season and environment.

Organoleptic evaluation, which involves the assessment of the sensory attributes of a product, is an essential tool in the quality assessment of fish and fishery products (Huss, 1995). Sensory attributes, such as appearance, odor, texture, and flavor, are crucial determinants of consumer acceptability and marketability of fish (Olafsdottir *et al*., 1997). Assessing the organoleptic properties of fish species from different water bodies can provide valuable insights into their quality, freshness, and suitability for various culinary and industrial applications. Organoleptic evaluation is often a key component in the development of quality standards and regulations for fish and fishery products, which are essential for protecting consumer interests and ensuring fair trade practices.

It was observed that these two species of fishes were common in this water body and are also the most consumed among the populace. A lot of researches have been done in this water body and on this particular species but to the best of my knowledge, sufficient work have not been done on the proximate/nutritional composition and the organoleptic analysis of the fishes. It was on this note that this research became very essential.

MATERIALS AND METHODS

Study Area

The New Calabar River is a major freshwater river located in the Niger Delta region of Nigeria. The river originates from the Awka-Orlu Uplands and flows in a southerly direction, eventually emptying into the Atlantic Ocean (Ogamba *et al*., 2016). The New Calabar River is an important water body that supports diverse aquatic ecosystems and provides various ecological and economic services to the surrounding communities.

The Tombia segment of the New Calabar River in Nigeria is located within the geographical coordinates with Longitude:6°59'00"E to 7°01'00"E and Latitude: 4°46'00" N to 4°48'00" N. The river flows through several local government areas, including Obio/Akpor, Ikwerre, Etche, and Oyigbo, before reaching the Atlantic Ocean (Abowei, 2010).

The river has a meandering course and is characterized by a relatively narrow channel, with an average width of approximately 200 meters (Ogamba *et al*., 2016). The depth of the river varies along its course, with deeper sections in the central and lower reaches and shallower areas near the riverbanks and tributaries.

The New Calabar River supports a diverse array of fish species, including tilapia (*Oreochromis niloticus*) and silver catfish (*Chrysichthys nigrodigitatus*), which are the focus of this study (Abowei, 2010). These fish species, along with other commercially important species, are widely harvested by local artisanal fishermen and play a significant role in the regional food security and economy.

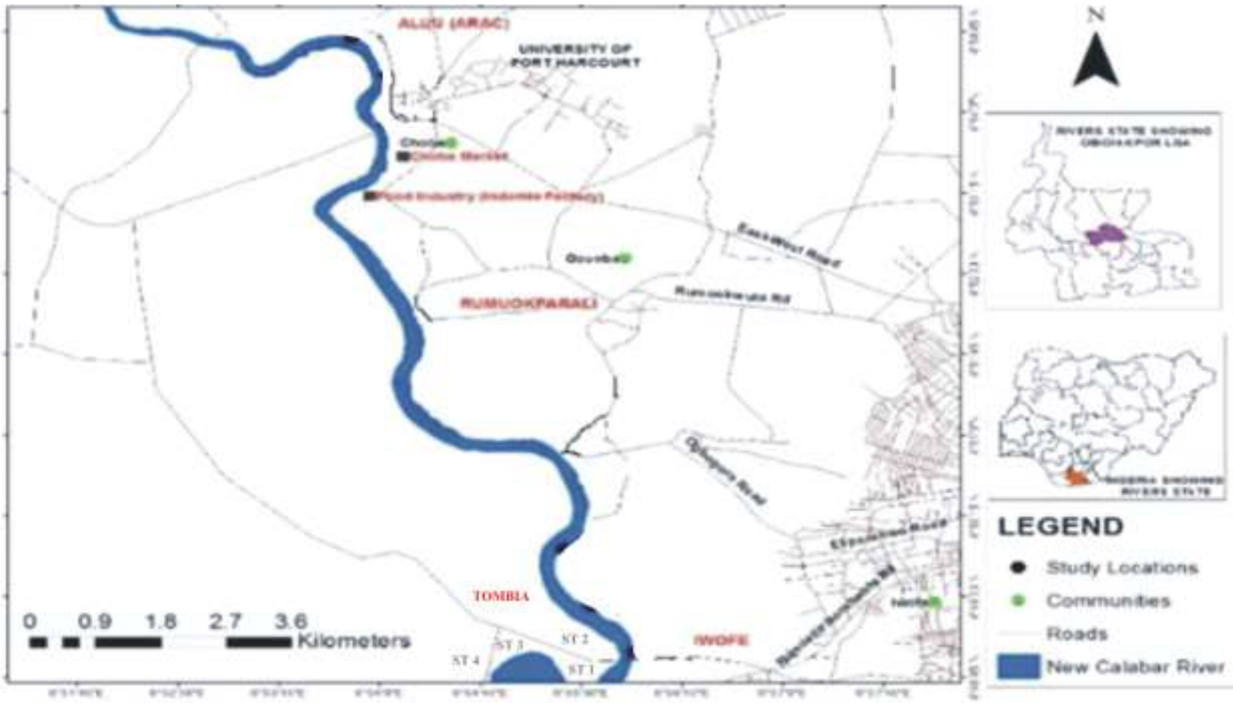

Figure 1: Map of the Study Area Showing Sampling Stations

Sample Collection and Preparation

A total of 90 fresh specimens of tilapia (*Oreochromis niloticus*) and silver catfish (*Chrysichthys nigrodigitatus*) were collected from the major fish landing sites in the Tombia segment of the New Calabar River, Port Harcourt, Nigeria for three months. The fish samples were transported to the laboratory in insulated containers with ice packs to maintain their freshness.

In the laboratory, the fish samples were washed, scaled, and filleted. The fillets were then homogenized using a laboratory blender, and the resulting homogenates were used for the proximate composition analysis.

Proximate Composition Analysis

The proximate composition of the fish samples, including moisture, crude protein, crude fat, and ash content, was determined following the standard methods of the Association of Official Analytical Chemists (AOAC, 2012, Igwe *et al*.,2017) in the Department of Food Science and Technology Laboratory, Rivers State University, Port Harcourt. The parameters were determined as follows:

Estimation of Moisture: The initial weights of the samples were first taken, and the samples were dried in an ovun (Memmet 854 Schwabach) at about 105°C for 10 hours until a constant weight was reached and cooled in a desiccator (Bel-art H420580001). The dried samples were reweighed and minced in an electric grinder. The percentage (%) of moisture was calculated from the formular:

% of moisture= Weight loss/Original weight of the sample x100.

Lipid Estimation: The dried fish samples left after moisture determination were finely grounded followed by fat extraction using a non-polar solvent, ethyl ether done by heating the sample in 40ml of Ethyl ether and allowed to cool. After extraction, the solvent was evaporated, and the extracted materials were weighed. This was calculated using the formular:

% of fat = (Weight of extract/Weight of sample) × 100

Protein Estimation: Micro-kjeldahl method was used to determine the protein content of the fish samples which involves conversion of organic nitrogen to ammonium sulphate by digestion with concentrated sulphuric acid in a micro-kjeldahl flask. The digest was diluted, made alkaline with sodium hydroxide and distilled water. The liberated ammonia was collected in a boric acid solution and was determined via titration. This was calculated using the formular:

% of protein = (c-b) × 14 × d × 6.25/a × 1000 × 100

where

a = sample weight (g)

b = volume of NaOH required for back titration and neutralize 25ml of 0.1N H2SO4 (for sample)

c = volume of NaOH required for back titration and neutralize 25 ml of 0.1N H2SO4 (for blank)

d = normality of NaOH used for titration, 6.25= conversion factor of Nitrogen to protein

Ash Estimation*:* The residue left after ashing in a muffle furnace (Gerhardt) at about 55°-60° C till the residue turned white is the ash content of a sample. This was calculated as:

% of ash = (Weight of ash / Weight of Sample) × 100

Estimation of Carbohydrates**:** About 0.2g of sample was homogenized by adding 10ml of 2.5% H_2SO_4 and boiled for 20 minutes, allowed to cool then filtered to get a filtrate of about 20ml. 0.1ml of diluted solution was diluted with 1ml of water, filtered with 0.1% anthrone followed by boiling of the mixture for ten minutes.

Carbohydrate content was calculated as follows:100 – (Weight in grams (protein + fat + water + ash + alcohol] in 100g of food).

Crude Fibre Estimation*:* Percentage crude fibre was obtained by subtracting the sum of total carbohydrate, total lipid content, total protein, ash content and moisture content. Blank is prepared with 1ml of water and 3ml of anthrone, and absorbance is read at 620nm.

Crude fibre = 100 - Carbohydrate% + Lipid% + protein% + ash% + moisture%

Organoleptic Analysis

Twenty panelists evaluated the organoleptic quality of the two fish species after smoking. The organoleptic test was based on taste, texture, flavour, colour, sweetness and overall acceptability of the smoked fish products. Panelists were asked to complete questionnaires using the 6-point hedonic scale described in literature as follows: 1 (dislike very much), 2 (dislike moderately), 3 (dislike slightly), 4 (like slightly), 5 (like moderately) and 6 (like very much) (Badaine *et al.*,2018).

Statistical Analysis

Statistical Packages for Social Sciences (SPSS) software version 25.0 and Excel were used to analyze the experimental data. The collected data were presented as mean value ± standard deviation (mean ± SD). In order to test for significant difference in proximate composition and organoleptic properties among the *Chrysichtys nigrodigitatus* and *Oreochromis niloticus*, analysis of variance (ANOVA) was used at 95% confidence level ($p < 0.05$). Fisher's Least Significant Difference (LSD) was to ascertain significant differences among the treatment means at $p < 0.05$.

RESULTS

The overall mean percentage values of proximate composition of *O. niloticus* and *C. nigrodigitatus* from the Tombia segment of the New Calabar River. The moisture content of *C. nigrodigitatus* (76.822±2.71%) differed significantly from *O. niloticus* (67.217±1.32) at P<0.05. The percentage crude protein content of *C. nigrodigitatus* (17.528±0.61%) and *O. niloticus* (13.472±0.710%) also differed significantly from the other at (P<0.05) while the fat contents (1.303±0.17, 1.710±0.13 did not vary significantly at P<0.05. The ash, crude fibre and carbohydrate content of the fish species did not vary significantly from the other at P<0.05 unlike their moisture contents and crude protein. Apart from the crude protein and carbohydrate contents, others such as moisture, ash, fat and crude protein contents were consistently higher in the *O. niloticus*, than the *C. nigrodigitatus*. The percentage composition of the fish species studied varied across the Months with the highest valued of moisture ash, fat and carbohydrate contents observed to be higher in May.

The average organolepticc values for *C. nigrodigitatus* and *O. niloticus* is as presented in Table 2 below. The results showed that there was significant difference in consumer preference between *O.niloticus* and *C. nigrodigitatus* at p<0.05 with respect to taste and flavor but not significant with respect to colour and texture. In terms of overall acceptability, there was no significant difference between the species with respect to consumer preference. Specifically, the mean scores for all the organoleptic parameters/variables were consistently higher in *O. niloticys* than *C. nigrodigitatus* except color which was lower.

Table 3 showed the correlation coefficient of proximate composition and organoleptic analysis of *O. niloticus* and *C. nigrodigitatus* in the area. Moisture correlated positively and weakly with ash (0.384), fat (0.296), fat (0.296) crude protein (0.032) but correlate strongly and positively with crude fibre (0.750).

Table 4 showed the Analysis for variance of the proximate composition of the fishes in the area. Crude protein content showed significant different at P<0.05 while others such as moisture, crude fibre, fat and carbohydrate showed no significant difference between and across the status.

Table 1: Proximate Composition (%) of *O. niloticus* and *C. nigrodigitatus* in the Study Area

	Moisture	Ash	Fat	Crude Fibre	Crude Protein	Carbohydrates
X	67.217±1.32^{b}	2.321±0.15^{a}	1.303±0.17^{a}	2.393±0.10^{a}	17.53±0.61^{a}	1.427±0.05^{a}
Range	65.60-69.50	2.15-2.64	0.89-1.45	2.24-2.60	16.60-18.50	1.35-1.500
Y	76.822±2.71^{a}	2.486±0.12^{a}	1.71±0.13^{a}	2.412±0.10^{a}	13.47±0.71^{b}	1.212±0.07^{a}
Range	70.80-80.00	2.30-2.70	1.45-1.90	2.250-2.550	12.55-14.60	1.10-1.300

Key: Mean with similar superscript along the same row are not significantly different at p<0.05
X=*Chrysichtys nigrodigitatus*, Y=*Oreochromis niloticus*

Table 2: Monthly Mean Values of Proximate Composition of Fishes in the Study Area

Month	Sample	Moisture	Ash	Fat	Crude Fibre	Crude Protein	Carbohydrate
March	*C.nigrodigitatus*	67.67	2.32	1.3	2.43	18.07	1.4
	O. niloticus	77.75	2.46	1.71	2.45	14.25	1.23
April	*C.nigrodigitatus*	66.86	2.33	1.22	2.37	17.42	1.71
	O. niloticus	74.33	2.57	1.6	2.32	13.32	1.17
May	*C.nigrodigitatus*	67.17	2.317	1.33	2.38	17.17	1.46
	O. niloticus	78.68	2.48	1.8	2.47	12.85	1.23

Key: O=*Oreochromis*, C=*Chrysichtys*

Table 3: Correlations coefficient of Proximate Composition of Fishes in the Study Area

Control Variables			Moist	Ash	Fat	CF	CP	Carboh	Taste	Flavour	Colour	Text
Statio	Moist	Correlation	1.000									
		Sign(1-tailed)	.									
	Ash	Correlation	.384	1.000								
		Signifi(1-tailed)	.174	.								
	Fat	Correlation	.296	-.036	1.000							
		Signifi (1-tailed)	.238	.466	.							
	CF	Correlation	.750	.485	.396	1.000						
		Signifi(1-tailed)	.016	.112	.165	.						
	CP	Correlation	.032	.029	.019	.123	1.000					
		Signifi (1-tailed)	.470	.473	.482	.386	.					
	Carbohy	Correlation	-.270	-.667	.420	-.019	-.076	1.000				
		Signif (1-tailed)	.259	.036	.150	.482	.429	.				
	Taste	Correlation	.576	.354	-.090	.070	.376	-.534	1.000			
		Signif (1-tailed)	.068	.195	.416	.435	.179	.087	.			
	Flavour	Correlation	.010	.685	-.380	-.072	-.203	-.426	.378	1.000		
		Signifi (1-tailed)	.490	.030	.177	.433	.315	.146	.178	.		
	Colour	Correlation	-.911	-.208	-.075	-.464	-.137	.411	-.734	.055	1.000	
		Signifi (1-tailed)	.001	.310	.430	.124	.373	.156	.019	.448	.	
	Texture	Correlation	-.388	.050	-.205	-.502	.502	-.101	.357	.378	.210	1.00
		Signific (1-tailed)	.171	.454	.313	.103	.102	.406	.193	.178	.309	.

Key: Moist=Moisture, CF=Crude fibre, CP= Crude Protein, Carbohy=Carbohydrates

Table 4: Analysis of Variance (ANOVA) for Proximate Composition of Fishes in the Study Area

			Sum of Squares	df	Mean Square	F	Sig.
Moisture * Month	Between Groups	(Combined)	31.467	2	15.734	3.455	.100
	Within Groups		27.323	6	4.554		
	Total		58.791	8			
Ash * Month	Between Groups	(Combined)	.002	2	.001	.063	.939
	Within Groups		.115	6	.019		
	Total		.117	8			
Fat * Month	Between Groups	(Combined)	.058	2	.029	2.529	.160
	Within Groups		.069	6	.012		
	Total		.127	8			
Crude Fib * Month	Between Groups	(Combined)	.039	2	.019	2.897	.132
	Within Groups		.040	6	.007		
	Total		.079	8			
Crude Pro * Month	Between Groups	(Combined)	3.049	2	1.524	9.511	.014
	Within Groups		.962	6	.160		
	Total		4.011	8			
Carbohy * Month	Between Groups	(Combined)	.008	2	.004	.655	.553
	Within Groups		.037	6	.006		
	Total		.045	8			

DISCUSSION

The variations in proximate composition of *O. niloticus* and *C. nigrodigitatus* is in line with the finding of Otene *et al* (2023) and Ukwe *et al* (2018) from Okrika fish landing site, Bonny River and Amadi fish loanding site Port Harcourt. The observed difference could be attributed to difference in feed intake, age, sexual changes, seasons, metabolic efficiency content of *O. niloticus* and *C. nigrodigitatus.* This study is in the same range with that reported for *O. niloticus* (81.18±0.61%) and *Clarais gariepinus* (77.76±0.45%) by Anarado *et al* (2023). This moisture content is however contrary to the finding of Ndome *et al* (2010) who from the Cross River Estuary. The observed significant difference in protein in the species in this study could be attributed to difference in species and some other physiological factors. The result of this study is contrary to the finding of Ndome *et al* (2010), Nanna *et al*, (2003), Lisette, 2005, Karena *et al*, (2006), Gjederem (2004) and Grigorakis *et al* (2002) who reported protein to have the highest concentration than other parameters.

The observed non significant variation in crude oil fibre, ash and carbohydrate in this study is contrary to the finding of Otene *et al*, (2023) but in line with the assertions that higher water/moisture is present in fish with how fat content (Osman *et al*, 2007). The observed consistent variation in proximate composition of fishes with higher values in May could be attributed to climate change and increase in water volume due to rainfall. The higher ash content of *O. niloticus* than the *C. nigrodigitatus* in this study could be attributed to difference in minerals such as calcium, potassium, zink, iron and magnessuim.

The observed difference (significant) in consumer preference between *O. niloticus* and *C. nigrodigitatus* in this study especially with respect to taste and flavor could be attributed to difference in proximate composition of the fish species. Anardo *et al* (2023) opined that proximate composition of fish determines its organoleptic variables such as taste, flavor, colour and texture. Gabr *et al* (2007) and Grigorakis (2007) disclosed that moisture content of a fish is crucial for the maintenance of its freshness and Succulence hence, higher fat content results in better taste and flavor while lower moisture content and higher protein content result in firmer texture.

CONCLUSION OF RECOMMENDATION

The result provided vital information concerning the nutritional composition and organoleptic analysis of *C. nigrodigitatus* and *O. niloticus*. The result also showed that both species of fish studied contain essential nutrient like protein with *O. niloticus* having higher consumer preference compared to *C.*

nigrodigitatus with respect to taste and flavor. More awareness should be created by carrying out research of this nature on fish for patronage.

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