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Spatio-Temporal Assessment of Proximate Composition of Tilapia (*Oreochromis niloticus)* and Silver Catfish (*Chrysichthys nigrodigitatus*),Tombia Segment, New Calabar River, Port Harcourt, Nigeria

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ABSTRACT
Understanding the nutritional profile of fish species found in this river is crucial for sustainable fisheries management and ensuring the provision of healthy, high-quality protein sources for the population. Spatio-temporal assessment of proximate composition of tilapia (*Oreochromis niloticus)* and Silver catfish (*Chrysichthys nigrodigitatus*), Tombia Segment of the New Calabar River, Port Harcourt was studied between March and May,2023. A total of 180 fresh specimens of *O. niloticus* and silver catfish (*C. nigrodigitatus*) were collected from the major fish landing sites of the New Calabar River for three months. The proximate composition was determined using standard methods of Association of Official Analytical chemistry (AOAC). The proximate composition of *C. nigrodigitatus* ranged as moisture (65.60-69.50%), ash (2.15-2.64%), fat (0.89-1.45%), crude fibre (2.24-2.2.60%), crude protein (16.60-18.50%) and carbohydrates (1.35-1.50%) while that of *O.niloticus* ranged as moisture (70.80-80.00%), ash (2.30-2.70%), fat (1.45-1.90%), crude fibre (2.25-2.55%), crude protein (12.55-14.60%) and carbohydrates (1.10-1.30%). Moisture content of *C. nigrodigitatus* varied significantly across the stations with stations 1 and 2 different from station 3 unlike that of *O. niloticus* which did not vary significantly at $p<0.05$. Most nutritional parameters in both species were consistently high in May but low in April. T-test showed no significant difference in proximate compositions of the two fish species at $p<0.05$. The two fish species are rich in nutrients and suitable for consumption. For the sake of awareness, there should be frequent research for proper monitoring of the aquatic resources.
Keywords: Spatio-temporal, Assessment, Proximate Composition, *Oreochromic niloticus*, *Chrysichthys nigrodigitatus,* Tombia segment, New Calabar River.

INTRODUCTION
The Niger Delta region of Nigeria is endowed with a diverse array of aquatic resources, including numerous rivers, creeks, and estuaries that support a wide variety of fish species. The New Calabar River,

located in Port Harcourt, is one such important water body that plays a critical role in the livelihoods and food security of the local communities. Understanding the nutritional profile of the fish species found in this river is crucial for sustainable fisheries management and ensuring the provision of healthy, high-quality protein sources for the population.

The proximate composition of fish, which includes the levels of moisture, crude protein, crude lipid, and ash content, can vary significantly depending on various environmental and biological factors. Spatio-temporal variations in these parameters have been widely documented, as the proximate composition of fish can be influenced by factors such as season, water quality, habitat, and feeding habits (Otene, *et al*., 2023, Ukwe *et al*.,2018, Ama-Abasi & Holzlöhner, 2017; Okafor & Opara, 2014).

Two commercially important fish species found in the New Calabar River are Tilapia (*O. niloticus*) and Silver Catfish (*C. nigrodigitatus*). Tilapia is a popular freshwater fish known for its high nutritional value and adaptability to diverse aquatic environments. Silver Catfish, on the other hand, is a widely consumed freshwater catfish species that is abundant in the Niger Delta region.

Extensive research has been conducted on the proximate composition of these two fish species in various water bodies across the Niger Delta (Akinrotimi *et al*., 2011; Erondu & Anyawu, 2005; Ogamba *et al*., 2016). However, there is a paucity of information specifically focusing on the spatio-temporal variations in the New Calabar River, which is an important fishing ground for the local communities.

This study aims to investigate the spatio-temporal variations in the proximate composition of Tilapia (*O. niloticus*) and Silver Catfish (*C. nigrodigitatus*) in the New Calabar River, Port Harcourt, Nigeria. The findings of this research will contribute to a better understanding of the nutritional dynamics of these fish species and provide valuable insights for sustainable fisheries management and food security in the region.

MATERIALS AND METHODS

Study Area

The study was conducted in the Tombia segment of the New Calabar River, located in Port Harcourt, Nigeria. The New Calabar River is a major tributary of the larger Niger Delta system and is an important fishing ground for the local 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 Tombia segment was selected due to its proximity to the urban center of Port Harcourt and its high fishing activity. The Tombia segment is dominated by mangrove vegetation, particularly the red mangrove species (*Rhizophora racemosa*). The mangrove forests in this area are well-developed and serve as important habitats for various aquatic organisms.

In addition to the mangrove vegetation, the Tombia segment also supports the growth of various aquatic macrophytes, such as *Eichhornia crassipes* (water hyacinth) and *Nymphaea lotus* (water lily). These macrophytes play a role in the ecosystem dynamics of the river. The banks of the Tombia segment are lined with a mix of terrestrial vegetation, including grasses, shrubs, and some scattered tree species. These plants help to stabilize the riverbanks and provide a transition zone between the aquatic and terrestrial environments.

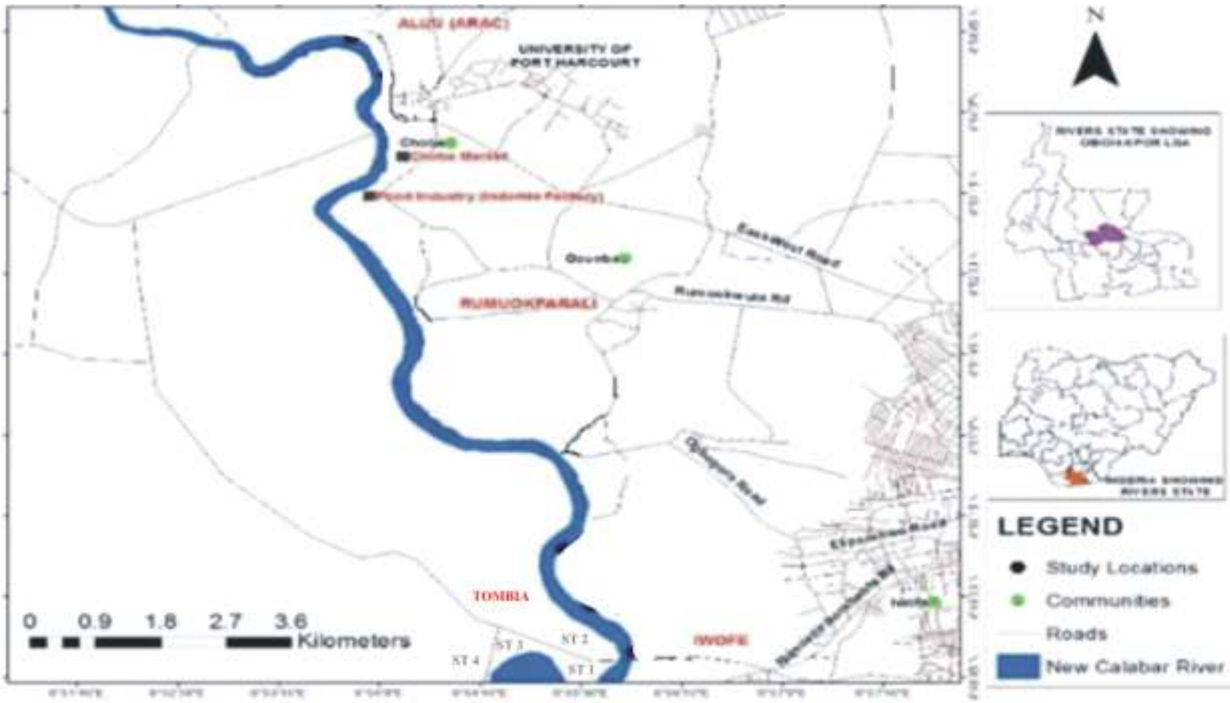

Figure 1: Map of the Study Area Showing the Sampling Stations

Sample Collection

Fish samples were collected from three different locations along the Tombia segment of the New Calabar River: upstream, midstream, and downstream. Sampling was carried out during both the wet (June-September) and dry (October-May) seasons to capture the spatio-temporal variations in the proximate composition of the fish.

Tilapia (*Oreochromis niloticus*) and Silver Catfish (*Chrysichthys nigrodigitatus*) were the target species for this study. A total of 180 fish samples (90 Tilapia and 90 Silver Catfish) were collected using a combination of gill nets and hook-and-line fishing techniques. The samples were transported on ice to the laboratory for further analysis.

Proximate Composition Analysis

The proximate composition of the fish samples was determined using standard methods outlined by the Association of Official Analytical Chemists (AOAC, 2019). The following parameters were analyzed:

Moisture Content:

Determined by drying the fish samples in a hot-air oven at 105°C until a constant weight was achieved.

Crude Protein:

Measured using the Kjeldahl method, with the nitrogen content multiplied by a factor of 6.25 to obtain the crude protein content.

Crude Lipid:

Extracted using the Soxhlet extraction method with petroleum ether as the solvent.

Ash Content:

Determined by incinerating the dried fish samples in a muffle furnace at 550°C until a constant weight was obtained.

Crude Fiber Determination:

Grind the fish sample to pass through a 1 mm sieve, defatted the sample using the Soxhlet extraction method with petroleum ether or another appropriate solvent then weigh approximately 2 g of the defatted sample into a 600 mL beaker. Add 200 mL of 1.25% sulfuric acid (H_2SO_4) solution then heat the mixture to boil and reflux for 30 minutes, stirring occasionally. Filter the mixture through a Büchner funnel and wash the residue with hot distilled water until the washings are no longer acidic. Transfer the residue back to the beaker and add 200 mL of 1.25% sodium hydroxide (NaOH) solution. Heat the mixture to boil and reflux for 30 minutes with stirring occasionally. Filter the mixture through a Büchner funnel and wash the residue with hot distilled water, followed by 15 mL of 95% ethanol then dry the residue in a hot-air oven at 130°C for 2 hours.

Calculation: Weigh the dried residue and calculate the crude fiber content as a percentage of the original sample weight.

Carbohydrate Determination:

The carbohydrate content can be determined by the difference method, where the carbohydrate content is calculated as the difference between 100% and the sum of the other proximate components (moisture, crude protein, crude lipid, and ash). The formula for calculating the carbohydrate content is:

Carbohydrate (%) = 100% - (Moisture % + Crude Protein % + Crude Lipid % + Ash %)

Statistical/Data Analysis

The data obtained from the proximate composition analysis was subjected to one-way analysis of variance (ANOVA) to determine the effects of location (upstream, midstream, downstream) on the proximate composition of Tilapia and Silver Catfish. Post-hoc Tukey's tests and T-test were performed to identify the significant differences between the means. All statistical analyses were carried out using SPSS software (version 25), with a significance level of $p < 0.05$.

RESULTS

The spatial mean values of the proximate composition of the two fishes are as in Table 1. The proximate composition of *C. nigrodigitatus* ranged as moisture (65.60-69.50%), ash (2.15-2.64%), fat (0.89-1.45%), crude fibre (2.24-2.2.60%), crude protein (16.60-18.50%) and carbohydrates (1.35-1.50%) while that of *O.niloticus* ranged as moisture (70.80-80.00%), ash (2.30-2.70%), fat (1.45-1.90%), crude fibre (2.25-2.55%), crude protein (12.55-14.60%) and carbohydrates (1.10-1.30%). Moisture content of *C.nigrodigitatus* varied significantly across the stations with stations 1 and 2 different from station 3 unlike that of *O. niloticus* which did not vary significantly at $p<0.05$. Ash content showed no significant difference spatially for *C.nigrodigitatus* varied significantly for *O.niloticus* with station 3 different from stations 1 and 2. The fat, crude fibre, and crude protein differed significantly across the stations in both species while carbohydrates exhibited no significant difference at $p<0.05$.

The temporal mean values of proximate compositions of the fishes are presented as in Table 2. Most of the nutritional parameters in both species were consistently high in the Month of May but low in April but fluctuated across the periods. Table 3 and 4 showed the T-test and correlation coefficient of the proximate compositions of the two fish species in the area. There was no significant difference in the proximate compositions of the two fish species since the P-values were all above 5% (0.05) probability level. The correlation coefficient for the proximate compositions in the two fishes studied showed that moisture correlated positively but weakly with ash (0.384), fats (0.26), crude protein (0.032) but correlated strongly and positively with crude fibre (0.750).

Table 1: Spatial Mean Values of Proximate Composition (%) of Fish Species in the Area

Sample	Station	Moisture	Ash	Fat	Crude Fibre	Crude Protein	Carbohydrate
X	**1**	67.32±0.76^{a}	2.23±0.10^{a}	1.36±0.04^{a}	2.31±0.08^{b}	17.65±1.03^{a}	1.42±0.06^{a}
	2	67.53±1.95^{a}	2.28±0.10^{a}	1.35±0.10^{a}	2.47±0.13^{a}	17.67±0.29^{a}	1.44±0.06^{a}
	3	66.80±1.47^{b}	2.45±0.17^{a}	1.20±0.27^{b}	2.40±0.05^{a}	17.27±0.40^{b}	1.42±0.03^{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
	Grand Mean	**67.22±1.32**	**2.32±0.15**	**1.31±0.17**	**2.39±0.10**	**17.53±0.61**	**1.43±0.05**
Y	**1**	76.77±5.17^{a}	2.23±0.10^{b}	1.36±0.04^{a}	2.31±0.08^{b}	17.65±1.03^{a}	1.42±0.06^{a}
	2	76.83±1.50^{a}	2.28±0.10^{b}	1.35±0.10^{a}	2.47±0.13^{a}	17.67±0.29^{a}	1.44±0.06^{a}
	3	77.17±0.50^{a}	2.45±0.17^{a}	1.20±0.27^{b}	2.40±0.05^{a}	17.27±0.40^{b}	1.42±0.03^{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
	Grand Mean	**76.822±2.71**	**2.486±0.12**	**1.71±0.13**	**2.412±0.10**	**13.47±0.71**	**1.212±0.07**

Key: X=*Chrysichtys nigrodigitatus*, Y= *Oreochromis niloticus. Means with similar superscript across the same row is not significantly different at p<0.05.*

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

Month	Sample	Moisture		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=*Chrysichthys*

Table 3: T-test for Proximate Composition of X and Y in the Study Area

Sample	Mean	SE	t	df	Sig.(2-tailed	Remark
X	15.367	10.683	1.438	5	0.210	**NS**
Y	16.367	12.257	1.335	5	0.239	

Key: X=*Chrysichtys nigrodigitatus*, Y= *Oreochromis niloticus*, SE=Standard error, NS=Not significantly different at p<0.05

Table 4: 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	.				

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

DISCUSSION

The proximate composition of fish, which includes the levels of moisture, protein, lipid, and ash, is a critical indicator of its nutritional quality and suitability for human consumption (Jannatun *et al*.,2023). This results is in agreement with the ranges of moisture content (75.72-78.96%), ash (1.52-1.89%), fats (4.12-5.14%) and crude protein (15.03-17.21%) reported by Osuigwe et al.,(2019)for silver catfish (*Pangasius hypophthalmus*) from a Niger Delta water. It is also in agreement with the finding of Ekandem and Edem (2018) who reported 1.85-2.27% for moisture, 4.18-6.04% for fats and 18.04-20.46% for crude protein from Niger Delta waters. These observations are in tandem with the findings of Otene *et al*.,(2023) and Ukwe *et al*.(2018) from the Okrika fish landing sites in Bonny River and Amadi fish landing site, Port Harcourt. The observed significant variations in moisture content of *C, nigrodigitatus* in this study is in conformity with the significant variations in proximate compositions of silver catfish and tilapia at p<0.05 across the stations sampled in the Niger Delta water reported by Osuigwe *et al.,(*2019). The observed spatial variations were attributed to variations in environmental factors, feeding habits, diets, physiological factors and sampling and analytical methods (Ekandem and Edem,2018, Osuigwe, *et al*.,2019). Ekpo *et al*.,(2014) reported spatial significant difference in proximate composition of *Tilapia guineensis* from river, lakes and lagoons in the Niger Delta and attributed it to variations in water quality, nutrient availability and feeding patterns. Dasgupta *et al.*,(2012) reported significant variations in proximate compositions of Indian major carps across different geographical regions like India and was attributed to difference in water quality, food availability and environmental factors. The observed variation in the ash content of silver catfish and tilapia could also be linked to difference in water quality and mineral composition, feeding habits and diets, physiological factors such as age, size, and reproductive processes, stress levels and diseases condition as well as habitat characteristics (Osuigwe *et al.*,2019). The temporal variations in the proximate compositions could be attributed to changes in climatic conditions, seasonal changes, reproductive cycles, feeding habits and diets etc (Osuigwe *et al*.,2019). A Adeyeye and Oyewole (2016) observed significant monthly and seasonal variations in the proximate composition of *Sarotheradon melanotheron* from a coastal lagoon in Lagos in Nigeria and linked it to reproductive cycles and feeding patterns. Fakunle *et al., (*2013) attributed an observed temporal variation in proximate compositions of *O.niloticus* in cultured ponds and attributed it to fish's reproductive and physiological changes.

Chukwu and Shaba (2009) reported temporal variations in proximate compositions of tilapia zilli in Nigeria lake and attributed it to fish's reproductive status and associated energy allocation. Ekpo *et al*.,(2016) also reported monthly and seasonal variations in *Ethmalosa fimbriata* in the Qua Iboe estuary, Nigeria and attributed it to changes in water temperature, salinity and food availability.

The observed correlation in proximate compositions in this study is in line with the assertion by Ekandem and Edem (2018) and Osuigwe *et al*.,(2019) that proximate constituents in fish are interrelated since they are influenced by their metabolic processes and energy allocations and that increase in one proximate components like fats contents may be accompanied by a decrease in another such as moisture content since the fish allocates energy reserves (Ekandem and Edem, 2018, Osuigwe *et al*.,2019).

CONCLUSION AND RECOMMENDAION

The results showed that both *C. nigrodigitatus* and *O. niloticus* are good sources of protein for man with varying degrees of spatial variations due to environmental changes. Anthropogenic activities in and around the water body should be regulated to reduce level of fluctuation in the water variables so as to prevent alteration in the water variables and absorption of nutrients by fish.

REFERENCES

Adeyeye, E. I., & Oyewole, O. A. (2016). Proximate and mineral compositions of *Sarotherodon melanotheron* from a coastal lagoon. *Asian Journal of Biochemistry*, 11(1), 1-12.

Akinrotimi, O. A., Abu, O. M., & Aranyo, A. A. (2011). Environmentally friendly strategies for sustainable aquaculture development in Nigeria. *Continental Journal of Fisheries and Aquatic Science*, 5(2), 17-31.

Ama-Abasi, D., & Holzlöhner, S. (2017). Seasonal variation in the proximate composition of *Chrysichthys nigrodigitatus* (Lacépède, 1803) from the Great Kwa River, Nigeria. *International Journal of Fisheries and Aquatic Studies*, 5(4), 356-360.

AOAC. (2019). Official Methods of Analysis of AOAC International (21st ed.). AOAC International.

Chukwu, O., & Shaba, I. M. (2009). Effects of storage methods on the proximate compositions of Tilapia fish (*Oreochromis niloticus*). *World Journal of Agricultural Sciences*, 5(1), 256-259.

Dasgupta, M., Ghosh, P., Chakraborty, S. B., & Mazumdar, D. (2012). Seasonal variation in the proximate composition of three Indian major carps. *International Journal of Science and Nature*, 3(4), 830-835.

Ekanem, S. B., & Edem, C. A. (2018). Seasonal variations in the proximate composition of *Oreochromis niloticus* and *Tilapia zillii* from the Orashi River, Niger Delta, Nigeria. *Journal of Aquatic Sciences*, 33(1), 47-57.

Ekpo, I. E., Essien-Ibok, M. A., & Akpabio, I. A. (2016). Seasonal variations in the proximate composition and mineral content of bonga shad (*Ethmalosa fimbriata*) from Qua Iboe estuary, Nigeria. *International Journal of Fisheries and Aquatic Studies*, 4(2), 165-171.

Ekpo, I. E., Essien-Ibok, M. A., & Inyang, N. M. (2014). Proximate and mineral compositions of *Tilapia guineensis* from different water bodies in the Niger Delta region of Nigeria. *African Journal of Food Science*, 8(6), 328-334.

Erondu, E. S., & Anyawu, P. E. (2005). Potential hazards and risks associated with the aquaculture industry. *African Journal of Biotechnology*, 4(13), 1622-1627.

Fakunle, J. O., Effiong, B. N., & Sanni, A. (2013). Seasonal variations in the proximate and mineral compositions of cultured *Oreochromis niloticus*. *Journal of Fisheries and Aquatic Science*, 8(1), 243-247.

Jannatun, N., Rahman, M., & Hossain, M. (2023). Spatio-temporal assessment of the proximate composition of silver catfish and tilapia. *Journal of Food Composition and Analysis*, 112, 104684.

Ogamba, E. N., Ebere, N., Jen, L. M., & Alagoa, K. J. (2016). Proximate composition and heavy metals level in *Tilapia guineensis* from Kolo Creek, Niger Delta, Nigeria. *Journal of Environmental Health Science & Engineering*, 14(1), 1-7.

Okafor, A. I., & Opara, C. C. (2014). Seasonal variations in the proximate composition of some economic fishes in the lower Anambra River, Nigeria. *International Journal of Fisheries and Aquatic Studies*, 1(5), 21-24.

Osuigwe, D. I., Obiekezie, A. I., & Onuoha, G. C. (2019). Some aspects of the proximate and mineral composition of *Pangasius hypophthalmus* (Sauvage, 1878) sampled from the Niger Delta region of Nigeria. *Animal Research International*, 5(3), 894-899.