



Nutritional evaluation of some selected fish specimens in (three division) Lagos state

Sadiq Shola Kamilu
skam942002@gmail.com

Federal Institute of Industrial Research
Oshodi, Lagos, Nigeria

Obaro-Idowu, Mildred A.
mildredidowuobaro68@gmail.com
Lagos State University, Ojo, Lagos,
Nigeria

Taiwo, Oluwatoyin E.
toyitaiwous@yahoo.com
Federal Institute of Industrial
Research Oshodi,

Chukwudebelu, Jane A.
adadebelu@yahoo.com
Federal Institute of Industrial Research
Oshodi, Lagos, Nigeria

Ojo, Bayonle I.
baytoss@yahoo.com
Federal Institute of Industrial Research
Oshodi, Lagos, Nigeria

Moradeyo, Oluwasola T.
solami_920@yahoo.com
Federal Institute of Industrial
Research Oshodi, Lagos, Nigeria

Okuneye, Olayinka J.
okuneyeolayinka19@gmail.com
Federal Institute of Industrial Research Oshodi, Lagos, Nigeria

ABSTRACT

There is information gap in the knowledge about fishes consumed in Lagos state especially as it relates to the nutritional values of these fish species. In this study the nutritional evaluation of selected fish specimens Croaker (*Pseudotolithus elongatus*), Tilapia (*Oreochromis aureus*) and Crab (*Callinectes sapidus*) were carried out. Samples were purchased from selected markets in Ikorodu, Badagry and Lagos Island, all in Lagos State. Proximate analysis (Protein, Fat and Ash) was determined. Protein determination was done using micro kjeldahl method with the mean values ranging between $19.90 \pm 0.34\%$ and $20.60 \pm 0.78\%$ for *Pseudotolithus elongatus*, $29.40 \pm 0.4\%$ and $30.52 \pm 0.5\%$ for *Callinectes sapidus*, $18.50 \pm 0.6\%$ and $20.80 \pm 0.00\%$ *Oreochromis aureus*. Ash content was carried out and the mean values ranged from $1.20 \pm 0.10\%$ and $1.13 \pm 0.10\%$ for *Pseudotolithus elongatus*, $1.20 \pm 0.00\%$ and $1.30 \pm 0.00\%$ for *Oreochromis aureus*, from $8.90 \pm 0.10\%$ and $10.10 \pm 0.20\%$ for *Callinectes sapidus*. Crude fat was carried out using soxhlet extraction method and the values determined gravimetrically and were found to range between $1.39 \pm 0.00\%$ and $1.50 \pm 0.02\%$ for *Pseudotolithus elongatus*, $1.10 \pm 0.00\%$ and $1.3 \pm 0.10\%$ for *Oreochromis aureus*, $0.5 \pm 0.04\%$ and $0.9 \pm 0.03\%$ for *Callinectes sapidus*. Vitamins A, D, B3, B6 and B12 were determined using the HPLC.

Keywords: Crab, Croaker, Tilapia, Proximate, Vitamins

1. INTRODUCTION

Fish is an important dietary component of many average families in Nigeria. Seafood products, which include finfish and shellfish, are noted for their health supporting characteristics (Moronkola *et al.*, 2011). Across the world, fish is considered an excellent source of nutrient for people, particularly as a source of protein. It is often assumed to be healthier than chicken and other varieties of meat (Paudel *et al.*, 2016). Fish is known to provide 40 percent of the protein intake of two-thirds of the world's population (Baruwa *et al.*, 2012) and recent world harvest of fish was estimated at about 70 – 100 million metric tons annually for food. People consume about 70% of fish caught yearly and 30% are used as mammal feed that helps produce other forms of protein (Ande *et al.*, 2012). The nutritional and medicinal values of fish products depend on their proteins, lipids, minerals and vitamins content. Protein is essential for the sustenance of life and exists in large quantities of all nutrients as a component of human body. It is rich in essential amino acids (lysine, methionine, cysteine, threonine and tryptophan), which plays an important role in human nutrition and health promotion (Sri sakthi Priyadarshini *et al.*, 2015). Apart from protein, fish also contains a wide variety of vitamins which include vitamins A, B (thiamine, riboflavin, nicotinic acid) C, D and E (Baruwa *et al.*, 2012). Also, aquatic animal fats are good sources of essential fatty acids that cannot be synthesized in the human body and they are required for the maintenance of growth, reproduction and synthesis of vitamins. Fats and essential polyunsaturated fatty acids (PUFA) contribute to dietary quality and sensory values (Karuppasamy *et al.*, 2013). The consumption of Omega-3 polyunsaturated fatty acids (PUFA), especially Eicosapentaenoic (EPA) acid and Docosahexaenoic (DHA) acid has both anti-atherogenic and anti-thrombotic effects as well as an important role in the control of hypertension, reducing the risk of coronary heart diseases, diabetes and cancer (Sri sakthi Priyadarshini *et al.*, 2015 and Njinkoue *et al.*, 2016).

Fish meat (Tissue) is also a rich source of minerals and the most abundant micro-elements are Zinc (Zn), Iron (Fe), Copper (Cu) and Manganese which are essential metals; since they play important roles in biological system and contribute also to the growth of these fishes (Damodharan *et al.*, 2013 and Mohamed *et al.*, 2010). The most important mineral salts are calcium, sodium, potassium, phosphorous and iron, while many others are also needed in trace amounts (Ogundiran, 2017). The human body usually contains small amount of these minerals and the deficiency in these principal nutritional elements induces a lot of malfunctioning as it reduces productivity and causes diseases (Elegba *et al.*, 2010). Fish plays an important role in food security and poverty alleviation among the low-income earners of the society. In Nigeria, fish consumption is either fresh, fried or smoked depending on the suitability of individual family.

2. MATERIALS AND METHODS

2.1 Sample collection: The specimens *Pseudotolithus elongatus*, *Oreochromis aureus*, and *Callinectes sapidus* used for this study were purchased from fish mongers at lagoon sites in Badagry, Lagos island and Ijede in the Ikorodu area of Lagos state and preserved in ice during transportation to the laboratory.

2.2 Specimen- preparation

The specimens were washed thoroughly with tap water followed by distilled water to remove adhering impurities and then allowed to drain in open air. The specimens were dissected using a knife to remove the intestine, bones and guts. While part of the tissues was dried and ground in preparation for digestion and the other parts were homogenized with an electric blender and sieved with a fine mesh and thereafter, stored in a deep freezer.

2.3 Proximate analyses: Crude protein, Ash and Fat content were determined using standard methods.

Determination of Total Ash (%): Ash content was determined according to the method of Association of Official Analytical Chemists (AOAC, 2000). An empty crucible was weighed; 5g of the specimen was weighed into the crucible and ashed in a furnace at 550°C to constant weight. Total ash was then calculated thus;

$$\text{Ash (\%)} = \frac{\text{weight of ash}}{\text{weight of sample}} \times 100$$

Determination of Fat: Fat content was determined according to the method of Association of Official Analytical chemists (AOAC, 2000). The bottle and lid were placed in the incubator at 105°C until constant weight was achieved. 5g of the dried specimens was weighed on a paper filter and wrapped. Wrapped specimen was placed in a thimble and transferred into a Soxhlet. 250mls of petroleum ether was put in a round bottom flask and placed on a heating mantle, with water running through to cool it. After heating round bottom flask is cooled and the solvent evaporated using a vacuum condenser. The round bottom flask and its dried content is reweighed. Fat content is calculated as follows:

$$\text{Fat (\%)} = \frac{\text{weight of fat}}{\text{weight of sample}} \times 100$$

2.4 Determination of Protein (%): Crude protein content of the samples was determined using Micro Kjeldahl method according to the method of AOAC (2000) and calculated as follows:

$$\text{Protein (\%)} = \frac{(A - B) \times 14.007 \times 6.2}{W}$$

Where

A = volume (ml) of 0.2N HCl used sample titration

B = volume (ml) of 0.2N HCl used in blank titration

N = Normality of HCl

W = weight (g) of sample

14.007 = atomic weight of nitrogen

6.25 = protein-nitrogen conversion factor for fish and its by-product

2.5 Determination of Vitamins

The vitamins extraction process was carried out as described in British pharmacopoeia 1980 Appendix VIII K.

Muscle tissues (fillets) below the dorsal fin of fresh specimens was taken and homogenized, using a blender. A portion of homogenized sample to be analysed for vitamins was stored in sample container.

Vitamin A

10.0g of the homogenized sample was weighed into an amber quick fit flask; 20ml of absolute ethanol, 1ml of sodium ascorbate solution, and 3ml of freshly prepared 50%W/V potassium hydroxide solution was added and swirled gently, boiled under reflux for 30minutes and cooled rapidly. The resulting solution was transferred into a separating funnel and washed using 15ml of distilled water. 100ml of 96% ethanol and 2 x 50ml of n- pentane was used for the extraction of the vitamin. This was done by shaking the solution vigorously for 10 minutes and allowed to separate into two layers. The lower ethereal layer was transferred into another separating funnel.

Weight of standard = 100.4mg

Absorbance of standard (Std) = 0.534, 0.534

Potency of Vitamin A standard (Std) = 0.9969

$$\text{Concentration } (\mu\text{g/g}) = \frac{\text{Absorbance of Sample X Dilution of Sample X Potency X } 1,000,000}{\text{Absorbance of Standard X Dilution of Standard X Weight of Sample}}$$

Vitamin D

1.0g homogenized sample was accurately weighed and dissolved in 20mL of deionized water and 0.15mL of bromo cresol green solution and 0.5M Hydrochloric acid on dropwise until colour change to full yellow. 5g of sodium chloride was added and shaking to dissolve and extracted with four quantities each of 20mL of a mixture of chloroform and methanol in ratio 1: 9. Each extract was washed with 10mL of deionized water the washed extracts was combined, and make up to 100mL with the chloroform and methanol (1.9).

Weight of standard = 25.4mg

Absorbance of standard = 0.432, 0.432

Potency of Vitamin D standard = 0.0084

$$\text{Concentration}(\mu\text{g/g}) = \frac{\text{Absorbance of Sample X Dilution of Sample X Potency X } 1,000,000}{\text{Absorbance of Standard X Dilution of Standard X Weight of Sample}}$$

2.6 Statistical Analysis

The analyses of samples used in this study were carried out in triplicates. The results were reported as mean - standard deviation. The differences between the mean values of (*Oreochromis aureus*), croaker (*Pseudotolithus elongatus*) and crab (*Callinectes sapidus*) were calculated using one-way analysis of variance (ANOVA), and statistically significant differences were reported at P<0.05. The Least Significant Difference (LSD) was conducted for independent sample-t test as may be required between two treatments. Data analyses were done with the use of SPSS 15.0 software.

3. RESULTS

3.1 Result

This study analyzed croaker (*Pseudotolithus elongatus*), Tilapia (*Oreochromis aureus*) and Cat fish (*Callinectes sapidus*) for percentage protein, fat and ash content. Table 1.0 shows percentage proximate composition of *Pseudotolithus elongatus*, *Callinectes sapidus* and *Oreochromis aureus*.

Table 1: Proximate analyses of Fish specimens

Specimens	Ikorodu			Badagry			Lagos Island		
	% Protein	%Fat	%Ash	% Protein	%Fat	%Ash	% Protein	%Fat	%Ash
Croaker	19.9±0.34 ^{by}	1.50±0.02 ^{by}	1.20±0.10 ^{ax}	18.50±0.50 ^{cx}	1.40±0.10 ^{ay}	1.20±1.13 ^{ax}	20.60±0.78 ^{ax}	1.39±0.00 ^{ax}	1.13±0.10 ^{ay}
Tilapia	18.50±0.60 ^{cx}	1.20±0.01 ^{ax}	1.30±0.00 ^{ax}	19.90±1.30 ^{by}	1.10±0.00 ^{ax}	1.20±1.10 ^{ax}	20.80±0.00 ^{ax}	1.30±0.10 ^{ax}	1.20±0.00 ^{ax}
Crab	29.40±0.40 ^{ax}	0.5±0.04 ^{ax}	10.10±0.20 ^{by}	29.50±0.50 ^{ax}	0.90±0.03 ^{ay}	8.70±1.01 ^{bx}	30.52±0.50 ^{by}	0.80±0.10 ^{ay}	8.90±0.10 ^{by}

Superscript with different letters in the same column (a,b,c) and in the same row(x,y,z) for each parameter in the different division indicate significant differences at P<0.05.

The result of analyses showed mean values for protein in Croaker (*Pseudotolithus elongatus*) across Ikorodu, Badagry and Lagos Island were 19.9 (± 0.34), 18.5 (±0.5) and 20.6 (±0.78) respectively. Protein contents in Crab (*Callinectes sapidus*) across the locations were 29.4% (± 0.4); 29.5% (± 0.5), 30.52% (±0.5) in ascending order for Ikorodu, Badagry and Lagos Island. The mean values of protein contents in Tilapia (*Oreochromis aureus*) across the locations were 18.5 % (± 0.6), 19.9% (± 1.3), 20.8% (±0.00), for Ikorodu, Badagry and Lagos Island respectively. In this study protein values were found to be significantly different (P<0.05) among the specimens and across the locations. The mean values of fat content in Croaker (*Pseudotolithus elongatus*) across the locations Ikorodu, Badagry and Lagos Island were given in the following order 1.50% (± 0.02), 1.40% (±0.1) and 1.39% (±0.00), while the values of fat in *Oreochromis aureus* were 1.20% (± 0.01), 1.10% (± 0.00), 1.30% (±0.10) for Ikorodu, Badagry and Lagos Island. The mean values of fat content observed in Crab (*Callinectes sapidus*) were 0.5% (± 0.04), 0.90% (± 0.03), 0.8% (±0.10) for Ikorodu, Badagry and Lagos Island divisions respectively. Study carried out indicates significant difference (P<0.05) across the locations.

The mean values of ash content in *Oreochromis aureus* are 1.30% (± 0.00), 1.20% (±1.10), 1.2% (±0.00) for Ikorodu, Badagry and Lagos Island respectively, while in Crab (*Callinectes sapidus*) the percentage ash content are 10.1% (± 0.20), 8.7% (±1.01), 8.9% (±0.10) for Ikorodu, Badagry and Lagos Island and ash content in Croaker (*Pseudotolithus elongatus*) were observed as 1.2% (± 0.10), 1.2% (± 1.13), 1.13% (±0.10). Statistical analysis showed significant difference (P<0.05) within the column and across the locations.

Table 2.1a: Comparison of mean values of some Water-Soluble vitamins within Specimens and Locations

Specimens	Ikorodu			Badagry			Lagos Island		
	Vitamin B3(ug/g)	Vitamin B6(ug/g)	Vitamin B12(ug/g)	Vitamin B3(ug/g)	Vitamin B6(ug/g)	Vitamin B12(ug/g)	Vitamin B3(ug/g)	Vitamin B6 (ug/g)	Vitamin B12(ug/g)

	Mean ±S.D	Mean ±S.D	Mean ±S.D	Mean ±S.D	Mean ±S.D	Mean±S.D	Mean ±S.D	Mean ±S.D	Mean ±S.D
Croaker	15.50±0.50 ^{ay}	25.60±0.5 ^{az}	19.90±0.40 ^{az}	10.30±0.30 ^{ax}	10.20±0.30 ^{ay}	1.80±0.30 ^{ay}	10.60±0.08 ^{ax}	10.30±1.10 ^{ax}	8.80±0.35 ^{ax}
Tilapia	9.80±0.60 ^{bx}	9.40±0.10 ^{bx}	11.90±0.90 ^{by}	9.50±0.20 ^{ax}	9.70 ±0.50 ^{ax}	10.50±0.30 ^{ax}	10.00±0.00 ^{ay}	ND*	10.40±0.10 ^{ax}
Crab	9.40±0.50 ^{bx}	9.70±0.70 ^{bx}	11.80±0.10 ^{by}	11.90±0.30	7.40±0.20 ^{bx}	9.30±0.40 ^{bx}	9.90±0.20 ^{ax}	ND*	7.00±0.30 ^{bx}

Superscript with different letters in the same column (a,b,c) and in the same row(x,y,z) for each parameter in the different division indicate significant differences at P<0.05.

N.D: Not Detected

Table 2.1a above, shows the result of vitamins B₃, B₆ and B₁₂. Mean values of vitamin B₃ in *Oreochromis aureus* were found to be 10.0µg/g (±0.00), 9.8 µg/g (±0.60) and 9.5µg/g (±0.2) for Lagos Island, Ikorodu and Badagry respectively. For *Callinectes sapidus* mean values recorded for vitamin B₃ were, 11.8µg/g (±0.10), 9.9µg/g (±0.20) and 9.4µg/g (±0.5) in Badagry, Lagos Island and Ikorodu, while the mean value of *Pseudotolithus elongatus* were 15.5 µg/g (± 0.50), 10.6µg/g (±0.80) and 10.3µg/g (±0.3) for Ikorodu, Lagos Island and Badagry in that order, however there was no significant difference (P>0.05) across the locations and columns. Mean values of vitamin B₆ in *Pseudotolithus elongatus* across the locations were 25.6µg/g (±0.5), 10.2µg/g (±0.3) and 8.8µg/g (±0.35) for Ikorodu, Badagry and Lagos Island. For *Oreochromis aureus* the mean value vitamin B₆ content were 9.7µg/g (± 0.50) and 9.4µg/g (±0.10) Badagry and Ikorodu divisions. In *Callinectes sapidus* the mean values of vitamin B₆ are 9.7µg/g (±0.7), 9.7µg/g (±0.70), 7.0µg/g (±0.30) for Ikorodu, Badagry and Lagos Island. Statistical analysis showed there was significant difference (P<0.05) within the columns and cross the division except for Badagry division. The values of vitamin B₁₂ content in *Pseudotolithus elongatus* were 19.9µg/g (±0.40), 11.8µg/g (±0.30) and 10.3µg/g (±1.10) for Ikorodu, Badagry and Lagos Island. In *Callinectes sapidus* the mean values of vitamin B₁₂ were 11.8µg/g (±0.10) and 7.0µg/g (±0.30) for Ikorodu and Badagry. While the mean value of *Oreochromis aureus* are 11.9µg/g (±0.90), 10.5µg/g (±0.30), 10.4µg/g (± 0.10) for Ikorodu, Badagry and Lagos Island. Vitamin B₁₂ was not detected in *Callinectes sapidus* from Lagos Island, statistical analysis indicates significant difference (P<0.05) in the column and across the divisions.

Table 2.2b below shows the result vitamin A and D in tilapia (*Oreochromis aureus*), croaker (*Pseudotolithus elongatus*) and crab (*Callinectes sapidus*). Vitamin A content in *Pseudotolithus elongatus* in the three sampling locations were 22.10µg/g (±0.80), 27.10µg/g (±1.00) and 23.02µg/g (±0.00) respectively for Ikorodu, Badagry and Lagos Island, the mean values of vitamin A in *Callinectes sapidus* were 5.30µg/g (±0.40), 6.90µg/g (±1.20), 8.70µg/g (±1.20) for Ikorodu, Badagry and Lagos Island division. While the mean values of vitamin A in *Oreochromis aureus* are as follows 16.40µg/g (±1.40), 26.50µg/g (±0.20), and 2.90µg/g (± 0.20) for Ikorodu, Badagry and Lagos Island divisions. Statistical analysis showed significant difference (P<0.05) across locations and in the columns.

Mean values of Vitamin D content in *Pseudotolithus elongatus* for Ikorodu, Badagry and Lagos Island were 5.20µg/g (±0.02), 4.40µg/g (±0.30) and 3.00µg/g (±0.20) respectively. For *Oreochromis aureus* the mean values are 3.60 µg/g ± (0.30), 3.58µg/g (± 0.20) and 2.90µg/g (±0.20) for Ikorodu Badagry and Lagos Island, for *Callinectes sapidus* the mean values of vitamin D were 2.30µg/g (±0.10), 2.10µg/g (±0.20) and 1.80µg/g (±0.00) Badagry, Ikorodu, Lagos Island in that order, however statistical analysis varied significantly (p<0.05) except for Lagos Island.

Table 2.2b: Comparison of Mean values of some Fat-Soluble Vitamins within the Specimen and Locations

Specimens	Ikorodu		Badagry		Lagos Island	
	Vitamins A(ug/g)	Vitamin D (ug/g)	Vitamins A(ug/g)	Vitamin D (ug/g)	Vitamins A (ug/g)	Vitamin D (ug/g)
	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D
Croaker	22.10 ± 0.80 ^{cx}	5.20 ± 0.02 ^{by}	27.10 ± 1.00 ^{az}	4.40 ± 0.30 ^{ay}	23.02 ± 0.00 ^{cy}	3.00 ± 0.20 ^{ax}
Tilapia	16.40 ± 1.40 ^{bx}	3.60 ± 0.30 ^{ay}	26.50 ± 0.20 ^{ay}	3.58 ± 0.20 ^{ay}	17.90 ± 0.20 ^{bx}	2.90 ± 0.20 ^{ax}
Crab	5.30 ± 0.40 ^{ax}	2.10 ± 0.20 ^{bx}	6.90 ± 1.20 ^{by}	2.30 ± 0.10 ^{bx}	8.70 ± 1.20 ^{az}	1.80 ± 0.00 ^{cx}

Superscript with different letters in the same column (a,b,c) and in the same row (x,y,z) for each parameter in the different division indicate significant difference at P<0.05

4. DISCUSSION

The result in table 1.0 reflects the mean- standard deviation and range of Percentage Protein, Fat and Ash content. Mean value of protein in *Callinectes sapidus* was observed to be higher than *Oreochromis aureus* and *Pseudotolithus elongatus*. The values obtained in this study were higher than the values observed for different parts of *Callinectes Amnicola* as reported by Moronkola et al., (2011) and *Spiralothelphusa hydrodroma* as reported by Varadharajan et al., (2014). The values obtained for *Callinectes sapidus* was comparable with values observed in *Callinectes amnicola* as reported by Williams et al., (2016). Similarly, mean values of protein in *Pseudotolithus elongatus* were observed to be higher than the one reported by Jolaoso et al., (2016) and Njinkoue et al., (2016) for the same species. Variation in values may be as a result of seasonal changes, habitat and the type of feed at the time of sample collection. The values show that these specimens are good sources of protein.

Mean value of Fat obtained in *Pseudotolithus elongatus* were higher than *Callinectes amnicola* and *Oreochromis aureus*. The values obtained were higher than the result obtained by Njinkoue et al., (2016) and Jolaoso et al., (2016) for the same species. Variation in values of fish species may be as a result of feed, age and activities of these species in their habitat. However, fish are categorized on the basis of fat content (Ackman, 1989); lean fishes (<2%), low fat fish (2-4%), medium fat fish (4-8%) and high fat fish (>8%). Hence, based on these categories of fish species, *Pseudotolithus elongatus* and *Oreochromis aureus* can be classified as lean-fat fishes.

Ash content was observed to be highest in *Callinectes sapidus* followed by *Pseudotolithus elongatus*. The result obtained for *Pseudotolithus elongatus* and tilapia *Oreochromis aureus* compares with the study carried out by Jolaoso *et al.*, (2016) for *Pseudotolithus elongatus* and *Pomadasy jubelini*. Ash content for crab (*Callinectes sapidus*) compares with the study observed by Williams *et al.*, (2016) for *Callinectes amnicola*. Hence, ash is shown to be a measure of the mineral content in food item; based on the inorganic residue that remains after the organic matter has been burnt off. The range of ash in this study suggests that these species of fishes are good source of mineral elements.

5. CONCLUSION

This study revealed the importance of fish specimen as a good source of protein and other essential nutrient for the proper functioning of the body. Of all the fishes, *Pseudotolithus elongatus* has the highest nutritive level followed by, *Oreochromis aureus* and *Callinectes sapidus*. This however will be an eye opener to the nutrient these fishes can provide and thus be a guide for the choice of consumption. Nevertheless, some variations in values exist between the mineral contents recorded in this study and those of other studies carried out. It has been reported that variations in the mineral composition of marine foods are closely related to seasonal and physiological differences in the area of catch, food source, and other environmental conditions. Hence it is possible that these factors were also responsible for the observed differences in protein composition of *Pseudotolithus elongatus* between the present study and others.

The research carried out has shown that people deficient in protein, vitamins and mineral elements could eat Croaker (*Pseudotolithus elongatus*), tilapia (*Oreochromis aureus*) and Crab (*Callinectes sapidus*). This is based on its availability and affordability for all category of people.

6. REFERENCES

- [1] Ackman, R.G. (1989). Nutritional composition of fats in seafoods. *Progress in Food Nutrition Science*. 13:161-241.
- [2] Ande Sesugh, Leke Luter, Eneji Ishaq and Yakubu Sunday (2012). Proximate Analysis of Smoked and Unsmoked Fish (Cat and Tilapia) in Ombi River Lafia Nasarawa state Nigeria.. *Elixir International Journal* 53: 11801-11803.
- [3] AOAC (2000). *Official Methods of Analysis* 17th ed. Gaithersburg, Maryland, USA, AOAC International.
- [4] Baruwa, O.I. Tijani, A.A. Adejobi, A.O. (2012). Profitability and Constraints to Fishery Enterprises: A Case of Artisanal and Aquaculture Fisheries in Lagos state, Nigeria. *Nigeria Journal of Agriculture, Food and Environment*, 8 (1): 52-58.
- [5] *British Pharmacopoeia* (1980) 13th edition, Appendix ViiiK University of California.
- [6] Damodharan, U and Vikram Reddy, M., (2013). Heavy Metal Bioaccumulation in Edible Fish Species from an Industrially Polluted River and Human Health Risk Assessment. *Ach. Pol. Fish*, 21:19-27.
- [7] Elagba Mohamed, H.A., Rabie Al-Maqbaly and Mohamed Mansour, H., (2010). Proximate composition, amino acid and mineral contents of five commercial Nile fishes in Sudan. *African Journal of Food Science*, 4(10): 650-654.
- [8] Jolaoso, A.O. Njoku, K.L. Akinola, M.O. Adesuyi, A. A. Adedokun, A. H (2016). Heavy Metal Analyses and Nutritional composition of raw and smoked Fish from Ologe and Lagos Lagoon, Lagos, Nigeria. *Journal of Applied Science and Environment Management*, 20 (2): 277-285.
- [9] Karuppasamy, A.k., Sri Sakthi Priyadarshini, R., Ramamoorthy, N., Sujatha, R., Ganga, S., Jayalakshmi, T., and Santhanam, P. (2013). Comparison of proximate, amino and fatty acid composition of *Penaeus monodon* (Fabricius, 1798), *Fenneropenaeus virilis* (Bate, 1881) of Nagapattinam landing centre, Tamil Nadu. *Journal of marine Biology Association of India*, 55(2):55-60
- [10] Moronkola, B.A., Olowu, R.A., Tovide O.O and Ayejuyo, O.O. (2011). Determination of proximate and mineral contents Of Crab (*Callinectes Amnicola*) living on the shore of Ojo river, Lagos, Nigeria. *Journal of Scientific Review and Chemical Communication*, 1 (1):1-6.
- [11] Njinkoue, J.M. Gouado, I. Tchoumboungang, F. Yanga Ngueguim, J.H. Ndinteh, D.T. Fomogne-Fodjo C.Y and Schweigert, F.J. (2016). Proximate composition, mineral content and fatty acid profile of two marine fishes from Cameroonian coast: *Pseudotolithus typus* (Bleeker, 1863) and *Pseudotolithus elongatus* (Bowdich, 1825). *Journal of NFS*, 4: 27-31.
- [12] Ogundiran. M.A. (2017). Nutritional composition and heavy metal accumulation Potentials of selected Fish Species from Ijede River, Lagos, Nigeria. *Journal of Aquaculture Research and Development*, 8 (508): 1-4
- [13] Paudel, P.N. Pokhrel, B. Kafle, B.K. Gyawali, R. (2016). Analysis of Heavy Metals in some Commercially Important Fishes of Kathmandu Valley Nepal. *International Food Research Journal*, 23 (3): 1005-1011
- [14] Sri Sakthi Priyadarshini, R., Karuppasamy, P.K., Santhanam, P., and Ramamoorthy, N. (2015). Nutritional Composition of Penaeidean shrimps along Tamil Nadu, southeast coast of Indian. *Journal of Marine Biology Association of India*, 55(2):46-51
- [15] Varadharajan, D., Soundarapandian, P. (2014). Proximate composition and mineral contents of freshwater Crab *Spiralothelphusa hydrodroma* (Herbst, 1794) from Parangipettai, South East Coast of India. *Journal of Aquaculture Research and Development* 5: 217.
- [16] Williams, I.O. Ekpenyong, E. Lawal, O.O Essien, N.C and Edemumoh, T.O (2016). Nutritional and energy composition of Flesh, Limbs and Carapace of *Callinectes amnicola* (Blue Crab) from Great Kwa River, South East Nigeria. *African Journal of Food Science and Technology*, 7(3):060-065