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Full Length Research Paper

Proximate Analysis and Mineral Composition of Some Fish Species in Ero Reservoir Ikun Ekiti, Nigeria

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Comparative analysis of the proximate, mineral composition and energy level of five fish species, *Clarias gariepinus*, *Lates niloticus*, *Sarotherodon galileaus*, *Heterotis niloticus* and *Oreochromis niloticus*, from Ero Reservoir, Ikun Ekiti, Ekiti State Nigeria, was carried out from July-September, 2017. Analysis of the samples was carried out at the Central Science Laboratory, Federal University of Technology, Akure according to the AOAC Official Method. The nutrients have the following ranges: Protein 60.03-81.59%; Fat 6.24-8.24%; Carbohydrate 1.80-12.52%; Moisture Content 11.32-13.54%; Ash 3.15-5.81%. Highest percentage protein and fat values (81.59% and 8.28%) were both recorded in *Heterotis niloticus* while *Sarotherodon galileaus* and *Oreochromis niloticus* have the least values of protein and fat respectively. Highest percentage values of ash and carbohydrate were recorded in *Sarotherodon galileaus*. Protein content of *Heterotis niloticus*, ash and carbohydrate contents of *Sarotherodon galileaus* differed significantly from other species studied ($P>0.05$). The energy levels of the species varied; highest level was observed in *Oreochromis niloticus* 1553.07 Kcal/kg while the lowest level was in *Clarias gariepinus* 1439.23Kcal/kg. The minerals tested have the following ranges; Calcium 18.54-19.65Mg/g, Potassium 18.54-22.47Mg/g and Phosphorus 93.10-102.33Mg/g. The pattern of mineral concentration of each species is in order $P>K>CA$. All the fish species are rich in crude protein, lipid, moisture and ash and they met the nutritional requirements for man.

Keywords: Proximate composition, Energy levels, Fish species, Ero Reservoir.

INTRODUCTION

Fish is known to be highly nutritious and excellent source of animal proteins which is consumed by a larger percentage of populace of the world because of its availability and palatability (Sutharshiny and Sivashanthin, 2011). Fish is also a vitamin and mineral rich food for young and old consumers (Koffi-Nevry *et al.*, 2011). The nutritional characteristics of the consumption of fish have been linked to health benefits such as reduced risk of coronary heart disease and maintenance of healthy body

(Arannilewa *et al.*, 2005). Fish has an edge over meat in Nigeria, because it is cheaper and relatively more abundant (Adewumi *et al.*, 2014).

The nutritional value of fish meat comprises the contents of moisture, dry matter, protein, lipids, vitamin and minerals plus the caloric value (Alexakis, 2000). Minerals are essential nutrient components of many enzymes and metabolism and it contributes to the growth of fish itself (Glover, 2002). Fish of various species don't provide the

same nutrient profile to their consumers (Takama *et al.*, 2000) and nutritive value of a fish varies with season (Varlien *et al.*, 2003). In human nutrition, essential elements are those chemical elements that are required for the normal maintenance of human body (Jiang *et al.*, 2015)

These elements (K, Ca, Mg, Na, Fe, Zn, Cu, Mn) participate in several biochemical reactions, Calcium, Magnesium and Phosphorus are crucial in formation of bones and teeth, Sodium and Potassium work together in transmission of nerve impulses and keeping electrolyte balance, Zinc is mostly found as a contractor in enzyme reactions, iron forms part of the hemoglobin molecule which transport oxygen around the body (Alas *et al.*, 2014). When these elements are not adequately provided to the body, mainly by dietary intake, the individual suffer from mineral deficiency diseases such as anemia, osteoporosis, goiter, stunted growth and genetic disorder (Bhandari and Banjara, 2014). The world Health organization (WHO, 2001) reported that about 2 billion of the World's population is suffering from mineral and vitamin deficiencies and majority of these are in the third world countries.

Several studies on chemical components of fish have been made from different freshwater and marine fish species around the world. In Nigeria, Adewumi *et al.*, (2014) carried a study on comparative analysis of the proximate and elemental composition of four fish species; *C. gariepinus*, *P. obscura*, *T. zilli*, and *T. galileus*, which were collected from Osimo Reservoir. Biochemical assay of the moisture, ash, crude protein, fibers, lipid and the elements, Fe, Na, K, Ca, Mg, Zn, Mn, and Cu of the fillets were carried out. All the fish species examined are rich sources of protein, moisture, lipid, ash and minerals and meet the requirement for human nutritional needs. They belong to the high-protein, (18-23%), high moisture and low oil (<5%, except *P. obscura*) category. The pattern of elemental concentration in the fillets of each of the species, is in the order Na>K>Ca>Mg>Fe>Mn>Cu>Zn. Based on their concentration in the fillets K, Na, Mg and Ca could be regarded as major elements of the species while Fe and Mn is classified as minor elements and Zn and Cu could be regarded as trace elements. Bolawa (2011) made similar observation on *Pseudotolithus senegalensis*, *Ethmalosa fimbrata* and *Oreochromis niloticus*.

Similarly, in Ghana Obodai *et al.*, (2009) studied the chemical composition of five commercial marine fish species (*Choloroscombus chrysurus*, *Pseudotolithus senegalensis*, *Sardinella aurita*, *Scombus japonicas* and *Syacium micurum*). These were analyzed using standard analytical techniques. The results indicate significant difference among the chemical compositions of the fish species studied. Moisture content ranged from 72.36% in *S. japonicus* (Chub mackerel) to 79.06% in *S. micurum*. The least protein content (16.71%) was observed in *S. micurum* and the highest value of 22.53% in *S. japonicus*; the fat content was highest in *S. japonicus* and lowest in *S. micurum*. In all the five fish species studied, calcium

content was highest, followed by Phosphorus and Iron content was the least. *P. senegalensis*, however, had highest phosphorus than calcium content. Also, in India, Sandhya and Smita (2013) worked on the proximate composition and seasonal variation in proteins of small indigenous fish species such as *Salmostoma sardinella*, *Cirrinus reba*, *Garra mullya*, *Rasbora daniconius* and *Puntinus conchoniuis*. The proximate composition was found to vary among the species. Protein was estimated in *S. sardinella* to be 25.64%, *C. Reba* 24.19%, *G. Mullya* 28.69%, *R. daniconius* 32.79% and *P. conchoniuis* 27.10%. The findings revealed that the highest protein content as compared to the other fishes was found in *R. daniconius*. The result showed that the fishes are safe for food and supplement protein. The authors concluded that the proximate composition of fish depends on season and also to a great extent on reaction to size, age, sex, reproducing cycle, breeding season and region of catch.

Fish commonly found in natural water bodies are well known of its superior nutritional quality with a very good supply of essential minerals (Fawole *et al.*, 2007). This resource is accessible to poor and vulnerable communities prone to nutrient deficiency disease. Food base strategies are considered sustainable and currently being evaluated for enhancing material intake. Fish has big potential for this strategy because it can provide variety of nutritional quality; these fish qualities depend on their species, age, size, diet and water quality (Rebole *et al.*, 2015).

Regular consumption of fish can promote the defense mechanism for protection against invasion of human pathogens because fish food has antimicrobial peptide (Ravichandran *et al.*, 2010). Ingesting fish can reduce the risk of heart disease and lower the risk of developing dementia, including alzhelmer's disease (Grant, 1997). Dementia is a general term for a decline in mental ability severe enough to interfere with daily life, memory loss is an example and alzheimer's disease is the most common type of dementia. The omega-3 fatty acids found in fishes, particularly fatty fish, are important for brain health and these play an important role in brain cells and may protect against alzheimer's disease, there are no treatment and no cure but eating seafood such as fish may be one way to reduce the risk (Kathryn, 2016)

The nutritive value of fishes is recognized all over the world, so, the chemical composition of fish is important since it is used in analyzing the nutritive quality of fish which is a very good source of food for humans. Biochemical composition of fish flesh is a good indicator of quality, physiological condition and the habitat of fish. In general, the chemical composition of fish species helps to assess its edible value in terms of energy units compared to other species. Nutritive benefits associated with fish consumption has therefore become important that fish's mineral and proximate composition and their health status be assessed in order to establish the safety level of the table sized species prior their consumption. The

measurement of some proximate profile such as protein content in fish by products is often necessary to ensure that they meet the requirements of food regulations in nutritional aspects and commercial specification. The aim of this work therefore is to analyze the chemical components of five fish species from Ero Reservoir. Specific objectives are: to determine the percentage components of protein, fat and carbohydrate in the fish species and also the minerals (Ca, K, and P) as well as energy levels

MATERIALS AND METHODS

STUDY AREA

The samples were collected from Ero Reservoir, situated in Ikun-Ekiti, Ekiti State, and Southwestern Nigeria. Geographically, it lies between longitude 5°31' of the Greenwich meridian and latitude 7°35' of the equator. The Reservoir is constructed on Ero River which takes its source from the highland region of Orin-Ekiti in Ido-Osi Local Government. The reservoir was impounded by the Ekiti State Government in 1985 at Ikun Ekiti in Moba Local Government Area of the State. The water surface is 450 hectares and the volume capacity is 20.9million cubic meter. The impoundment area is 4.5km. The major outflow river is River Ero. The vegetation of the area is evergreen consisting mainly of fresh tall trees and tall grasses which make it suitable for farming and the crops cultivated include cassava, yam, plantain, cocoyam, sweet potatoes and pepper. There are always heavy rain falls between July and September of each year.

Sample preparation

The fish specimens were purchased from local fishermen, once a month, for a period of 3months (July-September) at the landing site of the Ero Reservoir. They were immediately transported in good conditions to the Department of Zoology and Environmental Biology Laboratory Ekiti State University, Ado Ekiti. The fish were washed with tap water, identified using the fish identification key. Fish were then de-scaled, beheaded, gutted and they were later dried in a gas oven between the temperature of 70-80°C until the samples get constant weight. The samples were later grounded using the laboratory mortar and pestle and stored in dry envelope prior to analysis.

Methods of analysis for proximate composition

The dried fish samples were taken to the Central Science Laboratory at the Federal University of Technology Akure, Ondo state for proximate composition, mineral composition and energy level analysis using the procedures of

Association of Official analytical Chemists, AOAC Official Method (2006).

Statistical Analysis

Data recorded from the fish species studied were analyzed statistically using ANOVA to determine the variations in the parameters within the species.

RESULTS

Proximate Analysis

The results of the proximate composition Crude Protein, Moisture content, Fat content, Carbohydrate Content and Ash content studied for *C. gariepinus*, *L. niloticus*, *O. niloticus*, *S. galilaeus*, *H. niloticus* from the month of July to September are shown in Table 1, this table shows that all the fish species are rich in Protein, Fat, Moisture, Ash and Carbohydrate respectively.

Variation in moisture content between species was observed in fishes ranging from 11.32-13.54%, the highest moisture value was observed in *O. niloticus* (13.54%), followed by *S. galilaeus* (12.82 %), while the lowest moisture value was observed in *H. niloticus* (11.32%) followed by *L. niloticus* (11.85%) and there is no significant differences ($P < 0.05$) in the moisture content of the different species when tested statistically using ANOVA (Table 2). The ash value of these fish species ranged from 3.51-5.81%, highest ash value was observed in *S. galilaeus* (5.81%), followed by *C. gariepinus* (4.95%), while the lowest value was observed in *O. niloticus* (3.51%). Table 2 shows that the percentage ash value of *S. galilaeus* (5.81%) is significantly higher ($p > 0.05$) than the other species (4.45-3.51%). Protein percentage value of *H. niloticus* was the highest (81.59%) among all the species, followed by *L. niloticus* (74.06%), followed by *C. gariepinus* (73.26%), and the least value was in *S. galilaeus* (63.05%) (Table 1). The protein content of *H. niloticus* is significantly higher ($p > 0.05$) than the other species Table 2.

The carbohydrate value was found to be highest in *S. galilaeus* (12.52%) and the least value was recorded in *C. gariepinus* (1.80%) and this value was significantly higher ($p > 0.05$) than the other species (Table 2). There is variation in the fat value of the five species, the lowest percentage was observed in *O. niloticus* (6.24%), *S. galilaeus* (6.44%), while the highest percentage fat value was observed in *H. niloticus* (8.28%) and it was closely followed by other fish species. This shows a significant difference ($p < 0.05$) between *H. niloticus* and the other species. Also, the energy level obtained from the fishes varies as the highest energy level was recorded in *O. niloticus* (1553.07 Kcal/Kg), while the lowest was in *C. gariepinus* (1439.23Kcal/Kg). Figures 1 - 5 show

Table 1: Monthly Percentage Proximate Composition of Five Freshwater Fish Species From Ero Reservoir.

<i>Clarias gariepinus</i>						
MONTH	ASH %	M. C %	C.PROTEIN%	FAT %	CHO %	ENERGY Kcal/kg
JULY	-	-	-	-	-	-
AUGUST	3.82	10.82	77.70	6.31	1.35	1479.46
SEPTEMBER	6.08	14.30	68.82	8.60	2.20	1399.74
<i>Lates niloticus</i>						
MONTH	ASH %	M. C %	C.PROTEIN%	FAT %	CHO %	ENERGY Kcal/kg
JULY	5.89	10.90	71.51	8.83	2.87	1475.51
AUGUST	-	-	-	-	-	-
SEPTEMBER	3.01	12.80	76.60	6.69	0.90	1445.51
<i>Oreochromis niloticus</i>						
MONTH	ASH %	M. C %	C.PROTEIN%	FAT %	CHO %	ENERGY Kcal/kg
JULY	3.59	16.21	56.86	4.36	18.97	1762.27
AUGUST	3.47	13.49	76.33	6.24	0.45	1421.31
SEPTEMBER	3.47	10.91	76.55	8.11	0.96	1475.64
<i>Sarotherodon galilaeus</i>						
MONTH	ASH %	M. C %	C.PROTEIN%	FAT %	CHO %	ENERGY Kcal/kg
JULY	6.78	13.17	67.12	7.09	5.84	1483.43
AUGUST	3.58	12.47	58.97	5.78	19.20	1830.53
SEPTEMBER	-	-	-	-	-	-
<i>Heterotis niloticus</i>						
MONTH	ASH %	M. C %	C.PROTEIN%	FAT %	CHO %	ENERGY Kcal/kg
JULY	3.63	11.32	81.59	8.28	5.58	1598.35
AUGUST	-	-	-	-	-	-
SEPTEMBER	-	-	-	-	-	-

TABLE 2: Anova Table of Proximate Composition of Fish Species

SAMPLE	ASH %	M.C %	PROTEIN %	FAT %	CHO%	ENERGY Kcal/kg
<i>Clarias gariepinus</i>	4.95 ^{ab}	12.56 ^a	73.26 ^{ab}	7.46 ^{ab}	1.77 ^b	1439.23 ^b
<i>Lates niloticus</i>	4.45 ^{ab}	11.85 ^a	74.06 ^{ab}	7.76 ^{ab}	1.89 ^b	1460.49 ^b
<i>Oreochromis niloticus</i>	3.51 ^b	13.54 ^a	69.90 ^{bc}	6.24 ^b	6.80 ^{ab}	1553.08 ^{ab}
<i>Sarotherodon galilaeus</i>	5.81 ^a	12.82 ^a	63.05 ^c	6.44 ^b	12.52 ^a	1656.98 ^{ab}
<i>Heterotis niloticus</i>	3.63 ^{ab}	11.32 ^a	81.59 ^a	8.28 ^a	5.58 ^{ab}	1598.36 ^{ab}

Note: Column mean with the same letter are not significantly different (P>0.05)

M.C- Moisture content

CHO- Carbohydrate

Table 3: The Mineral Composition of the Fish Species from July -September.

<i>Clarias gariepinus</i>			
MONTH	Ca (Mg/g)	K (Mg/g)	P (Mg/g)
JULY	-	-	-
AUGUST	18.84	21.96	101.23
SEPTEMBER	20.47	22.97	103.42
<i>Lates niloticus</i>			
MONTH	Ca (Mg/g)	K (Mg/g)	P (Mg/g)
JULY	18.91	20.73	96.54
AUGUST	-	-	-
SEPTEMBER	17.37	16.37	89.66
<i>Oreochromis niloticus</i>			
MONTH	Ca (Mg/g)	K (Mg/g)	P (Mg/g)
JULY	16.59	16.23	93.24
AUGUST	18.22	20.77	90.39
SEPTEMBER	18.16	22.69	105.81
<i>Sarotherodon galilaeus</i>			
MONTH	Ca (Mg/g)	K (Mg/g)	P (Mg/g)
JULY	19.12	21.24	98.43
AUGUST	18.33	19.60	92.50
SEPTEMBER	-	-	-
<i>Heterotis niloticus</i>			
MONTH	Ca (Mg/g)	K (Mg/g)	P (Mg/g)
JULY	18.61	20.26	95.45
AUGUST	-	-	-
SEPTEMBER	-	-	-

Table 4: Anova Table of Mineral Concentration (Mg/G) of the Fish Species From Ero Reservoir.

SAMPLE	Ca(Mg/g)	K(Mg/g)	P(Mg/g)
<i>Clarias gariepinus</i>	19.65 ^a	22.47 ^a	102.33 ^a
<i>Lates niloticus</i>	18.14 ^{bc}	18.54 ^b	93.10 ^b
<i>Oreochromis niloticus</i>	17.66 ^c	19.90 ^{ab}	96.48 ^{ab}
<i>Sarotherodon galilaeus</i>	18.73 ^{ab}	20.42 ^{ab}	95.47 ^b
<i>Heterotis niloticus</i>	18.61 ^{bc}	20.26 ^{ab}	95.45 ^b

NOTE: Column mean with the same letter are not significantly different. (P>0.05)

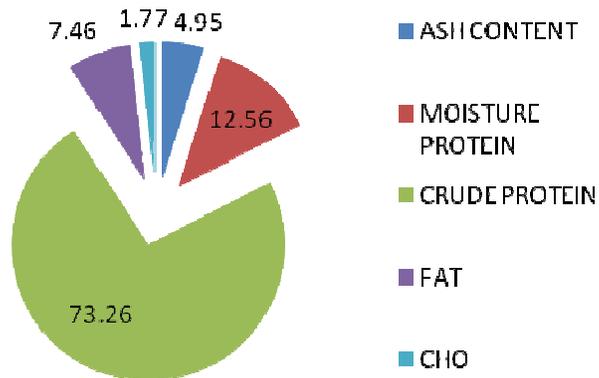


Figure 1: Comparative mean monthly proximate composition (% dry matter) of *Clarias gariepinus*

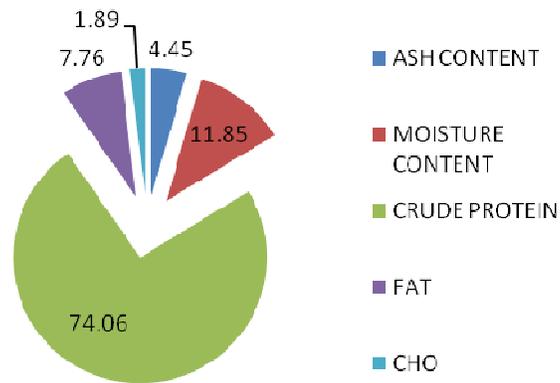


Figure 2: Comparative mean monthly proximate composition (% dry matter) of *Lates niloticus*

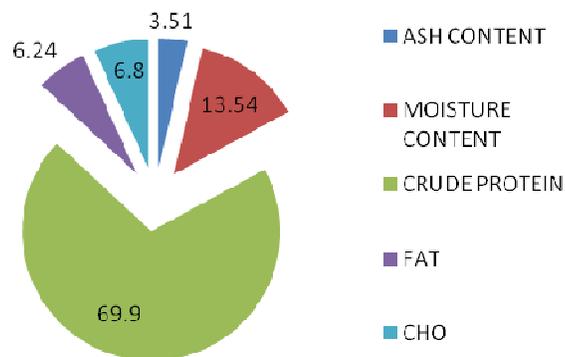


Figure 3: Comparative mean monthly proximate composition (% dry matter) of *Oreochromis niloticus*

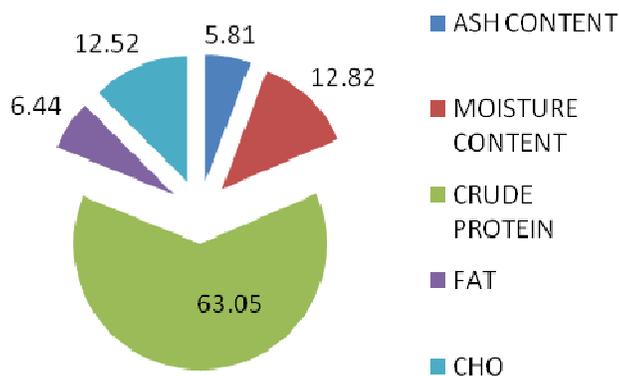


Figure 4: Comparative mean monthly proximate composition (% dry matter) of *Sarotherodon galilaeus*

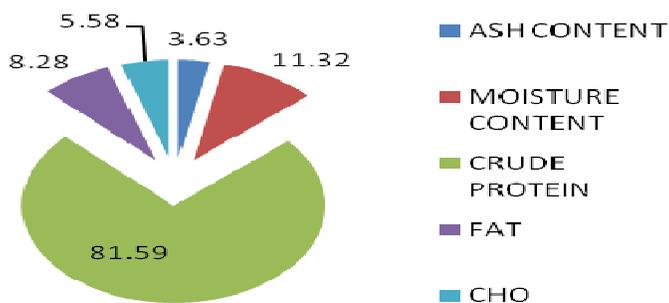


Figure 5: Comparative mean monthly proximate composition (% dry matter) of *Heterotis niloticus*

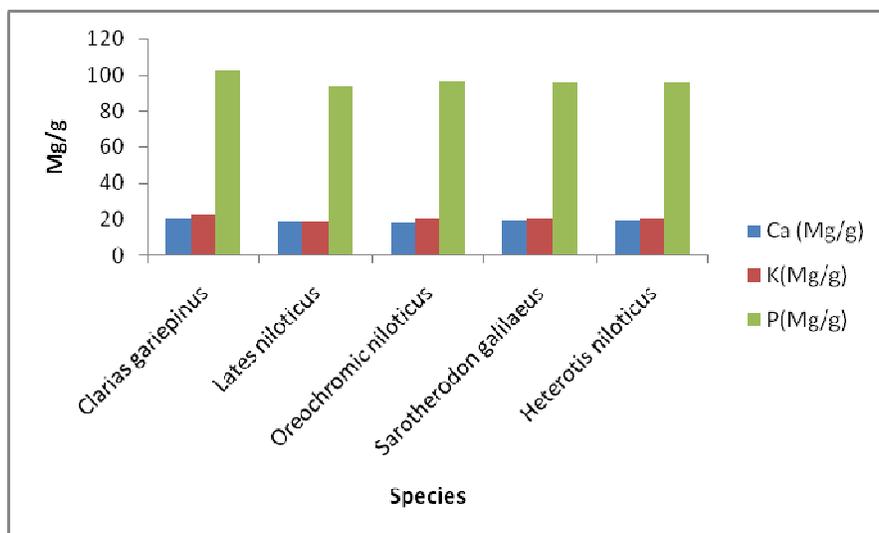


Figure 6: Comparative of Minerals Composition of The Fish Species

comparative mean of the monthly proximate composition of the fish species.

MINERALS

The Mineral composition of the five fish species (*Clarias gariepinus*, *Lates niloticus*, *Oreochromis niloticus*, *Sarotherodon galilaeus* and *Heterotis niloticus*) are shown in Table 3; the mineral concentrations of the fishes are expressed in Mg/g dry weight for greater accuracy.

The mean of the mineral concentration of the fish species are shown in table 4. The ranges of concentrations are as follows, Ca (17.66-19.65Mg/g), K (18.54-22.47Mg/g) and P (93.10-102.33Mg/g). Calcium was present in the amount ranging from 17.66Mg/g in *O. niloticus* to 19.65Mg/g in *C. gariepinus*. Among the three mineral element investigated the most abundant was phosphorus (102.33Mg/g), followed by potassium (22.47Mg/g) and calcium (19.65Mg/g). The table shows that the mineral composition (Ca, P, K) of *C.gariepinus*(19.65Mg/g, 22.47Mg/g, 102.33Mg/g) is significantly higher ($p>0.05$) than the other species. In the comparative analysis (Fig 6), phosphorus has the highest value of the three mineral examined.

DISCUSSION

The species investigated; *Clarias gariepinus*, *Lates niloticus*, *Oreochromis niloticus*, *Sarotherodon galilaeus*, *Heterotis niloticus*, are very common fish species present in Ero Reservoir. The proximate composition of these fish species shows encouragingly high crude protein values of 73.26%, 74.06%, 69.10%, 63.05%, and 81.59% respectively (Table 2). The relatively high percentage crude protein could be attributed to the fact that, fishes are good sources of pure protein (Burgess, 1975). Indeed the protein content of the species is higher than that of egg yolk (15%) reported by CFCD (2002). Amar-Abassi and Ogar (2012), reported that they are all under similar health conditions as the protein content only shows slight variation in all the species.

According to Ackman (1989), fish can be grouped into four categories according to their fat content: lean fish (< 20%), low fat (2-4%), medium fat (4-8%) and high fat (>8%). *Clarias gariepinus*, *Lates niloticus*, *Oreochromis niloticus*, *Sarotherodon galilaeus* could be classified as medium fat with fat value ranging from 6.24-7.76%, while *Heterotis niloticus* classified as medium fat with the fat value of 8.28%. Ash is a measure of the mineral content of food item, it is the organic residue that remains after the organic matter has been burnt off (Adewumi *et al.*, 2014). The observed range of ash content among the fish species (3.15-5.81%) indicates that the species are a good source of minerals such as calcium, potassium, phosphorus,

sodium, copper, manganese, iron etc. Another advantage of fish fat is the presence of omega-3-oil in it. This oil is a good source of vitamin A which is good for sustaining good eye-sight (Lali 1994).

S. galilaeus have the highest carbohydrate value of 12.52% and *C.gariepinus* have the lowest carbohydrate value (table 2), the results show that fish have lower value in carbohydrate than protein value, this shows that fish are very good source of protein than carbohydrate. The variations recorded in the concentration of the different nutritional components in the fish examined could have been as a result of the rate in which these compounds are available in the water (Yeannes and Almandous., 2003), and the ability of the fish to absorb and convert the essential nutrients from the diet or the water bodies where they live, this is supported by the findings of Window *et al.*, (1987) and Fawole *et al.*, (2007).

The minerals (Calcium, Phosphorus and Potassium) studied in this research are among the major mineral elements contributing to the proper functioning of the human body, hence they are considered important dietary elements, (Pye, 1986). The richness in phosphorus level in the five (5) species can also be attributed to the fact that phosphorus is a component of protein. Other elements (such as Calcium, Potassium) varied in concentration among the studied species. Variations in the concentration of minerals in fish flesh could be due to their concentration in the water bodies where they live, the fish physiological states (Ako and Salihu, 2004) and the ability of the fish to absorb the element from their diets and the water bodies. The minerals were present in the fish tissues in the following order (i.e. $P > K > Ca$). Most of these microelements are equally important in trace amounts as observed, but they tend to become harmful when their concentrations in the tissue, exceed the metabolic demands (Fawole, 2007).

Calcium is important for bone formation and fish is known to be good source of mineral, especially small fish (Kawarazuka and Bene 2011). In this study calcium ranged from 18.14-19.65Mg/g and recommended intake of calcium for adults is 19-881Mg/g (FAO/WHO, 2001); these results present that *Clarias gariepinus*, *Lates niloticus*, *Oreochromis niloticus*, *S.galilaeus* and *Heterotis niloticus* are good source of calcium, contributing daily Ca requirement. Based on this result, it can be assumed that regular consumption of these fishes will provide good bone formation and maintain skeletal integrity.

Phosphorus is a major constituent of bones together with calcium. This mineral showed significant concentration variability between species in this present work ranging from 93.10-102.33Mg/g. The P concentration in this work is within the FAO range of 67-550Mg/g and other freshwater fish obtained by Alas *et al.* (2014) was (232 – 426 Mg/g). The recommended dietary allowance for adults is 700Mg/g of P and this fishes can contribute some percentage of phosphorus to human body.

Potassium is important for muscle contractions, transmission of impulses in the nerves and sugar metabolism. The concentration of potassium ranged between 18.54 – 22.47Mg/g which is within the range of 19- 502Mg/g

CONCLUSION

Fish is a potential source of proteins, fat, moisture, ash and minerals. All the fish species examined in Ero Reservoir *Clarias gariepinus*, *Lates niloticus*, *Oreochromis niloticus*, *Sarotherodon galilaeus* and *Heterotis niloticus* are all rich sources of protein, moisture, lipid, ash and minerals. All the fish species examined belong to the high protein (63.05-81.59%) and medium fat (6.24-8.28) groups. The pattern of mineral concentrations in the sample of each species are in the order $P > K > Ca$. Variations in the concentration of each of the species could be due to their concentration in the water body, the fish physiological state and the ability of the fish to absorb the elements from their diets and the water bodies.

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