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Proximate, Minerals and Vitamin Composition of *Synodontis ocellifer* and *Malapterurus electricus* Freshwater Fish Species obtained from Ega Market in Idah Local Government Area of Kogi State, Nigeria

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ABSTRACT: The objective of this paper was to investigate the proximate, minerals and vitamin composition of *Synodontis ocellifer* and *Malapterurus electricus* freshwater fish species obtained from Ega Market in Idah Local Government Area of Kogi State, Nigeria using standard procedure. The highest protein content was recorded for *Synodotis ocellifer* at 24.76±0.000[a] and for *Malapteruru selectricus* at 20.625±0.019[b], highest moisture was recorded for *Malapterurus electricus* at 71.07±0.042[a] and for *Synodontis ocellifer* at 68.30±0.141[b].The highest ash content was recorded for *Synodontis ocellifer* at 3.075±0.035[a]and for*Malapterurus electricus* at 2.875±0.356[b].The highest crude fibre was recorded for *Malapterurus electricus* at 1.030±0.014[a], while the lowest crude fibre was recorded in *Synodontis ocellifer* 0.140±0.028[b].The highest Fat content was recorded *Synodontis ocellifer* at 3.110±0.014[a]and for*Malapterurus electricus* at 3.025±0.007[b]. The highest carbohydrate content was recorded for *Malapterurus electricus* at 1.38±0.084[a] and for *Synodontis ocellifer* at 0.705±0.134[b]. There is a significant difference between all the proximate compositions for *Synodontis ocellifer* and *Malapteruru selectricus* at p-value< 0.05.*Synodontisocellifer*, the highest mineral content was recorded for K at 942.10±0.14[a] followed by Ca at 317.950±0.214[a], while the lowest was observed in Fe at 2.35±0.70[b]. For *Malapterurus electricus*, the highest mineral content was recorded for K at 610.70±0.00[b] followed by Ca at 203.40±0.14[b], while the lowest was observed in Zn at 2.30±0.14[b].There was a significant difference between all the mineral compositions for *Synodontis ocellifer* and *Malapterurus electricus* except for P, at p-value< 0.05. The highest Vitamin C content was recorded for *Synodontis ocellifer* at 5.35±0.035[a], while the lowest Vitamin C content was recorded for *Malapterurus electricus* at 4.77±0.035[b]. The highest Vitamin A content was recorded for *Synodontis ocellifer* at 144.33±1.689[a], while lowest Vitamin A content was recorded at 130.02±0.000[b]. There is a significant difference between all the vitamin compositions for *Synodontis ocellifer* and *Malapterurus electricus* at p-value< 0.05.The nutrient profile of these fish species will provide information to dieticians, livestock farmers, marketing industries and other fisheries stakeholders. *Synodotis ocellifer* has the highest protein content and could be recommended as a possible effective way to solve protein malnutrition.

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Nutrition is the intake of food, considered in relation to the body's dietary needs (WHO, 2014). Nutrition and health are related to each other as good nutrition is the cornerstone of good health. Reduced immunity, higher susceptibility to disease, impaired physical and mental development, and decreased productivity can all be consequences of poor nutrition (Organization, 2018). Human nutrition is concerned with the supply of key nutrients in foods that are required for human survival and wellness. Fish in this context, is a healthy food and is a major player in human nutrition, ensuring about 20% of protein intake to a third of the world's population which is more evident in developing countries (Béné*et al*., 2007). Furthermore, fish is high in health-promoting oils such as omega-3 polyunsaturated fatty acids (PUFAs), eicosepantaenoic acid (EPA), and docosahexaenoic acid (DHA), and small indigenous fishes (SIFs) are micronutrient-dense, which could help eradicate micronutrient deficiency diseases that are common in developing countries (Mohanty *et al*., 2019). Fishes are known for their high nutritional value. They are one of the most important sources of animal protein and have been widely accepted as a healthy source of protein and other nutrients (Bolawa*et al*., 2011). Consumption of fish provides LLLessential nutrients to a large number of people worldwide and plays a key role in nutrition. Nutrients are the substances that nourish the body, promote growth, maintain and repair body parts (Srivastava *et al*., 2008). Nutrients can be divided into micro and macro nutrients that are vital for good health. Macronutrients such as proteins, lipids, ash and carbohydrates are present in the fishes (Lilly *et al*., 2017). Micronutrients such as vitamins (fat-soluble vitamins A, D, E and K and water-soluble vitamins B complex, vitamin C) and minerals (calcium, sodium, potassium, magnesium, iron, copper, selenium) are essential dietary elements that are essential in very small quantities i.e. they must be supplied from outside sources to the body (Mohanty 2015). Fish consumption on a regular basis can also help to prevent heart disease (Chrysohoou*et al*., 2007). In this context, fish is a major contributor owing to its richness in essential nutrients necessary to provide a balanced nutrition. Fish is a high-quality animal protein source with a higher satiety effect than other animal protein sources such as beef and chicken (Uhe*et al*., 1992, Mahanty*et al*., 2014). In comparison to the other dietary animal proteins sources, consumers have a vast choice for fish as far as affordability is concerned as there are many varieties of fish species available in tropical countries. Fish protein is easily digestible. Additionally, it is an important source of both essential and non-essential amino acid (Astawan 2004). Its amino acid content has a high quantity of cysteine than a large amount of other protein sources. Protein from fish contributes to the overall protein intake significantly as the digestibility of protein from fish is approximately 5–15% higher than that from plants .As proteins, deficiency of the essential fatty acids can lead to decreased growth of infants and children, higher susceptibility to infection as well as poor wound healing (Jeppesen *et al*., 1998). In addition to this, fat is an integral component of the human body that acts as a source of energy during excessive need of energy. Beneficial polyunsaturated fatty acids, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) have been reported to be present in adequate quantities in the tissues of fish (Njinkoué*et al*., 2002, Rasoarahona*et al*., 2005). These polyunsaturated fatty acids have been reported to have the ability to both prevent and also cure some diseases of man including cancers, heart diseases, rheumatoid arthritis and inflammation (Raatz*et al*., 2013). The lipid composition of fish is unique, having PUFA in the form of arachidonic acid (20:4n-6), EPA (20:5n-3) and DHA (22:6n-3), with many potential beneficial effects for adult health (Wang *et al*., 2006) and child development (Koletzko*et al*., 2007). Fish is also rich in micronutrients which tend to be more easily available than those from plant foods (Lilly *et al*., 2017). Hidden hunger, the chronic lack of minerals and vitamins, affects one in three people globally and keeping this in view, at the United Nation Millennium Summit (Summit 2000), micronutrient supplementations programs were incorporated as an essential component of Millennium Development Goals and their vision is through micronutrient initiatives to build a world free of hidden hunger. Hence, the objective of this paper was to investigate the proximate, minerals and vitamin composition of *Synodontis ocellifer* and *Malapterurus electricus* freshwater fish species obtained from Ega Market in Idah Local Government Area of Kogi State, Nigeria

MATERIALS AND METHOD

*Study Area***:** The study area was Idah Local Government Area of Kogi State, Nigeria. Idah is a town in Kogi State, Nigeria, on the eastern bank of the Niger River in the middle belt region of Nigeria. It is the headquarter of the Igala Kingdom, and also a Local Government Area with an area of 36 km^2. Idah had a population of 79,815 at the 2006 census. Idah is a town located on 7º.11' 0" N. Longitude: 6° 73' 0" E.

Collection of samples: Synodontis ocellifer and *Malapterurus electricus* fish samples for this study were obtained from Lower River Niger, Idah, Kogi State. Fish sample bought from local fisherman and weighed, two fish with similar body weights were selected for analyses and stored at a temperature of –18°C. Specimens of *Synodontis ocellifer* and

Malapterurus electricus sample was served as analytical material for determination of lipid and fatty acid profile. The fish were taken to the laboratory, remove the flesh (fellets) and dry. After dried, they were pounded with the laboratory mortal and pestel. Sample were divided into two units,

Biometric measurements: Fish samples were thawed in the open air in the laboratory and individual data for length, weight and sex taken and recorded. The standard length was measured using a measuring board. The weight was measured with a Satorious top loading electronic weighing balance.

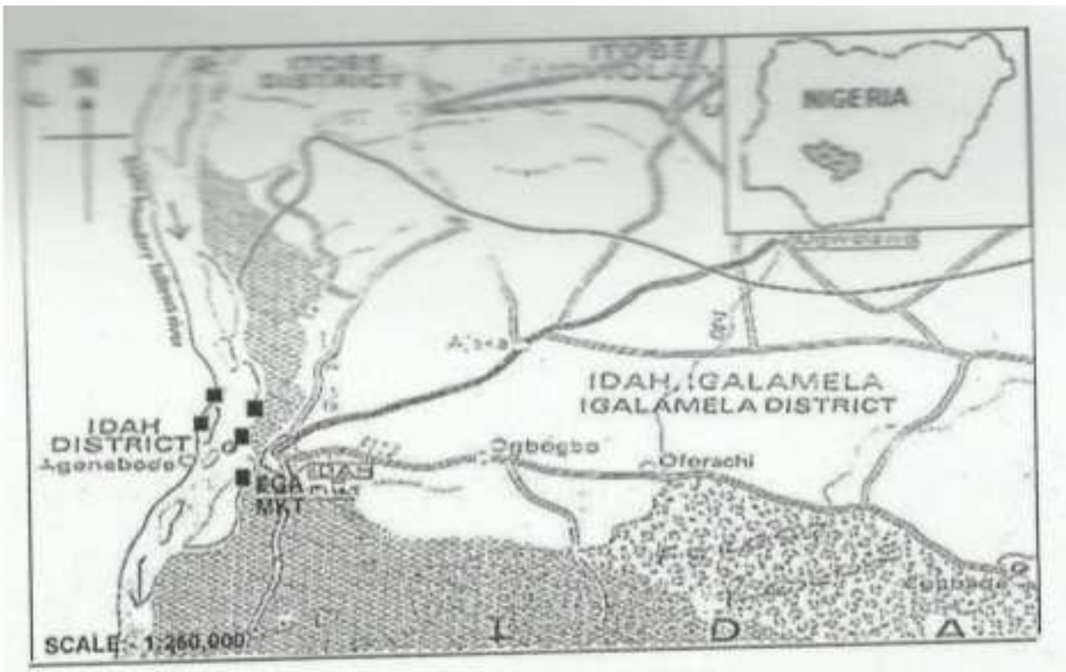

Fig1: Map of Kogi State showing study location (Idah)
Source: Source Google map

Sample preparation: Each fish will be dissected, gutted and the gonad removed to determine the sex by visual examination. The fish sample will then be cleaned, filleted and placed in a Warring blender and homogenized for 15min. Samples for the different chemical analyses was then taken from the homogenous material. Triplicate determinations were carried out on each sample.

Proximate Analysis: The proximate composition of the minced samples for their nutrient analysis wasperformed in biochemistry lab of Prince Abubakar Audu University, Kogi State. The analysis included proximate analysis i.e protein, fat, ash, moisture and carbohydrates. The proximate analysis was done by the methods: determination of moisture content (hot air oven method), crude protein micro-Kjeldahl), crude fat (ether extraction method) was done based on AOAC (2010) standard methods. All analyses were conducted in triplicates as the data obtained for the analysis were presented on a dry weight basis

Determination of Vitamin C: *Sample preparation:* Five grams of sample were homogenized with 25 mL of metaphosphoric acid - acetic acid solution, and it was quantitatively transferred into a 50 mL volumetric flask and shaken gently to homogenize solution. Then it was dilute up to the mark by the metaphosphoric acid - acetic acid solution. The obtained solution is filtered and centrifuged at 4000 rpm for 15 minutes, after what the supernatant solution is used for spectrophotometric determination (Perkin Elmer spectrophotometer Lambda 25) of vitamin C content in 21 samples of different fruits and vegetables.

Estimation of Vitamin C: Procedure: 0,23 mL of 3 % bromine water were added into 4 ml of centrifuged sample solution to oxidize the ascorbic acid to dehydroascorbic acid and after that 0,13 mL of 10 % thiourea to remove the excess of bromine. Then ml of 2, 4 - DNPH solution was added to form osazone. All standards, samples and blank solution were kept at 37°C temperature for 3 hours in a thermostatic bath. After it all were cooled in ice bath for 30 minutes and treated with 5mL chilled 85% H_2SO_4, with constant stirring. As a result, a colored solution's absorbance was taken at 521 nm.

Determination of Vitamin A: To express the vitamin A activity of carotenoids in diets on a common basis, a joint FAO/WHO Expert Group (FAO/WHO) in l967 introduced the concept of the Retinol Egavated (RE) and established the following relationships among food sources of vitamin A:

1 µg retinol = I RE method used. Variation in ecological growth conditions.

1 µg ß-carotene = 0.167 µg RE like variety and environmental aspects may also be

1 µg other pro vitamin A carotenoids = 0.084 µg RE contributing factors

These equivalences were derived from balance studies to account for the less efficient absorption of carotenoids (thought to be about one third that of retinol) and their bioconversion to vitamin A (one half for ß-carotene and one-fourth for other pro-vitamin carotenoids) it was recognized at that time that the recommended conversion factors (i.e 1:6 for vitamin A. ß-carotene and 1:12 for Vitamin A: all other pro-vitamin carotenoids) were only average estimates for a mixed diet.

Determination of Minerals: The method of Mbaeyi and Onweluzo (2010) was used in analyzing minerals. Mineral analysis of samples taken from the fermenting maize - pigeon pea ogi at 24-hr interval was determined in three phases: sample preparation, sample digestion, and atomic absorption spectrophotometer (AAS) analysis.

Sample preparation: Samples that were in grain form collected during the steeping period of fermentation were washed with distilled water and dried in the oven at 70°C for 3hr, afterward, they were blended to get grain powders. Samples in slurry form collected during the souring period of fermentation were weighed directly for the analysis. A solution of HNO3 and distilled water H_2O in the ratio of 3: 1 was used to digest the samples in order to free the mineral from their complex forms. Standard serial concentrations of pure forms of the minerals were prepared to standardize the AAS before reading the concentration of minerals. Serial dilutions used were 0.5mg, 1.0mg, 2.0mg, 4.0mg, and 8.0mg made from 100mg/100ml standard flask.

Sample digestion: Sample (0.67) was weighed into a glass beaker and 50 ml of HNO_3: H_20 was added to it. The solution was heated in a fume cupboard with Bunsen burner applying gentle heat. The HNO_3 fumes were allowed to escape gradually until no more fumes were seen. This indicated the end of the digestion. The digested samples were then filtered into a 50 ml standard flask and made up to volume with distilled water and ready for AAS analysis.

Atomic absorption spectrophotometer: analysis of digested samples A standard curve was obtained for each of the minerals using the serially diluted concentration standards using an appropriate lamp particular to a given mineral which was mounted on the AAS. After obtaining the standard curve at a particular wavelength, the digested sample in the container was sucked into the AAS for analysis. At that wavelength which a particular mineral absorbed highest, the molecules were excited and moved to higher energy level. On returning back to their ground state, the excess energy absorbed and given off was observed as the concentration of the minerals. The different minerals analyzed, their lamps and individual wavelengths were potassium (K lamp; 766nm), phosphorus (P lamp; 213nm), calcium (Ca lamp; 317nm), sodium (Na lamp; 589nm), magnesium (Mg lamp; 279nm), and iron (Fe lamp; 259nm).

Statistical Analysis: The data generated was subjected to statistical analysis (descriptive and one – independent sample t. Test) and Statistical Package for Social Sciences (SPSS) Version 20.0.

RESULTS AND DISCUSSIO

Table 1 is the proximate composition of *Synodontis ocellifer* and *Malapterurus electricus*gotten from Ega market. The highest Moisture content was recorded for *Malapterurus electricus*at 71.07±0.042[a], while the lowest moisture content was recorded for *Synodontis ocellifer*at 68.30±0.141[b]. The highest Ash content was recorded for *Synodonti socellifer* at 3.075±0.035[a], while the lowest Ash content was recorded for *Malapterurus electricus*at 2.875±0.356[b]. The highest Crude Fibre was recorded for *Malapteruruselectricus*at 1.030±0.014[a], while the lowest Crude Fibre was recorded in *Synodontisocellifer*0.140±0.028[b].

The highest Fat content was recorded *Synodontis ocellifer*at 3.110±0.014[a], while the lowest was recorded at *Malapterurus electricus*at 3.025±0.007[b]. The highest Protein content was recorded for *Synodontiso cellifer*at 24.76±0.000[a], while the lowest was recorded for *Malapterurus electricus*at 20.625±0.019[b]. The highest Carbohydrate content was recorded for *Malapterurus electricus*at 1.38±0.084[a], while the lowest was recorded for *Synodontis ocellifer*at 0.705±0.134[b].There is a significant difference between all the proximate compositions for *Synodontis ocellifer* and *Malapterurus electricus*at P-value< 0.05.

Table 1: Proximate Compositions of *Synodontis ocellifer* and *Malapterurus electricus* Gotten from Ega Market in Idah Local Government Area of Kogi State, Nigeria

	Proximate			Composition		
Sample	Moisture content	Ash content	Crude fibre	Fat content	Protein	Carbohydrate
Synodontis ocellifer	68.30±0.141[b]	3.075±0.035[a]	0.140±0.028[b]	3.110±0.014[a]	24.76±0.000[a]	0.705±0.134[b]
Malapterurus electricus	71.07±0.042[a]	2.875±0.356[b]	1.030±0.014a	3.025±0.007[b]	20.625±0.019[b]	1.38±0.084[a]
P. V	0.001	0.030	0.001	0.017	0.000	0.027

Values are means and standard deviations. Means in a column followed by different letters are significantly different (P<0.05).

Table 2: Mineral Compositions of *Synodontis ocellifer* and *Malapterurus electricus* Gotten from Ega Market in Idah Local Government Area of Kogi State, Nigeria.

			Mineral	Composition			
Sample	Na	K	Mg	Ca	Fe	P	Zn
Synodontis ocellifer	111.20±0.141[a]	942.10±0.14[a]	74.45±0.07[a]	317.950±0.214[a]	2.35±0.70[b]	6.80±0.14[a]	5.20±0.00[a]
Malapterurus electricus	73.50±0.00[b]	610.70±0.00[b]	51.80±0.004[b]	203.40±0.14[b]	4.50±0.00[a]	7.02±0.03[a]	2.30±0.14[b]
P. V	0.000	0.000	0.000	0.000	0.001	0.161	0.001

Values are means and standard deviations. Means in a column followed by different letters are significantly different (P<0.05).

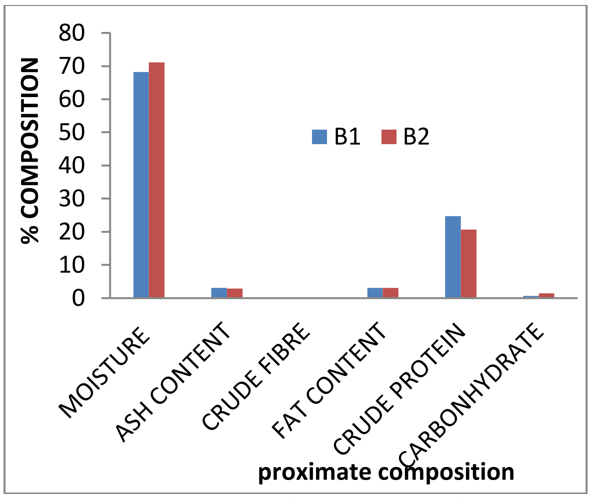

Fig 2: Proximate composition of *Synodontis ocellifer* and gotten from Ega market in Idah Local Government Area of Kogi State, Nigeria

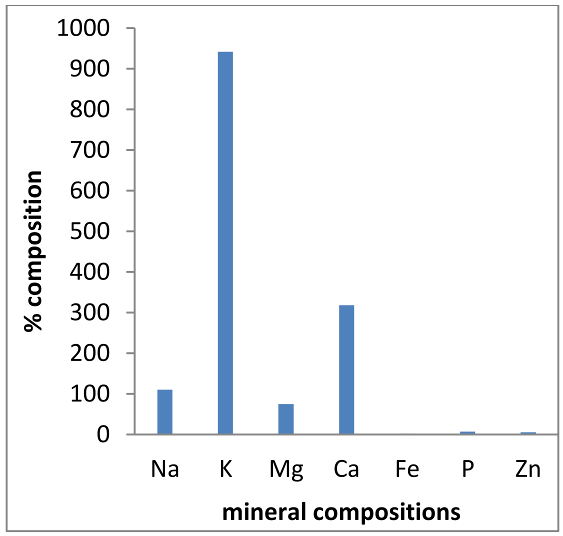

Fig 3: Mineral composition of *Synodontis ocellifer* gotten from Ega market in Idah Local Government Area of Kogi State, Nigeria.

Table 2 is the mineral composition of *Synodontiso cellifer* and *Malapterurus electricus*gotten from Ega market. For *Synodontisocellifer*, the highest mineral content was recorded for K at 942.10±0.14[a] followed by Ca at 317.950±0.214[a], while the lowest was observed in Fe at 2.35±0.70[b]. For *Malapterurus electricus*, the highest mineral content was recorded for K at 610.70±0.00[b] followed by Ca at 203.40±0.14[b], while the lowest was observed in Zn at 2.30±0.14[b]. There is a significant difference between all the mineral compositions for *Synodontis ocellifer* and *Malapterurus electricus* except for P, at P.value< 0.05. Table 3 is the Vitamin compositions of *Synodontis ocellifer* and *Malapterurus electricus* gotten from Ega market. The highest Vitamin C content was recorded for *Synodontis ocellifer*at 5.35±0.035[a], while the lowest Vitamin C content was recorded for *Malapterurus electricus*at 4.77±0.035[b].

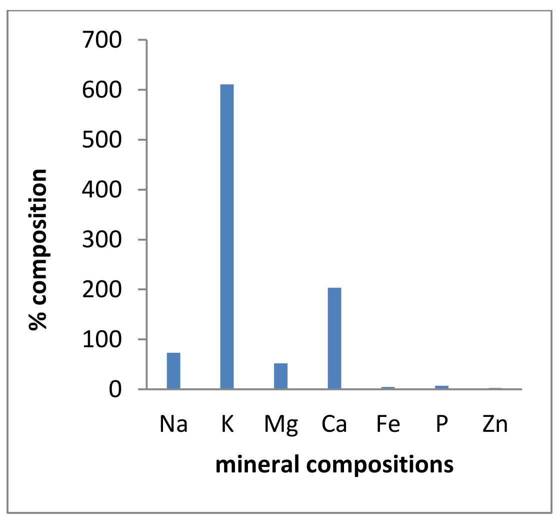

Fig 4: Mineral composition of *Malapterurus electricus* gotten from Ega market in Idah Local Government Area of Kogi State, Nigeria.

The highest Vitamin A content was recorded for *Synodontis ocellifer* at 144.33±1.689[a], while lowest Vitamin A content was recorded at 130.02±0.000[b]. There is a significant difference between all the vitamin compositions for *Synodonti socellifer* and *Malapterurus electricus*at p-value< 0.05.

Table 3: Vitamin Compositions of *Synodontis ocellifer* AND *Malapterurus electricus* Gotten from Ega Market in Idah Local Government Area of Kogi State, Nigeria.

	Vitamin	Composition
Sample	Vitamin C	Vitamin A
Synodontiso cellifer	5.35±0.035[a]	144.33±1.689[a]
Malapterurus electricus	4.77±0.035[b]	130.02±0.000[b]
P. V	0.004	0.007

Values are means and standard deviations. Means in a column followed by different letters are significantly different (P<0.05).

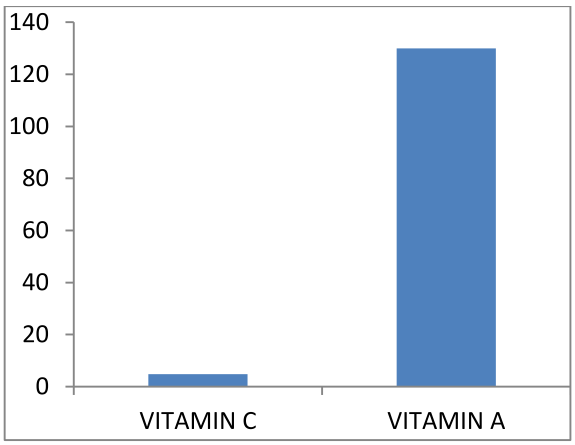

Fig 5: Vitamin composition of *Malapterurus electricus* gotten from Ega market in Idah Local Government Area of Kogi State, Nigeria

The moisture content of the sample fish species is an indication of the wetness caused by water, and could also be due to the stable water levels in the environmental location where the fish were collected from (Olagunju *et al*., 2012).The moisture content values obtained from this study shows that *Malapterurus electricus* had the highest content of 71.07±0.042[a]. However, moisture content is one of the limiting factor in deciding the storage life of culture fishery products (Nurullah *et al*., 2007), and it quantitative determination is absolutely essential in any quality control program for such products Alasalvar *et al*., (2002) reported that lipids from fish are well known as a rich source of some long-chain n-3 polyunsaturated fatty acids which cannot be synthesized by humans from their diets. Usually, moisture and lipid contents in fish are co-related inversely (Anthony *et al*., 2000), and the lipid content directly related to the nutritional quality of the fish. *Synodontis ocellifer* was recorded to have the highest lipid content of 3.110±0.014 the protein content recorded in this study was seen to be the highest in *Synodontis ocellifer* at 24.76±0.000[a]. Fishes are well known to be vital sources of good quality digestible protein, as they contain all the naturally-occurring amino acids (Louka *et al*., 2004). Wu *et al*., (2014) reported that proteins contribute to a wide variety of functions within each cell, ranging from being structural materials to performing mechanical functions in muscular tissues. However, the protein content in fish may vary with species due to factor in muscular tissues. However, the protein content in the fish may vary with species due to factors as differences in genotypes, seasons of the year, the effect of spawning, migration and food availability (Abdullahi, 2001). This study reported a considerably higher value at 3.075±0.035 in *Synodontis ocellifer* than in *malapterus electricus*. Waterman (2000) reported that the measurement of proximate profiles is often necessary to ensure that they meet the requirement of food regulations and commercial specification. Calcium and phosphorus are the main constituents of the bone skeletons and are important for regulating many vital cellular activities such as nerve and muscle function, hormonal actions, blood clotting and cellular mortality (Sakina *et al.*, 2013). Calcium is essential for healthy bones, teeth and blood, *Synodontis ocellifer* was recorded to have the highest result at 317.950±0.214.Sodium, potassium and magnesium value recorded *Synodontise ocellifer* to have the highest contents at 111.20±0.141, 942.10±0.07 and74.45±0.07 respectively.

Conclusion: Knowledge of the proximate compositions play paramount role in knowing the nutritive profile of the fish and also act as in dicators in accessing the nutritional status, physiological condition and quality of the fish, it also provide the most reliable information about the nutrient content of different fish species to those export who primary deal with fish and fishery related products. The consumption of *synodontise ocellifer* should be encouraged to people with low lipid profile, since this finding has shown that *Synodontis ocellifer* has more lipid contents compared to that of *Malapterus electricus*. This study also recommends the intakes of *Synodontis ocellifer* when low on calcium as to ensure healthy bones, teeth and blood

REFERENECS

Abdillahi, SA (2001) Investigation of nutritional status of *Chrysicchy snigrodigitatus*, *Baruus filamentous* and *Auchenoghatso occidentalis*, Family Bangdae. *J. Arid Zone Fish*: 39-50

Alasalvar, C; Taylor, KDA; Zubcov, E; Shahidi, F; Alexix, M. (2002). Differentiation of cultured and wild sea bass: total lipid content, fatty acid and trace minerals composition on food chemistry 79: 145-150.

Anthony, JA, Roby, D; Turco, KR. (2000). Lipid content and energy density of forage fishes from the Northern Gulf of Alaska. *J. Expert. Mar. Biol. Ecol.* 248(1): 53 –78.

Béné, C; Macfadyen, G; Allison, EH. (2007). Increasing the contribution of small-scale fisheries to poverty alleviation and food security. *Food & Agriculture Org*.

Chrysohoou, C; Panagiotakos, DB; Pitsavos, C; Skoumas, J; Krinos, X; Chloptsios, Y (2007). Long-term fish consumption is associated with protection against arrhythmia in healthy persons in a Mediterranean region-the ATTICA study. *Am. J. Clinic. Nutrit. 85*:1385-1391.

Koletzko, B; Cetin, I; Brenna, JT; Group, PLIW (2007). Dietary fat intakes for pregnant and lactating women. *British. J. Nutrition. 98*: 873-877.

Kumar, LR; Kasim, AK; Lekshmi, M; Nayak, BB; Kumar, S (2016). Incidence of methicillin-resistant staphylococci in fresh seafood. *Adv. Microbiol*. 6: 399.

Lilly, T; Immaculate, J; Jamila, P (2017) Macro and micro nutrients of selected marine fishes in Tuticorin, South East coast of India. *Inter. Food Res. J.*

Louka, L; Juhel, F; Allaf, K. (2004). Quality studies on various types of partially dried vegetables texturized by controlled sudden decompression: general patterns for the variation of the expansion ratio. *J. Food. Engineer.* 65(2):245 – 253.

Louka, L; Juhel, F; Allaf, K (2004) Quality studies on various types of partially dried vegetables texturized by controlled sudden compression: general patterns for the variation on the expansion ratio. *J. Food. Engineer. 65 (2): 245-253*

Mahanty, A; Ganguly, S; Verma, A; Sahoo, S; Mitra, P; Paria, P. (2014). Nutrientprofile of small indigenous fish *Puntius sophore*: proximate composition, amino acid, fatty acid and micronutrient profiles. *Nat. Acad. Sci. Let.* 37:39-44.

Mohanty, B. (2015).Nutritional value of food fish. *Conspectus of Inland Fisheries Management* 4:15-21.

Mohanty, BP; Mahanty, A; Ganguly, S; Mitra, T; Karunakaran, D; Anandan, R. (2019) Nutritional composition of food fishes and their importance in providing food and nutritional security. *Food Chem*. 293:561-570.

Njinkoué, JM; Barnathan, G; Miralles, J; Gaydou, EM; Samb, A. (2002) Lipids and fatty acids in muscle, liver and skin of three edible fish from the Senegalese coast: *Sardinella maderensis*, *Sardinella aurita*and *Cephalopholis taeniops*. *Comp. Biochem. Physiol*. Part B: *Biochem. Molecular Biol*. 131:395-402.

Nurullah, M; Kamal, M., Islam, MN, Ahasan CT; Shakunta, HT (2007). Shelf life of dired products from small indigenous fish species under various packing and storage conditions. *Banglades. J. Fisheries Res.* 11 (2): 229-236

Olagunju, A; Mohammed, A; Mada, S. B; Mohammed, A; Mohammed, HA; Mahamond, KT. (2012).Nutrient composition of *T. zilli*, *H. membranacea*, *Clupea harengus* and *Scromber scrombus* consumed in Zaria. *World. J. Life Sci. Med. Res.* 2:16-19.

Raatz, SK; Silverstein, JT; Jahns, L; Picklo, MJ (2013). Issues of fish consumption for cardiovascular disease risk reduction. *Nutrients* 5:1081-1097

Rasoarahona, JR; Barnathan, G., Bianchini, JP; Gaydou, EM (2005). Influence of season on the lipid content and fatty acid profiles of three tilapia species (*Oreochromis niloticus*, *O. macrochir* and *Tilapiare ndalli*) from Madagascar. *Food. Chem.* 91:683-694.

Sakina, YAE; Abd-Rahman, GOM; Elhassan, A; Mohammed, MA. (2013). Elemental analysis often Sudanese medicinal plants using X-ray fluorescence. *J. Appl. Indust.* Sci. 1 (1):49 –53.

Srivastava, RK; Yadav, KK; Trivedi, SP. (2008). Devicyprin induced gonadal impairment in a fresh water food fish, *Channapunctatus* (Bloch). *J. Environ. Biol. 2*9:187.

Wang, C; Harris, WS; Chung, M; Lichtenstein, AH; Balk, EM; Kupelnick, B (2006). n− 3 Fatty acids from fish or fish-oil supplements, but not αlinolenic acid, benefit cardiovascular disease outcomes in primary-and secondary-prevention studies: a systematic review. *Am. J. Clin. Nutri.* 84:5-17.

Waterman, JJ. (2000). *Composition and Quality of Fish*. Torry Research Station, Edinburgh. (pp. 143–179).

World Health Organization (2018). Thirteenth general program of work, 2019-2023

Wu, GY; Bazer, FW; Dai, ZL; Li; DF; Wang, JJ; Wu, ZL. (2014). Amino acid nutrition in animals: Protein synthesis and beyond. *Ann. Rev. Anim. Biosci.* 2:387–417.