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Nutritional Composition of Three Different Fishes (*Clarias gariepinus*, *Malapterurus electricus* and *Tilapia guineensis*)

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Abstract: Proximate and mineral compositions of three different fishes were carried out with standard methods. The fishes are catfish (*Clarias gariepinus*), electric fish (*Malapterurus electricus*) and tilapia fish (*Tilapia guineensis*). The results revealed the presence of moisture content ranging from 52.45 to 60.05%, protein 18.35 to 20.83%, lipids 6.53 to 13.86%, ash 3.14 to 4.57%, fibre 1.96 to 2.65% and carbohydrate 3.85 to 8.86%. Minerals included potassium (91.51-102.86 mg/kg), calcium (16.32-24.53 mg/kg), sodium (59.21-75.12 mg/kg) and magnesium (29.61-41.44 mg/kg) while iron and zinc were present in trace amounts. The data showed that the fishes are of high nutritional value and good source of proteins and minerals.

Key words: Proximate and mineral composition, *Clarias gariepinus*, *Malapterurus electricus* and *Tilapia guineensis*

INTRODUCTION

In developing countries, fish is one of the potential sources of animal protein and essential nutrients for the maintenance of a healthy body (Fawole *et al*., 2007). Compared to other sources of protein, fish are well known to be excellent sources of protein which can be seen from amino acid composition and protein digestibility (Louka *et al*., 2004). The number and variety of fishes that may be found in the stream or river is amazing. In the United States, the kind of fish you find will depend largely on what region you are from. Fish communities change from one area to another because of the following factors; water temperature, water velocity and clarity, alkalinity and available habitat. In recent years, fish has become favorite foodstuff for the majority of societies because of several health reasons (Ali and Kiumars, 2010). The principal components of fish are; water, protein, lipid and carbohydrate (Waterman, 1980), while the following minerals are commonly found in fish; sodium, potassium, calcium, magnesium, phosphorus, sulphur, iron, chlorine, silicon, manganese, zinc, copper, arsenic and iodine (Dana *et al*., 1985).

The knowledge of fish composition is essential for its maximum utilization. The nutritional composition of fish varies greatly from one species and individual to another, depending on age, feed intake, sex and sexual changes connected with spawning, the environment and season (Silva and Chamul, 2000). Processors have direct interest in the proximate composition of fish in order to know the nature of the raw material before chilling, freezing, smoking or canning can be correctly applied (FAO, 2004). Fish are known to be in close relationship with the aqueous environment, hence, the blood will reveal conditions within the body of the fish long before there is any visible manifestation of disease (Okechukwu *et al*., 2007). Haematological indices are therefore widely used by fish biologists and researchers the world over. Fernades and Mazon (2003) reported that fish blood is closely related to its response to changes in the environment where it lives, natural or artificial. The responses of fish to particular stressor vary according to their characteristics, however there are features of stress reaction common to the majority of most forms of environmental stressors which are known to alter their blood characteristics thereby leads to disruptions in metabolic activities (Ajani *et al*., 2007), reduced growth rate and impairment of reproductive process (Mgbeka *et al*., 2005) suppression of immune system (Auta, 2001) and in extreme cases results in mortality (Akinrotimi *et al*., 2009). Effects of acclimation on haematological parameter of fish have been studied in some *species* such as *Clarias gariepnus* (Ezerie *et al*., 2004; Gabriel *et al*., 2004). Spoilage is a metabolic process that causes food to be undesirable or unacceptable for human consumption due to changes in sensory and nutritional characteristics (Doyle, 2007). The processing and preservation of fresh fish were of utmost importance since fish is highly susceptible to deterioration immediately after harvest and also to prevent economic losses (Okonta and Ekelemu, 2005). If fish is not sold

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fresh, preservation methods should be applied to extend the shelf-life. These include freezing, smoking, drying and heat treatment (Sterilization, pasteurization, etc). Among the several methods of long term preservation of fish, smoking is perhaps the simplest method as it does not require sophisticated equipment or highly skilled workers. In an attempt to reduce the problems often encountered during smoking, Nigeria Stored Products Research Institute (NSPRI) fish smoking kiln was developed.

This study was designed to determine the proximate and mineral composition of catfish (*Clarias gariepinus*), electric fish (*Malapterurus electricus*) and tilapia fish (*Tilapia guineensis*) for food processors to know the nature of the fish before chilling, freezing, smoking or canning can be correctly applied.

MATERIALS AND METHODS

Reagents: All the chemicals and solvents used were of analytical reagent grade and used without further purification. Ethanol and Diethyl ether were purchased from BDH Chemicals, England, Concentrated Ammonium hydroxide, Hydrogen peroxide and Potassium dichromate were obtained from E. Merck, Germany, Concentrated sulphuric acid and hydrochloric acid were obtained from BDH Chemicals, England.

Source of samples: Fresh samples of catfish (*Clarias gariepinus*), electric fish (*Malapterurus electricus*) and tilapia fish (*Tilapia guineensis*) were obtained from Fish Market in Okada at Ovia North East Local Government Area Edo State, Nigeria. They were kept in cold iced box and transported to the laboratory. On arrival at the laboratory, the fresh fish were washed immediately and the bone and flesh were separated from the fish. Fish flesh were then washed until it was free from blood and placed in plastic bag, sealed and kept in freezer at -20°C before they were analyzed.

Chemical analysis of nutrients

Moisture content: The moisture content was determined according to the method of Association of Official Analytical Chemistry (AOAC) (1994). Porcelain crucibles were properly washed and allowed to dry in an air-oven at 110°C for 10 min to a constant weight. The crucibles were allowed to cooled in a desiccator for 30 min, then labeled and weighed (W_1). 2.0 g of each sample were accurately weighed into the crucibles and reweighed (W_2). The crucibles containing the samples were placed in an oven maintained at 105°C for 14 h. They were removed and transferred to desiccators to cooled, finally weighed (W_3). The percentage moisture content was determined.

Ash content: The AOAC (1994) method was used. Porcelain crucibles were washed and dried in an oven to a constant weight at 100°C for 10 min. They were allowed to cool in a desiccator and weighed (W_1). 2.0 g of each sample were weighed into the porcelain crucibles and reweighed (W_2). The crucibles containing the samples were transferred into a muffle furnace, which was set at 550°C for 8 h to ensure proper ashing. They were then removed and allowed to cool in the desiccators then finally weighed (W_3). The percentage ash content was determined.

Crude protein: Micro-Kjeldahl method as described by AOAC (1980) was used. Briefly, 0.5 g of each sample were weighed and placed on each nitrogen free filter paper, then folded and dropped into a Kjeldahl digestion tubes. 3.0 g of digesting mixed catalyst ($CuSO_4$ + Na_2SO_4) and 25 ml of Conc. Na_2SO_4 were added to each sample in the digestion tubes. The mixtures in the digestion tubes were transferred to the Kjeldahl digestion apparatus; the heater was regulated at a temperature below the boiling point of the acid until frothing ceased. The mixtures boil vigorously as temperature was increased, until clear (light) green color was obtained. The digests were allowed to cool and then transferred into separate 100 cm^3 volumetric flasks and diluted with distilled water to make up 100 cm^3. 10 ml aliquot of each digest was introduced into the distillation jacket of the micro-steam distillation apparatus that was connected to the main, as the water in the distiller flask boils. 20 ml of 40% NaOH was added to each digest in the distillation jacket. 50 ml of 40% boric acid was measured into separate conical flasks, four (4) drops of methyl red indicator was added to each. The conical flasks containing the mixture were placed onto the distillation apparatus with the outlet tubes inserted into each conical flask and NH_3 was collected through the condenser. The distillation continued until 25 ml of the distillate were trapped into the boric acid solution and colour changes from red to yellow. The distillates were then titrated with 0.02 M HCL and the titre values were recorded. Percentage nitrogen was first calculated and crude protein was determined by multiplying the percentage nitrogen with a factor of 6.25 for fish (Bernice and Merril, 1975).

Crude fibre: Crude fibre was analyzed following the procedure of AOAC (1994). 2.0 g of each sample were weighed into separate round bottom flasks. 100 ml of 0.25 M sulphuric acid solutions was added to each sample in the flask and the mixtures were boiled under reflux for 30 min. The hot solutions were quickly filtered under suction. The residues were thoroughly washed with hot water until acid free. Each residue was transferred into the round bottom flasks and 100 ml of hot 0.3 M sodium hydroxide solutions was added and the mixtures were boiled again under reflux for 30 min and filtered quickly under suction. Each insoluble residue was washed with hot water until it was base free. They were dried to a constant weight in an oven at

100°C for 2 hrs, cooled in desiccators and weighed (C_1). The weighed samples were then incinerated and reweighed (C_2). Percentage crude fibre content was determined.

Crude lipid: Crude lipid was determined by using the method described by Osborne and Voogt (1978). 2 g of each sample were place separate extraction thimbles and then covered with cotton wool. The extraction thimbles containing the samples were placed in the extraction jacket. Clean dried 500 ml round bottom flasks containing few anti-bumping granules were weighed (W_1) and 300 ml of petroleum either was poured into each flask fitted with sohxlet extraction units. The round bottom flasks and the condenser were connected to the sohxlet extractor and cold-water circulation was put on. The heating mantle was switched on; the heating rate was adjusted until the solvents were refluxing at a steady rate. Extraction was carried out for 6 hrs. The solvents were recovered and the oil was dried in the oven at 70°C for 1 hr. The round bottom flask and oil was cooled and then weighed (W_2). The lipid content was determined.

Total carbohydrate: The total carbohydrate content was determined by subtracting the sum of the percentage moisture, ash, crude lipid, crude protein and crude fiber from 100%, that is, Carbohydrate = 100 - (% moisture + % ash + % protein + % lipids + % fiber) (Eyeson and Ankrah, 1975).

Mineral analysis: The major elements, comprising calcium, magnesium, sodium, potassium and trace elements (iron and zinc) were determined according to the method of Shahidi *et al.* (1999). The ground samples were sieved with a 2 mm rubber sieve and 2 g of each of the samples were weighed and subjected to dry ashing in a well-cleaned porcelain crucible at 550°C in a muffle furnace. The resultant ash was dissolved in 5 ml of HNO_3/HCl/H_2O (1:2:3) and heated gently on a hot plate until brown fumes disappeared. To the remaining material in each crucible, 5 ml of deionized water was added and heated. The solution in each crucible was transferred into a 100 ml volumetric flask by filtration through a Whatman No 42 filter paper and the volume was made to the mark with deionized water. The solution was used for elemental analysis in an Alpha 4 Atomic Absorption Spectrophotometer (Chem Tech Analytical) attached to Alpha graphite atomizer A270 with a Gateway 2000 computer printer (Shahidi *et al.*, 1999).

Statistical analysis: Three analytical determinations were carried out on each independent replication for every parameter. Three independent replicates (n = 3) were obtained from each treatment and the results presented in tables and are reported as means ± standard deviation (SD). Data were analyzed by T-test ($p<0.05$).

Table 1: Proximate composition (%) of the fishes

	Composition of samples (%)		
Parameters	*Clarias gariepinus*	*Malapterurus electricus*	*Tilapia guineensis*
Moisture	52.45±0.12	54.97±0.16	60.05±0.13
Ash	4.05±0.05	4.57±0.04	3.14±0.06
Crude fibre	1.96±0.03	2.43±0.02	2.65±0.04
Protein	20.83±0.15	18.35±0.13	20.78±0.13
Lipid	13.86±0.02	10.82±0.04	6.53±0.06
Carbohydrate	3.85±0.02	8.86±0.01	6.85±0.02

Results are mean of triplicate determinations on a dry weight basis ± standard deviation

Table 2: Mineral composition of the fishes on mg/kg dry weight

Minerals	*Clarias gariepinus*	*Malapterurus electricus*	*Tilapia guineensis*
Macro elements			
Ca	24.53±0.10	16.32±0.12	17.63±0.10
Mg	29.61±0.09	33.33±0.07	41.44±0.05
Na	59.21±0.04	94.67±0.02	75.12±0.03
K	102.86±0.12	126.84±0.14	91.51±0.11
Micro elements			
Fe	85.67±0.01	103.24±0.04	67.75±0.02
Zn	38.24±0.02	54.81±0.02	34.21±0.03

Results are mean of triplicate determinations on a dry weight basis ± standard deviation

RESULTS

Table 1 summarizes the proximate composition of catfish (*Clarias gariepinus*), electric fish (*Malapterurus electricus*) and tilapia fish (*Tilapia guineensis*). The fishes had moisture content ranging from 52.45 to 60.05%. Their protein levels ranging from 18.35 to 20.83%, lipids 6.53 to 13.86%, ash 3.14 to 4.57%, fibre 1.96 to 2.65% and carbohydrate 3.85 to 8.86%.

The mineral contents of all the fish samples are shown in Table 2. Catfish (*Clarias gariepinus*) has the highest calcium (24.53 mg/kg) while electric fish (*Malapterurus electricus*) has the least calcium content (16.32 mg/kg). Magnesium ranges from 41.44 mg/kg in tilapia fish (*Tilapia guineensis*) to 29.61 mg/kg in Catfish (*Clarias gariepinus*). The highest amount of sodium was observed in electric fish (*Malapterurus electricus*) (94.67 mg/kg) while catfish (*Clarias gariepinus*) contains the least amount of sodium (59.21 mg/kg). Potassium also ranges from 126.84 mg/kg in electric fish (*Malapterurus electricus*) to 91.51 mg/kg in tilapia fish (*Tilapia guineensis*). The results showed that the most abundant macro element present in all the fish samples was Potassium. Iron was the most abundant micro element present ranging from 103.24 mg/kg in electric fish (*Malapterurus electricus*) to 67.75 mg/kg in tilapia fish (*Tilapia guineensis*). Zinc also ranges from 54.81 mg/kg in electric fish (*Malapterurus electricus*) to 34.21 mg/kg in tilapia fish (*Tilapia guineensis*).

DISCUSSION

Proteins, lipids and moisture contents were the major constituents, which had been considered in evaluating

the nutritional value of the fishes studied. The nutritional elements showed variable values in all the fishes analyzed; with crude protein recording the highest values and lipid recording the lowest. This makes the fishes important living resources of dietary protein as other sea and freshwater fish (Zuraini *et al*., 2006). High lipid fishes had less water and more protein than low-lipid fishes. This is in-line with the report of Steffens (2006), that protein forms the largest quantity of dry matter in fish.

All the fish samples examined contained appreciable concentrations of potassium, sodium, magnesium and calcium suggesting that these fishes could be used as good sources of minerals. Potassium was observed to dominate other minerals in all samples. The two heavy metals analyzed were present, but within tolerable limits. 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 components are available in the water body (Yeannes and Almandos, 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 Ricardo *et al*. (2002), Adewoye *et al*. (2003) and Fawole *et al*. (2007). Other elements (such as zinc and iron) varied in concentration among the three fishes studied. Most of these Micro elements are equally important in trace amounts as observed, but they tend to become harmful when their concentrations in the tissues exceed the metabolic demands (Ako and Salihu, 2004). Minerals are important for vital body functions such as acid, base and water balance. Calcium is good for growth and maintenance of bones, teeth and muscles (Turan *et al*., 2003). Normal extra cellular calcium concentrations are necessary for blood coagulation and for the integrity, intracellular cement substances (Okaka and Okaka, 2001). Sodium is an activator of transport ATP-ases in animals and possibly also in plants (Adeyeye, 2005). There is also direct relationship of sodium intake with hypertension on human (Dahl, 1972). Iron is an important constituent of heamoglobin (Onwordi *et al*., 2009). The presence of zinc in the fishes could mean that the fishes can play valuable roles in the management of diabetes, which result from insulin malfunction (Okaka and Okaka, 2001).

Conclusion: It can be suggested that taste, size, freshness and other related external appearances should not be the only factors to be considered in making choice for marketing and consumption of fishes. Likewise, since the interest in commercial culture of fish has increased to fill the gaps between supply and demand, therefore, this information is useful in developing nutrient-balanced, cost-effective diets and practical feeds for cultured fish. In addition, since the chemical composition of fish meat was found to vary with sex, seasons, size, age and geographical locality of catch, therefore, it is essential to be determined and evaluated for different fishes in relation to these factors. The chemical composition could influence the post-harvest processing and storage and could assist in determining the suitability of the different fishes to specific processing and storage techniques.

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