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Proximate and Macro Element Composition of Four Fish Species from Lower River Benue Makurdi Benue State Nigeria

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Abstract

A study was conducted on four fresh water fish species: *Protopterus annectens, Labeo coubie, Auchenoglanis occidentalis* and *Mormyrus rume* from lower river Benue, Makurdi to determine the proximate and macro elements composition of these fish species from lower river Benue Makurdi. A total of 600 fish samples were collected, 50 samples from each species for the period of three months. Fish samples were collected and transported to the University of Agriculture Makurdi, Department of Fisheries and Aquaculture laboratory for analysis. Proximate analysis showed significant differences ($P< 0.05$) among the fish samples. Crude protein in fish samples was in the range (61.65-58.52%) while fat was (8.14-8.34%). Ash content was in the range (6.17-4.15%). For Macro elements studied, Mercury was not discovered in *Protopterus annectens* and *Auchenoglanis occidentalis.* Lead value ranged from 0.09% to 0.03%. Results for other macro element under study were all within permissible limit given by the World health organization.

Keywords: Proximate composition, Macro Elements, *Protopterus annectens, Labeo coubie, Auchenoglanis occidentalis and Mormyrus rume*.

Introduction

Fish is one of the most important sources of animal protein available in the tropics and has been widely accepted as a good source of protein and other vital nutrients for the maintenance of a healthy body [13]. The less developed countries capture 50% of the world harvest and a large proportion of the catch are consumed internally (FAO, 1985). In many Asian countries over 50% of the animal protein intake comes from fish while in Africa, the proportion is 17.50% [77]. In Nigeria, fish constitute 40% of the animal protein intake [55]. They have significant role in nutrition, income, employment and foreign exchange earning of the country. Fresh fish is a central point in fish for food utilization. The knowledge of fish composition is essential for its maximal utilization [68]. Fish is safer and healthier to be consumed when compared with goat, mutton, buffalo meat and chicken meat. 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 [44].

Proximate body composition is the analysis of water, fat, protein and ash content of the fish [45]. Proximate composition is a good indicator of physiology which is needed for routine analysis of fisheries [26]. Lipid is regarded as one of the most important food reserves and has led to the use of fat indices as a measure of relationship between percentage of water and fat [66]. A number of investigators have attempted to relate changes in body composition to seasonal variables [27, 38]. The feeding frequency has an influence on body composition [26]. Body size or age has been shown to have a definite effect on body composition [8-10]. Several studies have shown significant changes in whole body composition or in the composition of specific organs or muscle tissues due to age, feeding frequency, migration, ration, sex, starvation and temperature [48, 76].

Heavy metals are serious pollutants in natural environment due to toxicity, persistence and bioaccumulation problems [72]. All heavy metals are potentially harmful to most organisms at some level of exposure and adsorption [80, 47]. High concentration of heavy metals can result in poor water quality and low productivity of aquatic ecosystems [33, 75]. The development in industrialization and technological advances in agriculture, has introduced various pollutants into the aquatic ecosystems, which serves as the ultimate sink for most metals. Waste water streams containing heavy metals are produced by many manufacturing processes and find their way into the environment [53]. Some research findings have shown that heavy metals in aquatic environment could accumulate in biota especially fish, the most common aquatic organisms at higher tropic level [57, 74]. Bio-accumulation in fish has been reported by many researchers [61, 81, 25, 51]. Other factors for bioaccumulation has been reported to depend upon the rate of uptake through gut from food and the rate of excretion species differences as well as feeding habitat and trophic status of the fish [36]. Most heavy metals have no beneficial functions to the body and can be highly toxic. If enter the body through inhalation, ingestion and skin can accumulate in the body tissue faster than the body's detoxification pathways

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and disposition [29]. High concentration exposure, overtime, can reach toxic concentration at low levels [63, 7]. Fish is a valuable and cheap food item and source of protein to man. Concern about heavy-metal contamination of fish has been motivated largely by adverse effects on humans, given that fish consumption primary route of heavy metal exposure [52].

Since there is no formal control of effluents discharged into the river Benue, it is important to monitor the levels of metals contaminants in the river Benue fish and assess the suitability for domestic uses. In order to effectively control and manage water pollution due to heavy metals, it is important to have a clear understanding of the distribution and profiles of heavy metals in the biota [65].

Therefore, the present work aimed to determine the proximate and Macro elements composition of four selected fish species *Protopterus annectens, Labeo senegalensis, Mormyrus reme and Auchenoglanis occidentalis* from lower river Benue Makurdiand evaluate the hazards and toxicity to fish and consumers in general.

Material and Methods

Sampling Site

The fish samples were collected from River Benue at Wadata Market, Makurdi the capital of Benue State, Nigeria, located at longitude 7o 43' N and latitude 8° 32' E. Benue River is the major tributary of the Niger River and it is approximately 1,400 km long and is almost entirely navigable during the summer months. As a result, it is an important transportation route in the regions through which it flows. It rises in the Adamawa Plateau of northern Cameroon, from where it flows west, and through the town of Garoua and Lagdo Reservoir, in to Nigeria south of the Mandara mountains, and through Jimeta, Ibi and Makurdi before meeting the Niger at Lokoja. The river's largest tributary is the Mayo Kebbi, which connects it with the Logone River (part of the Lake Chad system) during floods. Other tributaries are Taraba River and River Katsina Ala River Benue divides the town into the North- and South-bank and flows all year round though the water volume fluctuates with season. The river overflows its banks during the rainy season (May-October), but decreases drastically in volume leaving tiny island in the middle of the river during the dry season (November-April). The river contains several species of fresh water fishes of different families such as *Protopteridae, Claroteidae, Mormyridae and family Cyprinidae*.

Sample Collection

A good number of fish samples of *Protopterus annectens, Labeo coubie, Auchenoglanis occidentalisand Mormyrus rume* were obtained from lower river Benue Makurdi Benue state Nigeria. The fish samples were kept in cold iced box and transported to the Department of Fisheries and Aquaculture Laboratory University of Agriculture Makurdi Nigeria for Proximate analysis.

Proximate Composition

Proximate composition of fishes was determined using AOAC methods (1990). Moisture content was measured by weighing differences before and after oven drying at 100-105°C for 16h. Lipid determination was carried out using the modified Bligh and Dyer procedure (1959), the ash content of the fish was determined by igniting the sample at 550°C for 5-6 hours until the sample was completely free from carbon particles in a carbonite muffle furnace while the total nitrogen was determined by Kjedahl method as described by AOAC, (1994) and a factor of 6.25 was used for converting the total nitrogen to crude protein of the fish sample.

Determination of Macro Elements

The following macro elements (Nitrogen, Phosphorus, Potassium, Sodium, Calcium, Magnesium, Iron, Lead and Mercury) of the four fish samples were determined directly using Atomic Absorption Spectrophotometer (AAS) in the laboratory. This process involves the absorption by free atoms of an element of light at a wavelength specific to that element.

Instruments Used

1. Flame Photometer (FP 640) was used to determine Sodium (Na) and Potassium (K);

2. Spectrophotometer: (B & L Spectrome 70) was used to determine Phosphorus (P);

3. Atomic Absorption spectrophotometer (AAS; BULK SCIENTIIFC) VGP-210 [Mg, Ca, Fe, Pb, and Hg]

Statistical Analysis

All data were analyzed by one-way ANOVA analysis using SPSS 17.0 for windows. A value of $P<0.05$ was used to indicate significant differences.

Results and Discussion

Mean percentage for moisture protein, fat, ash and carbohydrate content of fishes are given in table 1. The four fishes had moisture content ranging from 3.99% to 5.26% (Table 1). Similar result was reported by [3]. The proximate composition of Auchenoglanis occidentalis showen couragingly high crude protein contents of 61.65% while it was least with Protopterus annectens 58.52% (Table 1). The relatively high to moderate percentage crude protein in Auchenoglanis occidentalis among others could be attributed to fish's consumption or absorption capability and conversion potentials of essential nutrients from their diet or their local environment into such biochemical attributes needed by the organisms body. Adewoye and Omotosho et, al. also attributed high protein content in fish to their local environment and biochemical attributes of the fish. Abdullahi SA also opened that the protein content in fish might vary with species due to certain factors such as the season of the year, effect of spawning and migration, food available etc [1].

All the species in this study had high moisture content in the range of (5.12%-5.26%) except for Auchenoglanis occidentalis that had moisture content of (3.99%). This could be as a result of water absorption capability and the source of heat used in the processing. High moisture contents have been similarly reported in other freshwater species by [1, 2, 30]. Differentiation in moisture and lipid content between dorsal and ventral portions

Table 1: Proximate Composition of Selected Fish Species from Lower River Benue

Proximate Component	Protopterus annectens	Auchenoglanis occidentalis	Labeo cubie	Mormyrus rume	*P-Value*
Moisture	5.26±0.17^{b}	3.99±0.47^{a}	5.12±0.41^{b}	5.23±0.14^{b}	0.07
Ash	4.88±0.13^{ab}	4.15±0.93^{a}	6.17±0.19^{b}	5.74±0.19^{ab}	0.07
Lipid	8.14±0.43^{bc}	6.62±0.12^{a}	7.32±0.17^{ab}	8.34±0.17^{c}	0.01
Fiber	7.77±0.33^{a}	6.85±0.58^{a}	6.75±0.22^{a}	7.53±0.18^{a}	0.2
Protein	58.52±0.64^{a}	61.65±0.52^{b}	60.00±0.30^{ab}	59.45±0.49^{a}	0.01
NFE	15.47±1.08^{ab}	16.74±0.64^{b}	14.65±0.43^{ab}	13.72±0.44^{a}	0.08

*Mean in the same row with different superscripts differ significantly (P<0.05)

of three farmed fish species has also been reported by [69]. The ash content of *Protopterus annectens, Labeo coubie, and Mormyrus rume* were generally low (4.88% - 6.17%) and it was significantly (*P<0.05*) lower with *Auchenoglanis occidentalis* (4.15%). The crude fat also ranged from (7.32% - 8.34%) and was least with *Auchenoglanis occidentalis* (6.62%). Abdullahi reported higher values (30.0–31.3/100g) from Chrysichthys nigrodigitatus, Bagrus filamentosus and Auchenoglanis occidenntialis.

There was no significant differences (*P<0.05*) in the crude fiber for all the fish species under this study. Negligible amounts of these nutrients have been reported by other authors [54, 30].

Macro Element Composition

Results of macro elements composition from this study revealed significant differences (*P<0.05*) in the distribution of Macro elements among the four the studied species of fish. There observed variation in the mineral contents of the four species studied. The Nitrogen, Phosphorus, Potassium, Sodium, Calcium, Magnesium, Iron, Lead and Mercury contents varied among these species. This observation agrees with the reported work of Oladimeji and Sadiku who studied the mineral constituents of three freshwater fish species Table 2 [56].

The Calcium, Phosphorus and Magnesium values in this study were higher than other macro elements analyzed for the four species. This observation agrees with the similar work of S.G Solomon and Akogu C.C. (2005). Who reported high level of Calcium and Phosphorus in Protopterus *annectens, Labeo senegalensis and Auchenoglanis occidentalis*. Accumulation of different macro elements depends on many factors such as the physiological needs, feeding habits and genetic composition, sex of each fish species and the biochemical significant role of each metal [40]. The high levels of these two elements (P and Mg) in these fish species studied may be attributed to the rate in which they are available in the water body and the ability of the fish to absorb these organic elements from their diet and the environment where they live [3].

Eyo (2001) opened that, mineral content of fish makes it unavoidable in the diet since mineral contribute great good health. Pb was the most common toxic Macro element in the samples analyzed followed by Hg. The level of Pb and Hg was significantly (*P<0.05*) different among the four species. *Protopterus annectens* was observed to contain the highest level of Lead (0.09mg/kg) compared to the other species. The main reason could be the feeding habit and habitat of *P. annectens*. This result disagreed with the findings of Elagba and Mohamed that

Table 2: Macro Element Compositions of Selected Fish Species from Lower River Benue

Macro elements	Protopterus annectens	Auchenoglanis occidentalis	Labeo cubie	Mormyrus rume	WHO Permissible Limit	*P-Value*
Nitrogen (N)	0.41±0.01^{c}	0.00±0.00^{a}	0.33±0.03^{b}	0.36±0.01^{bc}	1.00±0.00^{d}	0
Phosphorus (P)	4.88±0.30^{b}	6.05±0.37^{c}	4.34±0.26^{b}	4.03±0.40^{b}	0.10±0.00^{a}	0
Potassium (K)	0.29±0.02^{ab}	0.34±0.02^{b}	0.27±0.02^{a}	0.23±0.01^{a}	2.00±0.00^{c}	0
Sodium (Na)	0.26±0.01^{bc}	0.27±0.02^{c}	0.22±0.01^{ab}	0.21±0.01^{a}	10.00±0.00^{d}	0
Calcium Ca)	4.64±0.28^{a}	4.79±0.29^{a}	4.84±0.18^{a}	4.74±0.20^{a}	10.00±0.00^{b}	0
Magnesium (Mg)	3.89±0.24^{a}	4.29±0.25^{a}	3.64±0.22^{a}	3.61±0.22^{a}	10.00±0.00^{b}	0
Iron (Fe)	0.36±0.02^{bc}	0.41±0.03^{c}	0.31±0.02^{ab}	0.27±0.02^{a}	1.00±0.00^{d}	0
Lead (Pb)	0.09±0.01^{c}	0.06±0.00^{b}	0.12±0.00^{d}	0.03±0.00^{a}	0.20±0.00^{e}	0
Mercury (Hg)	0.00±0.00^{a}	0.00±0.00^{a}	0.01±0.00^{b}	0.02±0.00^{c}	0.01±0.00^{b}	0.01

*Mean in the same row with different superscripts differ significantly (P<0.05)

Protopterus annectens contain least level of most of heavy metals in both tissues and head compared to the other species because it normally lives on flood plains, and when these dry up it secretes a thin slime around itself which dries into a cocoon [31]. So the fish is not continuously exposed to pollutants like other species. Results also reveals the levels of *Mercury in Mormyrus rume* to be significantly high (*P<0.05*) compare to other fish species. This observed increase in *Mormyrus rume*, (0.02 Mg/kg) could be as result of its feeding habitat and its mode of feeding. *Mormyrus rume* has an inferior mouth (downturn mouth) which enables it to feed on the debris or the organic matters deposited into the river and accumulate at the bottom of the river. This observation is in agreement with the work of Amoo *et, al.* who reported high increase of Hg. in Mormyrus rume due to pollution from sewage effluents [12]. Generally, heavy metal concentrations in the muscles of freshwater fish vary considerably among different studies possibly due to differences in metal concentrations and chemical characteristics of water from which fish were sampled, ecological needs, metabolism and feeding patterns of fish, and also the season in which studies were carried out [61, 80, 6, 51, 59, 50]. The variation in Macro element concentrations could also be due to the presence of major sources of metal pollution, intensive human activity and discharge of municipal domestic waste and effluents.

Fish are often at the top of the aquatic food chain and have the tendency to concentrate large amount of some heavy metals from the water [46]. Bioaccumulation of heavy metals is toxic to fish [24, 19]. Pb and Hg are considered as potential toxic elements. Metal stresses were reported to cause reproduction failure and losses in fish populations [5, 64]. The gills serve as respiratory organs through which ions are absorbed [42]. Fish can absorb metals from both the surrounding water and from their contaminated food and bioaccumulate them in their tissue. Some metals are essential, but at high concentrations, they can be toxic to fish, cause mortality, growth retardation, and reproductive impairment [5, 64]. Even If the minerals contents is lower than threshold values indicated by WHO (1996), contamination of aquatic ecosystems should be expected through bioaccumulation.

Conclusion

The result obtained in this study has provided scientific information and detailed knowledge of the proximate composition of these four important selected fish species. The results showed that the fish species had high quality protein, essential amino acids and fatty acids. Overall, *Auchenoglanis occidenntialis* appears to be best as diet for humans due to its relatively high protein and nutrient components. Therefore consumption of it is good for people's health.

The concentrations of macro elements in the body of fish depend in most cases on the biological factors, such as the species. In the case of iron depends also on the feeding type because predatory fish contain less iron than non-predatory fish.

The present studies has added information that the fishes are a good sources of macro elements that may contribute to health, growth and development of human beings and a safe food from environment concern due to negligible level of toxic elements. Although, the results obtained from the concentration of the Macro elements in selected fish species from the study area were below the permissible limit of World Health Organization (WHO), it does not mean the fish are free from the danger posed on consumers due to their bio accumulative nature in human and aquatic environment.

However, results will be important for the nutritionists and researchers for improving processing. It is also helpful for similar academic studies and to prepare tables of compositions of food.

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