Nutritional status of the muscle meat of male and female African freshwater catfish *Heterobranchus bidosarlis* (Pisces: Clariidae) (Geoffrey Saint-Hilaire, 1809) from the Lower Cross River System, Nigeria.

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Abstract: Nutritional status of adult male and female African freshwater catfish *Heterobranchus bidosalis* (45.52-50.20±0.1cm total length and 664.58-670.64±0.1g wet weight) was investigated on individuals bought from the artisanal fishermen at Itu, one of the major landing ports of the artisanal fisheries of the lower Cross River System, AkwaI bom State, Nigeria. The analysis was carried out using the internationally accepted methods of AOAC. The results of the analysis revealed that the proximate compositions and mineral contents of the catfish were sex-related. Moisture contents was 88.52% in the males and 78.78% in the females; carbohydrate (males; 3.34%, females; 3.98%), protein (males: 24.60%, females; 26.62%), fibre (males: 0.53%, females; 0.48%), ash (males: 6.03%, females; 8.96%) and lipid (males: 6.04%, females: 8.94%). For the minerals, calcium was 125.68mg/100g in the males, 130.63mg/100g in the females, Magnesium (males: 8.42mg/100g, females: 8.74mg/100g), Potassium (males: 4.33mg/100g, females: 5.98mg/100g), Iron (males: 94.47mg/100g, females: 105.23mg/100g), Zinc (males: 0.56mg/100g, females: 0.78mg/100g), Phosphorus (males: 7.67mg/100g, females: 8.43mg/100g). Copper was not detected in both sexes of the catfish. The implications of the results of the present study are discussed in relation to human nutrition and health.

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1. Introduction

Recent decade has witnessed global consumption of fish and derived fish products. There has also been an increase in demand for fish as a result of the geometrical growth in population, higher standards of living and the understanding of the nutritional values of fish. Wim *et al* (2007) maintain that change in consumer trend could be based on a number of distinct factors, foremost among these is the growing knowledge that fish constitutes an important and essential part of human diet, owing mainly to the presence of ω-3 polyunsaturated fatty acids (PUFA), which play an essential role in human health (Ackman (1998), Hossain (1996), Sidhu (2003), Ruxton *et al* (2004), Job and Ekanem (2010) and Ayeloja *et al (2013)* and Job *et al* (2015).

The presence of essential vitamins in fish and shellfish species and their derivatives has also endeared their consumption. Fish and shellfishes as a whole, is also of high potential for the provision of relief from malnutrition, especially in developing countries of the world (Ashraf *et al*. (2011) Ayeloja *et al*. (2013), while also providing income for the populace (FAO (2005,2009) Job & Ekanem (2010) and Job *et al* (2015). The nutritional contents of fish have been reported to relate to the fish sex. These include studies by Amer *et al* (2005), Islam and Joadder (2005), Nargis (2006), Bhaven *et al* (2010), Cornelia (2012) and Alemu *et al* (2013). None of these studies however reported on the nutritional status of male and female *Heterobranchus bidorsalis*. This catfish is abundantly distributed in the lower Cross River system, lower and upper Niger and Benue Rivers in Nigeria and Lake Chad (Teugels *et al*. (1992) and Olaosebikan & Raji (2010).

The present study is therefore aimed at investigating the nutritional status of adult male and female individuals of the catfish from the lower Cross River system, AkwaI bom State, Nigeria.

2. Materials and Methods

Fifteen freshly caught adult males and females *Heterobranchus bidosalis* of between 45.50-50.20±0.1cm total length and 664.58-670.64±0.1g wet weight were bought from fish sellers at Itu, AkwaI bom State, one of the major landing ports of the artisanal fisheries of the lower Cross River system, Nigeria. The study area is described in Etim & Brey (1994).

Proximate compositions were determined by conventional methods of AOAC (2006). All proximate

composition were analysed in duplicates and reported as mean on % dry weight basis.

At first, the initial weight (g) of the samples was taken. Then samples were dried in an oven at about 105°C for about 8 to 10 hours until a constant weight was obtained and cooled in desiccators and weighed again. The percentage of moisture content was calculated following equation:

$$\text{Percentage (\%) of moisture} = \frac{\text{weight loss}}{\text{original weight of sample}} \times 100$$

For the estimation of fat content, the dried samples left after moisture determination were finely ground into powder form and the fat was extracted with a non-polar solvent, ethyl ether. After extraction, the solvent was evaporated and the extracted materials were weighed. The percentage of fat content was calculated as:

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

The protein content of the fish was determined by micro-kjeldahl method. It involved conversion of organic nitrogen to ammonium sulphate by digestion with concentrated tetraoxasulphate (vi) acid in a micro-kjeldahl flask. The digest was diluted, made alkaline with sodium hydroxide and distilled. The liberated ammonia was collected in a boric acid solution and was determined titrametrically. The percentage of protein in the sample was calculated by the following equation:

$$\text{Percentage (\%) of protein} = \frac{(c-b)\times 4\times d\times 6.25}{a\times 1000} \times 100$$

where: a = sample weight (g)

b = volume of NaOH required for back titration and neutralise 25ml of $0.1NH_2SO_4$ for sample

c = volume of NaOH required for back titration and neutralise 25ml of $0.1NH_2SO_4$ (for blank)

d = normality of NaOH used for titration

6.25 = conversion factor of N to protein

14 = atomic weight of N

The ash content of a sample is the residue left after ashing in a muffle furnace at about 550-660°C till the residue becomes white. The percent of ash was calculated as follows:

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

Crude fibre was also analysed following the procedure of AOAC (2006). About 2.09g of each sample was weighed into separate round bottom flasks and 100ml of 0.25M tetraoxosulphate (vi) acid solution was added to each sample in the flask. The mixtures were boiled under reflux for 30 minutes. 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 100ml of hot 0.3M of sodium hydroxide solution was added and the mixtures were boiled again under reflux for 30 minutes and filtered quickly under suction. Each insoluble residue was washed with hot water until it was base-free. These were dried to a constant weight in an oven at 100°C for 2 hours, cooled in desiccators and weighed (C_1). The weighed samples were then incinerated and reweighed (C_2). Percentage crude fibre content was determined by subtracting the initial weight C_1 from the final weight C_2 and multiplied 100.

The total carbohydrate content was determined by subtracting the sum of the percentage moisture, ash, crude lipid, crude protein and crude fibre from 100%, that is, % carbohydrate = 100 – (% moisture + % ash+ %protein + %lipids + % fibre).

The following elements: Calcium, Magnesium, Sodium, Potassium, Iron and Zinc were determined by the methods recommended by AOAC (2006). The ground samples were subjected to dry-ashing in a well-cleaned porcelain crucible at 550°C in a muffle furnace. The resultant ash was dissolved in 5ml of HNO_3/HCI/H_2O (1:2:3) and heated gently on a hot plate until the brown fumes disappeared. To the remaining material in each crucible, 5ml of deionised water was added and heated. The solution in each crucible was transferred into a 100ml volumetric flask by filtration through a Whatman No. 42 filter paper and the volume was made to the mark with deionised water. The solution was used for elemental analysis in an Atomic Absorption Spectrophotometer at appropriate wave lengths.

Data obtained were subjected to analysis of variance (ANOVA) at 0.05 level of significance according to (Sohal & Rohif (1968) and Ogbeibu (2005) to establish the difference in the proximate and mineral composition of the male and female individuals of the catfish. The proximate composition and mineral content values were also compared with international permissible limits of FAO (2010) and USDA (2010).

Table 1: Proximate composition of male and female *Heterobranchusbidorsalis* from the lower Cross River system, Nigeria.

proximate composition (%)	Males	Females	FAO (2010) & USDA (2010) limits (%)
Moisture	88.52	78.78	78-90
Carbohydrate	0.34	0.98	2-5
Protein	24.40	26.62	15-28
Fibre	0.53	0.48	*
Ash	6.03	8.96	*
Lipid	6.04	8.94	15-18

Key * Not stated

Table 2: Mineral contents of the males and females *Heterobranchusbidorsalis* from the lower Cross River system, Nigeria.

Mean mineral contents (mg/100g (Dm)	Males	Females	FAO (2010) & USDA (2010) limits (mg/100g) Dm
Calcium, Ca	125.68	130.63	19-881
Magnesium, Mg	8.42	8.74	4.5-452
Sodium, Na	81.64	94.49	30-134
Potassium, K	4.33	5.98	19-502
Iron, Fe	94.47	105.23	1-56
Zinc, Zn	0.56	0.78	0.23-2.1
Phosphorus, P	7.67	8.43	68-550
Copper, Cu	0.00	0.00	0.001-3.7

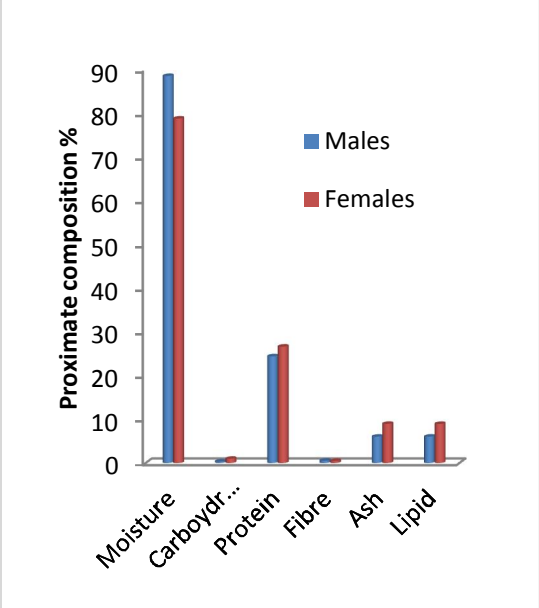

Fig. 1: Percentage distribution of mean proximate composition in the males and females *Heterobranchusbidorsalis* from the lower Cross River system, Nigeria.

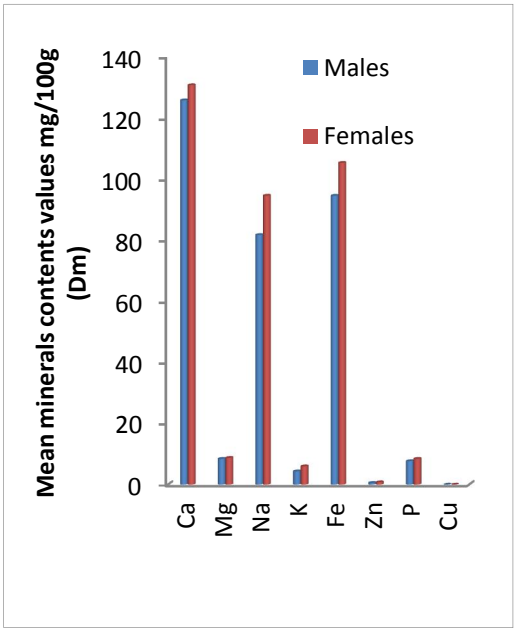

Fig. 2: Mineral content (mg/100g) Dm distribution in the male and female *Heterobranchusbidorsalis* from the lower Cross River system, Nigeria.

3. Results

The results of the percentage proximate compositions and mineral contents in the muscle of adult male and female *Heterobranchusbidorsalis* revealed that they were sex-related. These are presented in Tables 1 and 2 and illustrated in Figures 1 and 2. Moisture content of 88.52% were detected in the male individuals and 78.78% in the females with carbohydrate content of 0.34% in males and 0.98% in females. Protein was 24.40% in males and 26.62% in females, fibre (0.53 in males and 0.48% in females), ash (6.03% in males and 8.96% in females). Total value of 6.04% ash was detected in males with of 8.94% in females. There was a significant difference ($P<0.05$) in the moisture content of males and females (males > females) with similar significant difference

(P<0.05) in the protein, ash and lipid content in females being higher than in males (females > males). There was however, no significant difference (P>0.05) in the carbohydrate and fibre content in both sexes.

As shown in Figure 2, the male individuals had more moisture than the females, (males > females) while more protein, ash and lipid were detected in the females than the males (females > males).

The mineral contents in the female *H. bidorsalis* generally showed significant difference (P<0.05) over those of the males. The females had 130.63mg/100g of Calcium with 125.68mg/100g in the males, while 8.74mg/100g of Magnesium were detected with in females 8.42mg/100g in males; 94.49mg/100g of Sodium in females and 81.64mg/100g in males. Others were Potassium (5.98mg/100g in females, 4.33mg/100g in males) and Phosphorus (8.43mg/100g in females, 7.67mg/100g in males). There was however no significant difference (P>0.05) in Zinc content in both sexes. The males contained 0.56mg/100g of Zinc with 0.78mg/100g in the females. No copper was detected in both sexes of the catfish. The general pattern of the distribution of the minerals in the catfish as shown in Figure was in the following order: Ca>Fe>Na>Mg>P>K>Zn>Cu. The proximate compositions and mineral contents were all within the permissible limits of FAO (2010) and USDA (2010). It was generally observed that the protein content in both sexes of the catfish was higher (24.40-20.62%) than that of egg yolk of chicken which has 15% protein.

4. Discussion

The results of the proximate composition and mineral contents of the muscle of adult male and female individuals of *H. bidorsalis* revealed that both sexes are good sources of essential nutrients that are required in human nutrition. The males were however observed to contain higher amount of moisture than the females. The females on the other hand contained higher amount of protein, ash, lipid and minerals than the males. This is in corroboration with the results of Amer *et al* (1991) who reported higher moisture content in male prawns over the females, Islam and Joadder (2010), who reported higher moisture content in freshwater male Gobi (*Glosaogobius giuris*) from the river Padma, Bangladesh, Nargris (2006) who reported higher moisture content in the body flesh of Koi fish *Anabestes tidineus*, Bharan *et al* (2010), who studied the proximate composition and profiles of amino acids and fatty acids in the muscle of adult males and females of commercially viable prawn species *Macrobrachium rosenbergii* collected from natural environment and reported higher moisture contents in the male individuals of the prawn, Cornelia (2012) who investigated the chemical composition and nutritional value of smoothhound shark (*Mustelus mustelus*) meat, Abdi *et al* (2012) who reported on the proximate and fatty acid composition of red tail catfish (*Hemibagrus nemurus*) and African catfish (*Clariasgariepinus*) in Malaysia.

The lower moisture content in the female *H. bidorsalis* can be attributed to high organic materials in its muscle and less water than that of the males, Amer *et al* (1991), Nargis (2006), Bharvan *et al*., (2010), Cornelia (2012), Abdi *et al* (2012) and Alemu *et al.* (2013). The high protein, ash, lipid and mineral content in the females than the males in the muscle of *H. bidorsalis* also agrees with the results of Ahmed *et al* [4], Rubbi *et al (1978)* Thammapet *et al* (2010) and Mohamed *et al* (2010).

The high protein content in the female *H. bidorsalis* can be attributed to their selective feeding habits on diets with high protein contents by female fishes than the males (Adewumi & Olayeye (2014). Again, *H. bidorsolis* is known to exhibit sexual dimorphic growth where the females grow significantly faster, larger and more uniform in size than the males (Olaosebikan and Raji (1998) owing to the female's selective feeding habit on protein-rich diet (Teugels *et al* (1992). The generally high mineral contents in the muscle of the female individuals of *H. bidorsalis* may not be unconnected with the high ash content in the female's muscle and in conformity with the submission of previous workers on other freshwater fish species (Nargis *et al* (2006) Shamsan & Ansari (2010), Alemu *et al* (2013) and Islam & Joadder (2005).

The absence of copper in the muscle of both sexes of *H. bidorsalis* may be traced to the unpolluted nature of the lower Cross River system where anthropogenic activities are reduced to the bearest level without the injection of effluence containing copper (Enejiet *al*. (2012). Copper is one of the essential elements that promotes the activity of certain enzyme systems in the body of man and other vertebrate and invertebrate animals, Mills, (1980), Window *et al*. (1987), FAO (2006) and USDA (2010). This element may be toxic when ingested in large amounts, however. Though it was not detected in the muscle of both sexes of the catfish (*H. bidorsalis*) from the lower Cross River system, Nigeria, Eneji *et al* (2012) report the availability of the metal in the muscle of *Clarias gariepinus* and *Oreochromis niloticus* from the Benue River Nigeria in the ranges of 1.05 – 2.26mg/kg and 1.65-2.28mg/kg, respectively and attributed it to the high impact of effluence containing trace copper in the river system.

High concentrations of trace metals in the aquatic environment according to Eneji *et al* (2012) may result in the elevation of the toxic effect on organisms which of course, is a function of pH of the habitat, and in due

time, may be directly or indirectly absorbed by the organisms through the classical food web (Burger & Gochfeld (2005).

Both the males and females of *Heterobranchus bidorsalis* can be classified as good source of protein, ash, lipid and minerals and belong to high protein (> 23%) and high lipid (25%) category. *H. bidosarlis* is a freshwater species and the relatively high crude protein recorded in the fish attributes to the fact that freshwater fishes are good source of pure protein (Staniskiene *et al* (2006) and Adewumi *et al* (2014). The protein content of the male and female individuals of *H. bidorsalis*is however generally higher (24.40-26.62%) than that of egg yolk of chicken (15%) reported by CFCD (2002).

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