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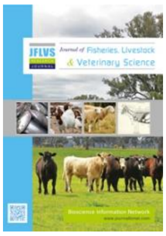

Proximate composition of male and female African catfish (*Clarias gariepinus*) and tilapia (*Tilapia zilli*) in Jega river, Kebbi state, Nigeria

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ABSTRACT

Fish is highly nutritious, tasty, and easily digestible. It is much sought after by a broad cross-section of the world's population, particularly in developing countries as it provides the cheapest protein source. Nigeria is blessed with numerous inland freshwater rivers and lakes scattered all over the country. This freshwater habitat consists of many species of fish that have successfully dominated all niches over time and have for many reasons remained unstudied. The situation concealed a lot of scientific information particularly on food security and safety to the inmates and the country at large. Jega River which transcended many States in the North-Western part of Nigeria to open into the river Niger is one of such rivers largely uncared for, study-wise. African catfish (Clarias gariepinus) and Tilapia (Tilapia zillii) have been wisely selected for the present proximate composition studies. The juveniles of these fishes were purchased from local fishermen in Mariner Waje landing site of the river which flows by Jega town, a local government area in Kebbi State, Nigeria. For the study, the methodology approved by the Association of Official Analytical Chemists (AOAC) was used to determine the proximate composition of the fishes. The highest percentage crude protein content of 49.18 ± 0.30% was observed in juvenile female C. gariepinus; while the lowest protein content of 39.22± 0.50% was observed in juvenile male T. zilli. The highest percentage lipid content of 11.75± 1.50% was observed in juvenile female tilapia; while the lowest percentage lipid content of 6.25± 0.29% was observed in male African catfish. The highest percentage fibre content of 4.00 ± 0.29% was observed in male and female C. gariepinus, while the lowest percentage fibre content of 0.75± 0.29% was observed in male tilapia. There were variations (p< 0.05) when the protein and lipid contents of both the species were compared with each other. There was also a significant difference (p< 0.05) when the carbohydrate contents were compared between the fish species, but there was no significant difference (p > 0.05) when the fibre content was compared within the species. The analyses showed that both the male and female fish species studied had high protein contents.

Key Words: *River, Crude protein, Lipids, Fibre, Ash content, Carbohydrates and Fish species*

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I. Introduction

Fish is the cheapest source of protein and essential nutrients required in human diets. It is one of the few sources of animal protein available to many Nigerians with an estimated annual per capita fish consumption of 13.3 kg in 2013 (FAO, 2017). Fish contains four basic ingredients in varying proportions: water, protein, fat, and minerals. Flesh from healthy fish contains 60–84% water, 15–24% protein, and 0.1–22% fat, mineral usually constitutes 1–2% (Clucas and Ward, 1996). Fish is highly nutritious, palatable with tender flesh hence easily digestible (Effiong and Fakunle, 2011). It is much sought after by a broad cross-section of the world's population, particularly in developing countries (FAO, 2005; Egbal et al., 2017; Mazunder et al., 2008). According to FAO (2005); Isaac et al. (2018) fish also contain significant amounts of all essential amino acids, particularly lysine which is relatively poor in cereals (common human food sources). Fish protein can be used therefore to complement the amino acid pattern and improve the overall protein quality of a mixed diet.

In human nutrition, fatty acids such as linoleic and linolenic acids important for preventing skin diseases are considered essential as they cannot be synthesized by the organism. In marine fish, these fatty acids constitute only about 2% of the total lipids, which is a small percentage when compared to many vegetable oils (Elvevoll and James, 2002). However, fish oils contain other "essential polyunsaturated fatty acids which act in the same way as linoleic and arachidonic acids. As members of the linoleic acid family (first double bond in the third position, ω-3) counted from the terminal methyl group), they also have neurological benefits in growing children. One of these fatty acids, Eicosapentaenoic acid (C20: 5 ω 3), has attracted considerable attention since Danish scientists found a significant amount of the acid in the diet of a group of Greenland Eskimos who proved virtually free from arteriosclerosis. Meanwhile, fish is noted to occupy a significant part in the food menu of these Eskimos. Convincing evidence now exists for the significant role of fish and fish oils which decreases the risk of developing cardiovascular diseases and improving fetal brain development (Elvevoll and James, 2002). According to Ackman (1990), muscle is the main part of fish used for human consumption and when fish is suggested as a means for improving health; fatty acid and amino acid composition should be considered. Excessive fatty acid consumption result in becoming overweight. Therefore, fish lipids and proteins have been recognized as being beneficial for human health.

Measurement of constituents of fish products are sometimes necessary to meet the requirements of food regulations or commercial specifications (Murray and Burt, 1983). In industrial processing of fish, knowledge of the composition of fish is important in several ways; information on the oil content of certain species and how oil content varies with the season or location of capture is needed to evaluate the possibility of its utilization in the manufacture of oil. Moreover, information on the fatty acid content and amino acid profiles of fish is important in determining the suitability of fish oils for processing and the suitability of fish meal as protein supplement in animal feeds. In addition, such information will be useful in prescribing the diets for health conscious people and those with certain medical conditions to change to poly-unsaturated fatty acids.

Aspect of the biology of tilapia species occurring in the Lagos lagoon (Bolawa et al., 2011; Fagade, 1971; Fagade and Olaniyan, 1972), their abundance in Lake Kainji (Akintunde and Imevbore, 1979) and abundance of *C. gariepinus* in Anambra River Basin 2 (Mgbenka and Eyo, 1992) as well as fatty acid of smoked *C. gariepinus* in Northern Nigeria (Glew et al., 2004) have been extensively studied. Despite high demand, commercial value and distribution of these fish, there is the need for precise data on their nutrient composition in North-West Nigeria where they are highly consumed. In an earlier report (Effiong and Fakunle, 2011), the feeding habit, sex, species, seasonal variation are among the factors which greatly affect the nutrient composition of an individual fish species. Thus, this study was carried out to determine the proximate composition such as fatty acid and amino acid profile of the two common freshwater fish species *C. gariepinus* and *T. zilli*.

The water bodies in Nigeria harbor a variety of fish species that serve as food and an economic resource to the country. Some of the most important species accounting for about 90% of Nigerian's fishery include croakers (*Micropogonias undulates*), catfishes (*C. gariepinus*), tilapia *(T. zilli)*, threadfins *(Eleutheronemos tettradactylurus)*, soles *(Soleasolea)* and the clupeids (Clupeidae) (FDF, 2004). Total fish supply of Nigeria was 1.16 million Tons in 2004. The major sources were: imported (56%); coastal, brackish-water and inland fishery (37.6%); Industrial trawl fishery (2.6%) and aquaculture production (3.8%) (FAO, 2013). Total domestic fish production in 2007 according to the same sources

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stood at an estimated 0.6 million Tons, while imported fish was estimated at about 0.7 million tons valued at about US $500 million annually. At present, there has been expansion of aquaculture in Nigeria, especially culture of African catfish and two species of tilapia such as *T. zilli* and *Oreochromis niloticus* due to their tolerance to a wide range of temperature, fast growth rate, adaptation to diverse environmental conditions, as well as tolerance to low oxygen and high salinity levels (Hecht et al., 1996).

Fish lipids are well known to be rich in long-chain n-3 polyunsaturated fatty acids (LC n-3) PUFA), especially eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). Long-chain, n-3 PUFA cannot be synthesized by human body and must be obtained from the diet (Elvevol and James, 2002). It is well known that polyunsaturated fatty acids can regulate prostaglandin synthesis, hence induced wound healing (Bowman and Rand 1980; Gibson, 1983). The ω-3 and ω-6 polyunsaturated fatty acids (PUFA) have been shown to have positive effects on cardiovascular diseases and cancer prevention (Conner, 1997). It is thus important, for human health, to increase the consumption of fish and fishery products which are rich in polyunsaturated fatty acids (Burr, 1989; Sergent, 1997). Polyunsaturated fatty acids composition may vary among the fish species, even the freshwater and marine fishes (Abdul Rahman et al., 1995). Certain amino acids like aspartic acid, glycine, and glutamic acids are known to play a key role in the process of wound healing (Chyun and Griminger, 1984). Knowledge of the fatty acid composition is desirable for the fish species such as catfish and tilapia, not only because of the value of the fish as products but also because of possible new industrial applications of the fish oil. In light of the recent dietary and medical emphasis on the role of fatty acids in human physiology, it is important to know the fatty acid composition of fishes.

The lipids and protein contents of some fish species are well documented in the temperate regions of the world. Therefore, the most important fish species, catfish (*C. gariepimus*) and tilapia (*T. zilli*) were chosen for this work based on the fact that they have good consumer acceptance, economically viable, and are low in fat content. They are also the most farmed fishes in the tropical and sub-tropical regions of Africa and have been playing an increasingly important role in the nation's source of nutrition as relatively cheap animal protein (FDF, 2004). Hence, this study aimed to determine the proximate composition of *C. gariepinus* and *T. zilli* and determine the differences in proximate compositions of male and female of the two fish species.

II. Materials and Methods

Study Area

Jega is located between the latitude 12°N, and longitude 40°E. The relative humidity in the region ranged from 21-47% and 51-79% during dry and rainy season respectively. The temperature range was between 14-41°C in dry season. Jega is a local government area in Kebbi State, Nigeria. Its headquarter is in the town of Jega. It has an area of 891 km^2 and a population of 269,600 people in 2020 (NBSN, 2020).

Collection of Fish Sample

The male and female specimens of both sexes of African catfish and tilapia were obtained from Marinar-waje landing site at Jega River, Kebbi State, Nigeria. The live specimens were obtained and kept in an ice chest and conveyed to the laboratory. The specimens were packaged in separate labeled polythene bags and eventually stored in a cold store at -22°C of Agric Chemical Laboratory of Usman Danfodiyo University (UDUS), Sokoto, Nigeria.

Morphometric Measurements

Fish samples were thawed in the open air in the laboratory and individual data for length, weight and sex information were recorded. The standard length of fishes were measured using a measuring board. Moreover, the weights were also measured with a Sartorius top loading electronic weighing balance (Sartorius- Werke GMBH, Type 1106/ Fabr. Nr. 2608053).

Sample Preparation

Each fish sample was dissected, gutted and the gonad was removed to determine the sex by visual examination. The fish sample was then cleaned, filleted and placed in a Waring Blender and homogenized for 15 min. The samples for different chemical analyses were taken from the homogenous material. Triplicate determinations were carried out on each sample.

Proximate Composition Analysis

Ash content determination: The ash content was determined by incineration in a carbonite Sheffield LMF3 mufflers furnace at 500°C (AOAC, 1990). The difference in weight of the fish samples before and after heating was taken as the ash content.

$$Ash\ content = \frac{w2-w0}{w1-w0} * 100$$

Where, w_0 =Empty crucible

w_1 =Ash sample weight before heating

w_2 = Dry sample weight after heating

Lipid content determination: Lipid extractions were performed on minced fish samples (10g) using the extraction methods of chloroform-methanol. Methylene chloride (100µL) and 1ml of 0.5M NaOH in methanol was added to oil extracts in a test-tube and heated in a water bath at 90°C for 10 min. The test tubes were removed from the water bath and allowed to cool before the addition of 1ml of 14%-BF3 in methanol. The test tubes were heated in a water bath for 90°C for 10 min and cooled to room temperature. One ml of distilled water and 200-500µL hexane was added to the test tubes and then extracted by vigorous shaking for about 1 min. Following centrifugation, the top layer was transferred into a sample bottle for GC analysis.

$$Crude\ Fats = \frac{w1-w2}{w2} * 100$$

Where, w_1 = the initial weight; w_2 = the weight after extraction

Crude fibre content determination: The crude fibre was analyzed by following the procedure of AOAC (1990). 2.0 g of each sample was weighed in a separate round bottom flask. 100 ml of 0.25 M sulphuric acid solution was added to each sample in the flask and the mixtures then boiled under reflux for 30min; 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 flask and 100 ML of 0.3 M. Sodium hydroxide solution was added and the mixtures boiled again under reflux for 30 min and filtered quickly under suction. Each insoluble was boiled at 100°C for 2 hrs. cooled in desiccators and weighed (C_I). The weighed samples were then incinerated and reweighed (C_2). Percentage of crude fibre content was then determined.

$$Crude\ fibre = \frac{w2}{w1} * 100$$

Where, w_1=the initial sample weight; w_2=the final weight

Protein content determination: The total nitrogen (crude protein) was determined by the Kjeldahl method. A known weight (0.5 g) of the prepared fish sample was taken and dropped at the bottom of the Kjeldahl digestion flask together with 6-8 glass beads, 4-5 spatula full of a granular mixture of $CuSO_4$ and K_2SO_4 as the catalyst. 20ml of concentrated H_2SO_4 was then added carefully. The flask was gently heated on a Gerhardt heating mantle in an inclined position in a fume cupboard until full digestion (when the liquid changed from brown colour to colourless). The contents of the flask were transferred to a clean 100ml volumetric flask and made up to volume 25ml, an aliquot was used for distillation. Then the formula for Percentage Nitrogen is given as:

$$\%\ \text{Nitrogen} = \frac{ml\ Acid\ titrated \times Normality\ of\ acid\ titrated \times 0.014}{weight\ of\ sample} * 100$$

$$\%\ Crude\ protein = \%\ Nitrogen * 6.25$$

Where, 6.25=animal conversion factor for nitrogen to protein

Carbohydrate content: Carbohydrate content was calculated as follows:
Carbohydrate = 100% - (% moisture + % ash + % crude protein + % fat)

Statistical analysis

The descriptive statistics (mean, standard deviation, range) were conducted while statistical significance of differences was determined (Duncan and LSD).

III. Results and Discussion

Morphometric neasurements of *T. zillii* and *C. gariepinus.*

The standard length of juvenile *T. zillii* ranged from 10.40-11.40 cm and 10.50-11.20 cm for both males and females respectively. Moreover, the total length and weight of juveniles ranged from 12.50-13.50 and 12.00-12.80 cm, 58.90-61.30 and 58.50-60.30 g respectively. While the dry weight of juveniles ranged from 10.40-12.30 and 10.20-12.60 g respectively (Table 01). In *C. gariepinus* the standard length for juvenile males and females ranged from 12.70-14.40 and 10.00-11.90 cm respectively. In addition, the total length and weight of males and females ranged from 11.50-13.00 and 10.40-11.70 cm, 40.70-68.50 and 48.00-52.30 g respectively. At the same time, the dry weight of juvenile males and females ranged from 17.21-19.33 and 18.32-19.56 g respectively (Table 01).

Proximate composition of *T. zillii* and *C. gariepinus*

Ash content of *T. Zillii* and *C. gariepinus*: The ash content of juvenile males and females *T. zillii* ranged from 10.25±0.58 and 11.00-12.50 respectively and mean value of 11.75±0.29. While, in *C. gariepinus* juvenile males and females, it ranged from 10.25 ± 0.25 and 10.00- 11.00% respectively. No significant difference in ash content was observed (p≥0.05) between the species (Table 02).

Lipid Content of *T. zillii* and *C. gariepinus:* The lipid content of juvenile males and females *T. zillii* ranged from 10.00-10.50 and 11.50-12.00% respectively. While in *C. gariepinus* juvenile males and females ranged from 6.00-6.50 and 9.00-10.00% respectively. There was a significant difference of lipid content observed (p≤ 0.05) between the species. The highest lipid content was obtained with the *T. zillii* female fish (Table 02).

Fibre content of *T. zillii* and *C. gariepinus:* The fibre content of juvenile males and females *T. zillii* ranged from 0.5-1.0 and 3.0-4.0% respectively. While in *C. gariepinus* of juvenile males and females ranged from 3.5-4.5 and 3.50-4.50% respectively. Female tilapia was fattier than male but similar in catfish male and female. No significant difference in fibre content was observed (p≥0.05) between the fishes.

Protein content of *T. zillii* and *C. gariepinus:* The crude protein content of juvenile males and females *T. zillii* ranged from 38.69-39.74 and 42.10-43.60% respectively. While in *C. gariepinus* of juvenile males and females ranged from 44.52-45.74 and 48.70-49.66 % respectively. Both the male and female catfish contain higher protein content than the tilapia. No significant difference in protein content was observed (p≥0.05) between the species. The highest protein content was recorded on the female C*. gariepinus.*

Carbohydrate (CHO) content of *T. zillii* and *C. gariepinus:* The carbohydrate content of juvenile males and females *T. zillii* ranged from 22.27-24.71 and 10.72 – 13.29% respectively. While *C. gariepinus* of juvenile males and females ranged from 14.27-15.52 and 8.92 – 13.41% respectively. both the male fishes contain higher carbohydrate level than the female. No significant difference in carbohydrate content was observed (p≥ 0.05) between the two species.

Table 01. Morphometric measurement of *C. gariepinus* and *T. zillii* fish species

Fish species	Sex	Weight range (g)	Length range (cm)	Standard length range (cm)
Juvenile *C. gariepinus*	Males	40.73- 68.50	12.70-14.40	11.50-13.00
	Females	72.40-74.30	10.40-11.60	10.00-11.60
Juvenile *T. zillii*	Males	58.90-61.30	12.50-13.50	10.40-11.40
	Females	58.90-60.30	12.00-12.80	10.50-11.20

Table 02. Percentage of ash and lipids of *C. gariepinus* and *T. zillii* fish species

Fish species	Sex	Ash content (%)		Lipid content (%)	
		Range	Mean (±SD)	Range	Mean (±SD)
Juvenile *C. gariepinus*	Males	10.00-10.50	10.25±0.25	6.00-6.50	6.25±0.29
	Females	10.00-11.00	10.50-±1.42	9.00-10.00	9.5±0.58
Juvenile *T. zillii*	Males	10.00-10.50	10.25±0.58	10.00-10.50	10.25±0.29
	Females	11.00-12.50	11.75±0.29	11.50-12.00	11.75±1.50

Table 03. Percentage of fibre, protein and carbohydrate content of C. *gariepinus* and *T. zillii*

Fish species	Sex	Fibre (%)		Protein (%)		Carbohydrate (%)	
		Range	Means(±SD)	Range	Means (±SD)	Range	Mean(±SD)
Juvenile *C. gariepinus*	Males	3.50-4.50	4.00±0.29	44.52-45.74	45.13±1.50	14.27-15.52	14.82±0.09
	Females	4.50-3.50	4.00±0.29	48.70-49.66	49.18±0.30	8.92-13.42	11.17±0.40
Juvenile *T. Zillii*	Males	0.5-1.00	0.75±0.29	38.69-39.74	39.22±0.50	22.27-24.71	23.49±0.90
	Females	3.00-4.00	3.50±0.50	42.10-43.60	42.85±0.90	10.72-13.29	12.00±1.10

Fish like other animals have the ability to accumulate lipids in their body; the two species (*C. gariepinus* and *T. zillii*) according to Kleimenov (1971) belong to the high protein and high fat content group of fish. The lipid content of each juvenile species was high. Shul'min (1974) in an early report indicated that the fat content of an individual fish is influenced by species, geographical region, age of the fish, and fish diet. The fishes with lipid content below 5% are considered lean fish (Ackman and Mc-Leod, 1988). The ash content of juvenile female *T. zillii* had a mean value of 11.75±0.29% which seems a bit higher than juvenile *C. gariepinus* with a mean value of 10.25±0.25%. The crude fibre content of juvenile *C. gariepinus* was higher in both the male and female (4.00) than the juveniles of *T. Zillii* with mean values of 0.75 and 3.50% male and female respectively. The juveniles *T. zilli* had higher lipids than the *C. gariepinus* (Table 02).

The crude protein content in *C. gariepinus* was higher in both the male and female with a mean value of 49.18±0.30 and 45.13±1.50% respectively. Fawole et al. (2007) reported that the proximate and mineral composition of *C. gariepinus* from some selected freshwater bodies in Nigeria indicated that the crude protein content had higher values, followed by ash content, whereas the crude fibre had the lowest value. The carbohydrate (CHO) content was higher in juvenile male and female *T. zillii* with the mean value of 23.49±0.90 and 12.00± 1.10%. By contrast, in *C. gariepinus,* it was a bit lower in both male and female with a mean value of 14.82±0.09 and 11.17±0.40%, respectively. All the above results were similar to the report by Osibona et al. (2009).

IV. Conclusion

The freshwater fish species in current study showed appreciably high protein and lipid content in their muscles but *C. gariepinus* had a bit higher protein content than *T. zilli* of both sexes. On the other hand, the *T. zillii* had higher lipid and carbohydrate content than *C. geriepinus.* As lipids and carbohydrates can be reserved in the human body unlike the proteins, *T. zilli* may be more appealing for consumption. The results also have the potential to gear up aquaculture entrepreneurs particularly in the study area and Nigeria in general where culture of tilapia is largely neglected. It can equally, prompt the catfish culture as the costly cultured fish due to high protein rich feed requirement but research has revealed tilapia as more appealing to the human body, hence could safely be overridden by tilapia culture.

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