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Quantitative composition of two economically important fish species in Ado Ekiti, Ekiti State

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ABSTRACT

Fish farming which is an aspect of aquaculture, is one of the fast-growing enterprises in Nigeria's economy so as to satisfy the continuously growing need for a relatively cheap source of protein in which fish fits in. Fish is commonly recognized to be an outstanding source of protein which is quite nourishing and as a result, forms a greater percentage of the diet of the world population due to its availability and palatability; it is also known to perform a crucial function in humans diet because of its essential nutritional components which is present in different proportion. In order to ensure consumption of healthy meals, people have become particular about the nutritional composition of their food intake hence the need to evaluate the nutritional content of two fish species which are of great economic importance due to their high demand in Nigeria. The proximate analysis of wet and dry Clarias garipinus (catfish) and Oreochromis niloticus (Tilapia fish) was determined by analyzing the moisture, fibre, carbohydrate, protein, fat and ash content. The results of the analysis for (wet) and (smoked) samples of the fish showed that the moisture content was the highest in wet catfish (62.453±0.011), while protein content had the highest value of 47.309±0.002 in the smoked sample of catfish. Ash contents of all the analyzed fish samples were significantly low, with the lowest value (0.191±0.001) and the highest value (2.217±0.002) in smoked catfish and wet tilapia, respectively. This study observed a considerably high amount of fat, with mean values ranging from 12.642±0.008 to 16.556±0.019 in all the processed fish samples. Generally, the smoked samples had higher protein values and lower fat contents than the wet samples. This suggests that smoked fish, either catfish or tilapia will be preferable as good sources of animal protein in meeting the nutritional demand of the populace.

Key Words: *Nutritional Content, Aquaculture, Smoked, Wet, Diet and Protein.*

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I. Introduction

Breeding of fish is a fast growing business which has contributed immensely to the world economy. Globally, production in aquaculture has increased to 106 million tons of live weight growing at an average annual rate of 66% since 1995 (FAO, 2017). Fish serves as a readily available source of protein as well as a means of livelihood for many people in developing countries. For instance, a notable percentage of the populace depends on fish farming as their sole or alternative means of income. It is projected that food production will increase by 300% to meet the demand of the global population, with a projection of over 9 billion by 2050, while Latin America will increase by 80% and Asia by 70% to provide minimum required diets for the projected population of 2 billion, 810 million and 5.4 billion people in the respective region (Anon, 1997). Recently, people have become more concerned about consuming healthy food than before. Most individuals now prefer fish meal to red meat due to its high nutritional contents. Fish is commonly consumed by a greater proportion of the world populace due to its unique taste and also being good protein source that is readily available and relatively affordable (Sutarshiny and Sivashanthin, 2011), therefore taking a crucial role in the nutritional diet of humans in developing nations due to its rich source of animal protein. Fish is highly nourishing and palatable with soft flesh hence easily digestible (Effiong and Fakunle, 2011). Fish is generally acceptable due to its excellent taste, low cholesterol, tender flesh, cheapness and aroma in cooking. Several animal protein sources in Nigeria are known, of which fish is primarily readily available, with an estimated annual per capita fish consumption of 13.3 kg in 2013 (FAO, 2017). Also, they are a good source of polyunsaturated fatty acids, particularly omega-3 fatty acids, Calcium, Zinc and Iron. Aside from other animal protein sources, fish is recognized as a meal composed of all the indispensable amino acids in the required proportion, hence called complete protein. It is a readily available and relatively cheaper source of animal protein for the less privileged (Thilsted et al., 2014).

The African catfish (*Clarias gariepinus)* and Tilapia fish belong to the family Claridae (air-breathing catfishes) and family Ciclidae, respectively. Both fish species are known to be commonly consumed in Nigeria. They feed on a wide variety of feedstuff and can survive various environmental conditions, including stress. Therefore, they are easily used in aquaculture due to their ease of breeding and high tolerance to severe conditions. (Njiru et al., 2002; Njiru et al., 2004; Pillay & Kutty, 2005). Knowledge of the nutritional component of fish is required for its maximum utilization. Varying fish species are composed of different nutrient profiles, hence supplying varying nutritional values to their consumer. Also, these value varies with different season (Varljen et al., 2003). Report showed quite a number of assessments have been done on the nutritional components of different freshwater fish globally.

The proximate analysis of Nigerian smoked *Clarias gariepinus* reported by Adebowale et al., 2008 showed a range of moisture, protein, fat and ash content as follows; 7.16-10.17%, 33.66- 66.04%, 1.58-6.09% and 9.12-12.16%, respectively (Adebowale et al., 2008). Okonji and Akhirevbulu (2013) explained the fatty acid components of two commercially important fish species which were *Clarias gariepinus* and *Oreochromis niloticus*. A study on the proximate composition, which includes amino acids, fatty acids and elemental composition of Giant River Catfish *Sperata seenghala,* was also reported (Mohant et al. 2012). Taiwo et al. (2014) determined the proximate chemical composition and lipid profile of muscles of the cultures and wild African Catfish, *Clarias gariepinus* from Nigerian waters. It was reported that certain proximate composition of fish species is a function of varying factors such as size, sex, maturity and sampling location. For instance, fish sampled from Ero Reservoir had varying moisture content values concerning their species as *O.niloticus* has a relatively higher moisture content (13.54%) than the other *S.galileaus* (12.82%) and *H.niloticus* (11.32%) (Idowu, 2020). Similarly, the crude protein content of fish samples varied with sex, as reported by Alemu et al. (2013) male and female Oreochromis niloticus had 14.5% and 14.6%, respectively, which also corresponds with the report of Namaga et al. (2020) male and female tilapia crude protein content ranged from 38.69-39.74 and 42.10-43.60% respectively. The difference in crude protein content could also result from the fish's ability to absorb and convert the basic nutrients in the fish meal (Rahman et al. 2021). The lipid content of fish also varies with species as well their diets. The crude fat content of *O. niloticus* collected from Lake Hashenge had a significantly higher value ($P<0.05$) than that of Tekeze reservoir despite being the same species. This could be attributed to the water temperature difference between the two reservoirs and the type of diet the fish consumes.

Ash content refers to the minerals and inorganics left after the food sample has been heated to a very high temperature removing moisture, volatile and organics. The observed range of ash content among

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the fish species in the study of Idowu (2020) on C. *gariepinus,* O. *niloticus* and some other fish species having the range (3.15-5.81%) indicates that the fish species analyzed can be a good source of mineral elements like calcium, potassium, phosphorus, sodium, copper, manganese, iron etc. The ash content reported by Tsegay et al. (2016) ranged between 0.81% and 1.16% in the sampled fishes, which is an indicator that the species of fish are good sources of minerals like Potassium, Magnesium and others because ash comprises the mineral component of food items and the inorganic residue that remains after the organic matter has been burnt off. Ash content recorded from *O. niloticus* collected from Tekeze reservoir was higher (1.16% in males) than in female *O. niloticus* (0.81%).

The nutritive value of fish, which comprises protein, fat, ash etc. and its mineral composition, has not only helped fish in terms of growth but much more has a positive significant impact on the consumption as a source of food and nutrient for humans to maintain some balance in their diet. Owing to its availability and cheap cost, many have opted to consume more fish than meat or egg because it has high protein content in relation to other protein sources in the diet. This present study seeks to assess two economically important fish species in Ado-Ekiti to find a solution to the nutritional requirement of the people, which should be affordable and also to compare the nutritional content of both species as wet and smoked.

II. Materials and Methodology

Sample collection and preparation

Eight samples were collected, including wet and smoked Cat fish (Clarias gariepinus and Nile Tilapia Oreochromis niloticus) from the Department of Fishery, Ministry of Agriculture, Ado Ekiti.

Proximate composition analysis

Ash content determination: The ash content was determined using standard methods (AOAC, 1990). The ash content was measured as the difference in the weight before and after combustion of the fish samples.

$Ash\ content = (w2-w0)/(w1-w0) * 100$

Where, w0 =Empty crucible
w1 =weight of original sample prior to heating
w2 = weight of ashes sample after complete heating

Fat content determination: 10g of the fish samples were minced and fat was extracted using chlorofoam-methanol. 100µL of methylene chloride and 1ml of Fat 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 were added to oil extracts in a test tube heated for 10min in a water bath at 90°C. The mixture was allowed to cool by removing the test tubes from the water bath, after which 1ml of 14%-BF3 in methanol was added. One ml of distilled water and 200-500µL hexane were added to the test tube mixture and then extracted by vigorous shaking for about 1 min. After centrifugation, the top layer was transferred into a sample bottle for GC analysis.

$Crude\ Fats = (w1-w2)/w2*100$

Where, w1 = the initial weight of sample;
w2 = the weight of sample after extraction

Crude fibre content determination: The crude fibre was analyzed by following the procedure of AOAC (1990). About 2.0 g of each homogenized sample was collected in a separate round bottom flask. After which, 100 ml of 0.25 M sulphuric acid solution was measured and added to each sample in the flask. The mixtures were boiled and shaken periodically to ensure proper boiling for 30 minutes; the hot solutions were quickly filtered under suction. The flasks were thoroughly washed with hot water to remove all acid residue. Each residue was transferred into separate cleaned round bottom flasks 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 hours, cooled in desiccators, and weighed as W1. The weighed samples were then burnt and weighed again as W2. The percentage of crude fibre content was then determined using the following:

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$Crude\ fibre = w2/w1 * 100$

Where, w1=the initial sample weight;
w2=the final weight

Protein content determination: The total nitrogen (crude protein) was determined by the Kjeldahl method. 0.5 g of the fish sample was collected and placed at the bottom of the Kjeldahl digestion flask in addition to 6-8 glass beads, 20 ml of concentrated sulphuric acid, 4-5 spatula full of a granular and mixture of copper tetraoxosulphate and potassium tetraoxosulphate were added as the catalyst. The flask was gently heated on a Gerhardt heating mantle in an inclined position in a fume cupboard until the liquid changed from brown colour to colourless. The residual mixture of the flask was then transferred to a clean 100ml volumetric flask and made up to volume 25ml, an aliquot was used for distillation. The Percentage Nitrogen was estimated as:

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

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

Where, 6.25=animal conversion factor for nitrogen to protein

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

Statistical analysis

SPSS version 20 was used for the statistical analysis. The data obtained from the proximate composition was presented using summary of the descriptive statistics, which entailed the mean and standard deviation.

III. Results

Proximate composition of analyzed sample

The results of the proximate analysis of wet and smoked samples of fish are presented in Table 01 and Table 02. The moisture, crude protein, crude fat, ash and carbohydrate content values were presented as percentage composition. The result of the wet sample clearly showed that the moisture content of the fish samples analyzed was the highest, with wet catfish having the highest value of 62.453±0.011 among other parameters, while protein contents had the highest value of 47.309±0.002 in the smoked sample of catfish. Ash contents of fish from all the analyzed fish species samples were significantly low, with the lowest value (0.191±0.001) and the highest value (2.217±0.002) in smoked catfish and wet tilapia respectively, as all the fish samples examined were low in ash content.

Moisture content of smoked Catfish (*Clarias gariepinus*) and Tilapia (*Oreochromis niloticus*)

The moisture content of smoked *Clarias gariepinus* mean value of 28.245±0.212, while smoked *Oreochromis niloticus* mean value was 19.719±0.004 (Table 02). The moisture content was not significantly different (p≥0.05) between the fish species.

Moisture content of Wet Catfish (*Clarias gariepinus*) and Tilapia (*Oreochromis niloticus*)

The moisture content of wet *Clarias gariepinus* mean value of 62.453±0.011, while wet *Oreochromis niloticus* mean value was 60.914±0.006 (Table 02). The moisture content was not significantly different (p≥0.05) between the fish species

Ash content of smoked Catfish (*Clarias gariepinus*) and Tilapia (*Oreochromis niloticus*)

The ash content of smoked *Clarias gariepinus* mean value of 0.316±0.004, while smoked *Oreochromis niloticus* mean value was 2.084±0.008 (Table 02). Hence, the ash content was significantly different (p≥0.05) between the species.

Ash content of wet Catfish (*Clarias gariepinus*) and Tilapia (*Oreochromis niloticus*)

The ash content of wet *Clarias gariepinus* mean value of 0.191±0.001, while wet *Oreochromis niloticus* mean value was 2.217±0.002 (Table 02). Hence, the ash content was significantly different (p≥0.05) between the species.

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Fat content of smoked Catfish (*Clarias gariepinus*) and Tilapia (*Oreochromis niloticus*)
The fat content of smoked *Clarias gariepinus* mean value of 14.922±0.011, while smoked *Oreochromis niloticus* mean value was 12.642±0.008 (Table 02). Hence, fat content observed between the species was significantly different (p≥0.05).

Fat content of wet Catfish (*Clarias gariepinus*) and Tilapia (*Oreochromis niloticus*)
The fat content of wet *Clarias gariepinus* mean value of 15.336± 0.002, while wet *Oreochromis niloticus* mean value was 16.556±0.019 (Table 02). Hence, no significant difference in fat content was observed (p≥0.05) between the species.

Fibre content of smoked Catfish (*Clarias gariepinus*) and Tilapia (*Oreochromis niloticus*)
The fibre content of smoked *Clarias gariepinus* mean value of 0.114±0.003, while wet *Oreochromis niloticus* mean value was 0.244±0.008 (Table 01). Hence, no significant difference in fibre content was observed (p≥0.05) between the species. Therefore, smoked tilapia is fattier than smoked catfish.

Fibre content of wet Catfish (*Clarias gariepinus*) and Tilapia (*Oreochromis niloticus*)
The fibre content of wet *Clarias gariepinus* mean value of 0.082±0.003, while wet *Oreochromis niloticus* mean value was 0.177±0.004 (Table 01). Hence, a significant difference in fibre content was observed (p≥0.05) between the species.

Protein content of smoked Catfish (*Clarias gariepinus*) and Tilapia (*Oreochromis niloticus*)
The protein composition of smoked *Clarias gariepinus* mean value of 47.309±0.002, while smoked *Oreochromis niloticus* mean value was 41.698±0.006 (Table 01). A significant difference in protein content was observed (p≥0.05) between the species. The value 47.309±0.002 is the highest protein content found in smoked *Clarias gariepinus.*

Protein content of wet Catfish (*Clarias gariepinus*) and Tilapia (*Oreochromis niloticus*)
The protein composition of wet *Clarias gariepinus* mean value of 20.199±0.005, while wet *Oreochromis niloticus* mean value was 18.369±0.008 (Table 01). There is a significant difference in protein content was observed (p≥0.05) between the species.

Carbohydrate content of smoked Catfish (*Clarias gariepinus*) and Tilapia (*Oreochromis niloticus*)
The protein composition of smoked *Clarias gariepinus* mean value of 9.093±0.001, while smoked *Oreochromis niloticus* mean value was 23.613±0.000 (Table 01). Smoked *Oreochromis niloticus* contain higher carbohydrate level than the other form of processed fish species. A significant difference in carbohydrate content was observed (p≥0.05) between the species.

Carbohydrate content of wet Catfish (*Clarias gariepinus*) and Tilapia (*Oreochromis niloticus*)
The protein content of wet *Clarias gariepinus* mean value of 1.740±0.019, while wet *Oreochromis niloticus* mean value was 1.767±0.041 (Table 01). There was no significant difference in carbohydrate content observed (p≥0.05) between the species.

Table 01. Percentage of fibre, protein and carbohydrate of the fish samples

Samples	**Fibre (%)** Mean (±SD)	**Protein (%)** Mean (±SD)	**CHO (%)** Mean (±SD)
Smoked Catfish	0.114±0.003	47.309±0.002	9.093±0.001
Smoked Tilapia	0.244±0.008	41.698±0.006	23.613±0.000
Wet Catfish	0.082±0.003	20.199±0.005	1.740±0.019
Wet Tilapia	0.177±0.004	18.369±0.008	1.767±0.041
CHO: Carbohydrate			
SD: Standard deviation			

Table 02. Percentage of moisture, ash and fat of the fish sample

Sample	**Moisture (%)** Mean (±SD)	**Ash (%)** Mean (±SD)	**Fat (%)** Mean (±SD)
Smoked Catfish	28.245±0.212	0.316±0.004	14.922±0.011
Smoked Tilapia	19.719±0.004	2.084±0.008	12.642±0.008
Wet Catfish	62.453±0.011	0.191±0.001	15.336± 0.002
Wet Tilapia	60.194±0.006	2.217±0.002	16.556±0.019

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IV. Discussion

Fish is composed of protein, carbohydrates, fat, ash, and fibre, and It is also regarded as a readily accessible and affordable source of protein and other basic nutrients needed in human diets. These nutrients when they are consumed by man serve a better nutritive value to the body's metabolism. The crude protein content was higher in both the smoked *Clarias gariepinus* and smoked *Oreochromis niloticus*, averaging 47.309±0.002 and 41.698±0.006, respectively. This value is similar to the result of Namaga et al. (2020) on the crude protein content of *Clarias gariepinus* with a value of 49.18±0.30 and 45.13±1.50% which corroborate the report of Iheanacho et al. (2017) that *C. gariepinus* subjected to two different fish processing methods contain a high percentage of crude protein. This suggests that fish processing methods also influence the nutritional component of the fish. A similar study by Fawole et al. (2007) showed that the crude protein content had higher values than the ash content and crude fibre with lowest value. Proximate composition study on genetically modified *Oreochromis niloticus* had significantly higher protein and fat contents (El-Zaeem et al., 2012). This study observed a considerably high amount of fat with mean values ranging from 12.642±0.008 to 16.556±0.019 within the four processed fish samples. The higher fat percentage in fish could result from variations in the temperature of both aquatic environments and fish diet composition. The concentration of lipids in tilapia can be influenced by some factors, which are the salt level of the water body, temperature, diet type, stage of life and species (Hernández and Elena, 2012) or the restricted movements in a confined environment in term of cultured fish, while the lower percentage of fat could be as a result of higher energy expended during food search or while trying to evade predators as a consequence of the unrestricted movement of wild fish in the wild aquatic habitat.

The observed value of ash content in *Clarias gariepinus* (0.191±0.001 and 0.316±0.004) and that of *Oreochromis niloticus* (2.084±0.008 and 2.217±0.002) shows that *Oreochromis niloticus* species has a high content value in ash than *Clarias gariepinus* irrespective of the method of processing. Generally, the ash content of both fish species assessed is an indicator that they are good sources of essential mineral elements like Calcium, Zinc, Iron, Potassium, and Magnesium since ash is a measure of the mineral content of food items and the inorganic residue that remains after the organic matter has been incinerated, which agrees with the findings of Tsegay et al. (2016) report which ranged between 0.81% and 1.16% in the sampled fishes.

Furthermore, there is a wide range of variation in the moisture content of the sample fish between the wet fish samples and the smoked samples. The wet *Clarias gariepinus* and *Oreochromis niloticus* showed a higher percentage mean value (62.453±0.011 and 60.194±0.006) than that of smoked *Clarias gariepinus* and *Oreochromis niloticus* (28.245±0.212 and 19.719±0.004). This variation may be due to several factors such as size, sex, maturity of samples and sampling locations that can affect the differences in the proximate composition of fish (Edirisinghe et al., 2013). Hence, the result of Solomon and Oluchi (2018) on the moisture content of Clarias *gariepinus* shows a lower percentage range based on the factor of the feed fed when compared to that of Tsegay et al. (2016).

V. Conclusion

The study showed a considerably high protein and moisture content in all the freshwater fish species sampled, but the protein content had higher value in both wet and smoked *Clarias gariepinus* than that of *O. niloticus*. However, wet *C. gariepinus* and *O. niloticus* had a high-fat content than the fat content of smoked *C. gariepinus* and *O. niloticus*. Unlike proteins, fat can be reserved in the human body, although *O. niloticus* may be more enticing for consumption. The results from this research can serve as means to encourage fish farmers and Agricultural entrepreneurs to look into Tilapia culture, as it is currently being neglected. Considering that catfish culture is costly due to high protein-rich feed requirement, but study has shown that tilapia has more beneficial as a diet for human. However, it can be agreed that when a high protein is recommended for a particular consumer, it is best to go for smoked fish species as it contains high protein value when being smoked. Further studies can consider the health hazards related to consuming smoked food products such as fish and subsequently weigh the risks involved.

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