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**Comparative Proximate and Mineral Analysis of Fishes (Tilapia And
 Catfish) Found in Damba and Wanke Road Dams –Gusau, Zamfara
 State, Nigeria**

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ABSTRACT

The study involved a comparative analysis of the nutritive values of tilapia and catfish found in Damba and Wanke Road Dams. Proximate and mineral compositions of fish parts (flesh, bones and gills) were carried out using standard methods. The following minerals were determined: Na, K, Ca, Mg, and P in the fish parts. The result of the study showed the superiority of Catfish over Tilapia in terms of Crude protein and Lipid content of flesh which were 54.25% and 18.50% against 28.96% and 9.50%, respectively. Both Tilapia and Catfish were rich in Mineral elements with the concentrations of these elements in the edible parts of the fish following this order Mg<Ca<P<Na<K. It is recommended that, fish from the two Dams could be used as a source of animal protein, lipid, and macro nutrients.

Keywords: Tilapia; Catfish; Proximate; Mineral; Compositions.

1.0 INTRODUCTION

Fishes are jawed, aquatic (fresh water and marine), poikilothermic (cold blooded), oviparous or ovoviviparous, streamlined vertebrates with gills for respiration and fins for locomotion. They exhibit enormous diversity as for their number, size, morphology, habitats, biology, behavior etc. (Nelson, 1994). Fishes form almost half of the number of vertebrates in both fresh and sea water, the largest number of species occurs in the tropics and there is a progressive reduction towards the polar areas. As per most of the estimates, the number of currently recognized fish species range between 17,000 and 30,000 (Nelson, 1994). Fish is one of the diverse groups of animals known to man with more than 20,500 species in existence (Lagler *et al.*, 1977). FAO (1990) indicated that a good amount of fish is produced in Nigeria annually. In 1985, a total catch of 22,000 tones were produced from the part of Lake Chad owned by Nigeria (Sagua, 1986). Welcomme (1979) claimed that 23,000 tones of fish were caught from rivers Niger and Benue. The 15,000km² of floodplains and swamps in the Niger Delta have

been estimated to yield about 60,000t (data based on mean performance of a sample of African floodplains) with official catch estimate reach 19,000t in 1980. Fish farming plays a good part in fish production in Nigeria. According to official statistics, production from fish farm in Nigeria was 20,476t in 1983 and 22,011t in 1984 with 95% of these coming from freshwater aquaculture. Average production was 2.5 – 3t/ ha / yr. FAO estimates were less than these figures being only 5,500t in 1986 (Trait, 1981; FAO, 1999; Andrew, 2001; Sani, 2006). Generally, consumption of significant quantities of dietary fibre has been shown to be beneficial to human nutrition, helping to reduce the risk of certain types of cancer, coronary heart disease, diabetes and constipation (USDA, 2005). This factor can also be attributed to the presence of other classes of foods in fishes that include fats, oil, protein, minerals, etc.

1.1 Paper Objectives

The study was primarily aimed at conducting comparative analysis of the nutritive values of commonly consumed fish species; Tilapia (*Clarias gariepinus*) and Catfish (*Oreochromis*

niloticus) found in Damba and Wanke road Dams. The results obtained would provide background Information on nutritional contents of these Fishes. To the best of our knowledge, from literature survey, no comparative analysis has been ever been carried out on the fish samples of the two Dams.

2.0 MATERIALS AND METHODS

2.1 Study Area

Damba Dam and Wanke Road Dams are Located in Gusau the Capital City of Zamfara State, Northern Nigeria. They are major reservoirs of portable water and fish for the inhabitant of the state capital. They lies within the coordinates of 12°10'N and 12°30' N latitudes and 6°15' E and 6°38' E longitudes, respectively.

2.2 Sample Collection

Samples for analysis include fresh *Clarias gariepinus*, and *Oreochromis niloticus* caught by local fishermen at the site of the two different sources: Damba and Wanke road Dams in Zamfara State, Nigeria. A total of 80 fish samples (40) from each dam for the different varieties of the species were purchased for the analyses. These species were widely distributed in the aquatic environment and have commercial importance. The fishes obtained from these Dams were transported to the laboratory in an ice container for Laboratory analysis at Usmanu Danfodio University Sokoto and kept under frozen condition until analysis.

2.3 Proximate Analysis

Proximate composition: After bringing the samples to uniform size, they were analyzed for moisture, protein, fat, ash, fiber and nitrogen free extract by the methods of AOAC (2003).

2.4 Methodology

2.4.1 Determination of Moisture Content

Principle: The principle assumes that the loss in weight of a sample on drying is due to the loss of moisture only. Therefore, a known weight of the fish sample was dried to constant weight in an oven and the loss in weight is equal to the moisture content of the sample (AOAC, 1991).

Determination of Moisture: Moisture was determined by oven drying method. 1.5g of well-mixed sample was accurately weighed in clean,

dried crucible (W_1). The crucible was dried in an oven at 100-105°C for until a constant weight was obtained. Then the crucible was placed in a desiccator for 30 min to cool. After cooling, it was weighed again (W_2).

The percent moisture was calculated by following formula:

$$\% \text{ Moisture} = \frac{W_1 - W_2}{W_t \text{ of sample}} \times 100$$

where

W_1 = Initial weight of crucible + Sample

W_2 = Final weight of crucible + Sample

Note: Moisture free samples were used for further analysis.

2.4.2 Determination of Ash Content

Principle: The principle is based on the fact that ash content is an estimate of the total mineral content of a sample, and is equated as the amount of inorganic residue remaining after water and the organic matter have been burnt away. Therefore, a known weight of a sample is ignited in a furnace at 600°C to a constant weight. The weight of the residue left after ignition is taken to be the ash content (AOAC, 1991).

Procedure: For the determination of ash, clean empty crucible was placed in a muffle furnace at 600°C for an hour, cooled in a desiccators and then weight of empty crucible was noted (W_1). One gram of each of sample was taken in crucible (W_2). The sample was ignited over a burner with the help of blow pipe, until it is charred. Then the crucible was placed in muffle furnace at 550°C for 3hrs. The appearances of gray white ash indicate complete oxidation of all organic matter in the sample. After ashing, furnace was switch off. The crucible was cooled and weighed (W_3).

The percentage ash content was calculated by the following formula:

$$\% \text{ Ash} = \frac{W_1 - W_3}{W_2 - W_1} \times 100$$

2.4.3 Determination of Crude Lipids

Principle: The principle of this method is based on semi-continuous solvent extraction, using a soxhlet extractor (AOAC, 1991).

Procedure: The extraction flask was washed and dried in an oven at 105-110°C, cooled in

desiccator and weighed. The powdered sample (2g) was weighed and transferred into the thimble and its mouth covered with cotton wool. The solvent used for the extraction (n-hexane) was poured into the extraction chamber. The extraction flask was heated on a heating mantle for six-hours

$$\% \text{ Crude lipid} = \frac{\text{Weight of extracted crude lipid}}{\text{Weight of sample}} \times 100$$

2.4.4 Determination of Crude Fibre

Principle: This principle is based on the quantity of crude fibre lost when a sample is ignited after being digested with an acid and a base. The defatted fish sample is continuously extracted with 1.25% H₂SO₄ and 1.25% NaOH (AOAC, 1991).

Procedure: Two grams of the sample was weight (W₀) and defatted by soxhlet extraction using n-hexane. The defatted sample was then transferred into a 500cm³ beaker. Sulphuric acid (25cm³ of 1.25%) and boiled water were added and the solution made up to 200cm³ with water. This was then boiled by gentle heating for 30 minutes. The resulting mixture was filtered through muslin cloth starched over 9cm Buchner funnel. The resulting residue was rinsed thoroughly with distilled water thrice to completely ensure the removal of acid from sample, then scraped back into the flask with a spatula. Sodium hydroxide (25cm³ of 1.25%) was then added and allowed to boil for 30 minutes. The solution was again filtered and the residue washed with water and rinsed with 10% HCl and n-hexane. The resulting residue was scraped back into a porcelain crucible and oven dried overnight at 105°C. The dry sample removed from the oven cooled in desiccators and weighed (W₁). The resulting sample was then ashes at 550°C for 90 minutes in a muffle furnace, cooled afterwards and then weighed (W₂).

Procedure: The sample (2.0g) was mixed with a table of selenium catalyst in the digestion tube. Concentrated H₂SO₄ (20cm³) was added to the tube which was carefully swirled to ensure homogeneity of the mixture. The tube was then placed in a fume digester cupboard until the solution became clear. This was the indication that organic nitrogen (except nitrates and nitrites) was transformed to ammonium sulphate and the other organic matter to H₂O and CO₂. The tube was then

after which the thimble was removed and the n-hexane recovered from the oil by evaporation.

The extraction flask containing the oil was removed and cooled in a desiccator and weighed. The crude lipid content was calculated using the following equation

The percentage crude fibre was calculated using the following equation

$$\% \text{ Crude fibre} = \frac{W_1 - W_2}{W_0} \times 100$$

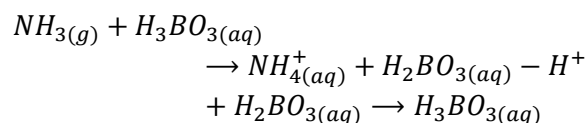
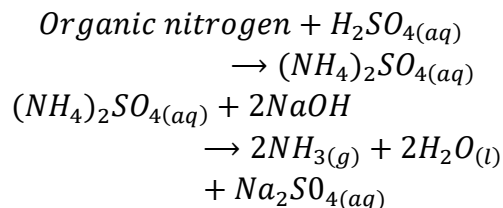
where W₀ = initial weight of sample

W₁ = weight of dry sample

W₂ = weight of ashed sample

2.4.5 Determination of Crude Protein

Principle: The principle is based on the fact that when a food sample is digested with a strong acid, it releases nitrogen which is determined by suitable titration. The amount of protein present is then calculated by multiplying the nitrogen concentration by a conversion factor of 6.25 (equivalent to 0.16g nitrogen per gram of protein) (AOAC, 1991). The equations for the reaction are given as below:



(Christian, 1980; Walter and Bryon, 1981).

removed and the solution diluted to 50cm³ with water. An aliquot (10cm³) of the resulting solution was pipette into the distillation flask in which 20cm³ of 40% NaOH was initially added. This solution was further diluted with 40cm³ water and distilled using the macro-Kjeldahl distillation apparatus. The distillate was collected into the connected receiving flask containing 25cm³ of boric acid indicator solution and then titrated

against 0.01M HCl until the colour changed from green to purple.

The percentage nitrogen content was calculated using the following equation:

$$\% \text{ Nitrogen} = \frac{T_v \times M \times 0.014 \times V \times 100}{W \times 10 \text{ cm}^3 (\text{aliquot used})}$$

where:

- T_v = Acid titer value
- M = Molar concentration of the acid
- W = Weight of sample
- 0.014 = Nitrogen factor
- V = Volume of sample
- 10 cm^3 = Volume of aliquot

The percentage crude protein was calculated as follows:

$$\% \text{ Crude protein} = \% \text{ Nitrogen} \times 6.25$$

Where 6.25 is a conversion factor

2.5 Determination of Calcium (Ca), Phosphorus (P) and Magnesium (Mg) by Atomic Absorption Spectrometry

2.5.1 Sample Preparation for AAS Analysis

Acid used for the Wet Digestion include: Nitric Acid (HNO_3) and Hydrogen Peroxide (H_2O_2) The samples were prepared by taking 1.0g of each of the oven dried sample in a beaker, followed by the addition of 30 cm^3 of freshly prepared 1:1 (V/V) HNO_3 and H_2O_2 . Each beaker was covered with a watch glass for about an hour to allow the initial reaction to subside. The beakers were heated on a hot plate with the temperature not exceeding 90°C for 30 minutes. The contents were then transferred into 50 cm^3 volumetric flask and diluted with distilled water to the mark (Douglas and Donald, 1976; Kakulu *et al.*, 1987)

2.5.2 Procedure for AAS Analysis

The alpha 4 model of atomic absorption spectrophotometer was set according to the manufacturer's instructions with the wavelength corresponding to that of the metal under investigation. Standard solutions prepared from the stock solutions and the blank were used to obtain the calibration curves. The absorbance of each sample was measured in duplicate with an automatic calculation of the average concentration in ppm.

2.6 Data 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 \pm standard deviation (SD). Data were analyzed by T-test. Differences were considered significant at an alpha level of 0.05.

3.0 RESULTS AND DISCUSSION

3.1 RESULTS

Damba and Wanke Road Dams are two the Dams located in Gusau the Capital of Zamfara State; that were selected for this Study.

Proximate analyses were conducted on the fish samples (i.e. tilapia and catfish) to determine the values of the proximate and mineral components.

The results of the proximate analysis for the two fish samples caught from the two Dams were presented in Tables 3.1 and 3.2. The mineral content of the two fish samples from the two Dams were presented in Tables 3.3 and 3.4. All the results presented were extrapolated as means of triplicate analyses.

Table 3.1. Proximate Composition of Fish samples caught from Damba Dam.

Fish type	% Contains				
Catfish	Moisture	Ash.	Crude Lipid	Crude Fibre	Crude protein
	Flesh				
Bones	10.0 \pm 0.01	6.0 \pm 0.01	10.5 \pm 0.01	1.0 \pm 0.00	54.25 \pm 1.06
	5.0 \pm 0.03	38.0 \pm 0.04	2.5 \pm 0.01	6.0 \pm 0.01	19.25 \pm 0.08 51.01 \pm 0.03

Gills	1.0 ±0.01	15.0 ±0.01	4.5 ±0.01	1.5 ±0.01	
Tilapia					
Flesh	8.5 ±0.08	12.0 ±0.01	9.5 ±0.04	1.5 ±0.01	28.96±0.02 10.76±0.01 23.45±0.01
Bones	3.0 ±0.01	27.0 ±0.02	3.0 ±0.01	4.5 ±0.03	
Gills	1.0 ±0.00	20.0 ±0.01	1.5 ±0.02	2.0 ±0.01	

Values are reported as mean ± standard deviation, (n = 3).

Table 3.2. Mineral contents of flesh, bones and gills of Fish samples of Damba Dam (DD)

concentrations are expressed in mg/kg					
Fish Type	Na	K	Ca	Mg	P
Catfish					
Flesh	170.0±1.30	9800±1.40	0.65±0.12	0.10±0.01	3.67±0.06
Bones	157.5±0.91	3400±2.00	0.85±1.09	0.60±0.03	3.48±0.01
Gills	147.5±0.23	4100±1.17	0.90±0.01	0.20±0.01	2.97±0.01
Tilapia					
Flesh	200.0±1.03	5500±0.04	1.00±0.01	0.20±0.00	3.13±0.05
Bones	170.0±0.01	1600±2.02	0.95±0.01	0.25±0.00	2.66±0.01
Gills	105.0±0.80	1200±0.23	0.90±0.02	1.65±0.01	2.92±0.00

Values are reported as mean ± standard deviation, (n = 3).

Table 3.3. Proximate Analysis of Fish samples caught from Wanke Road Dam.

Fish type	% Contains				
	Moisture	Ash.	Crude Lipid	Crude Fibre	Crude protein
Catfish					
Flesh					
Bones	11.5 ±0.07 2.5 ±0.01	5.0 ±0.02 40.5 ±0.05	9.5 ±0.02 1.5 ±0.01	1.5 ±0.01 5.5 ±0.01	52.15±1.02
Gills	1.5 ±0.01	13.0 ±0.01	2.5 ±0.01	1.0 ±0.00	16.45±0.09 40.60±0.12
Tilapia					
Flesh	7.5 ±0.01	11.0 ±0.01	8.5 ±0.02	1.0 ±0.01	29.93±0.03
Bones	1.5 ±0.01	24.5 ±0.09	1.0 ±0.00	3.5 ±0.01	9.28±0.01

Gills	1.0 ±0.00	19.6 ±0.02	1.5 ±0.01	1.5 ±0.02	20.21±0.01
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Values are reported as mean ± standard deviation, (n = 3).

Values are reported as mean ± standard deviation, (n = 3).

3.2 DISCUSSION

3.2.0 Proximate and Mineralization Analysis of Fish

3.2.1 Proximate Analysis of Fish Samples

The results of the proximate composition of the fish samples are shown in Tables 3.1 and 3.3, respectively. The values represent the mean of triplicate determinations and standard deviation. Mean values of triplicate determination and

Tilapia fish samples caught from the two Dams. The high moisture contents recorded for the two fish species are comparable to those reported by other fresh water fish species such as *Mormyrus*, *Oreochromis niloticus* and *Clarias lazera* (Otitologbonet *et al.*, 1997).

Ash: Ash content of the fish samples ranged from 5.0±0.02% to 40.5±0.05 %. The highest percentage of ash was determined in the bones of catfish samples caught from Wanke road dam and lowest value was found in the flesh of catfish samples caught from the same dam.

Crude Fibre: The crude fibre content of fish samples ranged from 1.0±0.00% to 6.00±0.01%. The highest percentage of Crude fibre was determined in the bones of catfish samples caught from Damba dam. While the least value was gotten from the gills of Catfish samples caught from Damba dam and gills of catfish samples from Wanke road dam. The significant reduction of fibre observed in this study posed no threat because fish is usually consumed as adjuncts or additives to other food. This observation agreed with the report of Adeyemi *et al.*, (2013) who reported that higher fibre is poorly digested by animals and interferes with other nutrients. Recently, the interest in dietary fibre has been stimulated due to its ability to prevent chronic diseases such as cardiovascular disease, cancer and diabetes mellitus (Adeyemi *et al.*, 2013).

Crude Protein: Crude Protein content of fish samples ranged from 9.28±0.01% to 54.25±1.06%. Protein was highest in the flesh of Catfish

standard deviation were reported for Moisture, Ash, Crude Lipid, Crude Fibre and Crude protein.

Moisture: Moisture content of the fish parts analyzed reveal that it ranges from 1.0± 0.00 % to 11.5± 0.07%. The highest percentage of moisture was found in the flesh of Catfish samples caught from Wanke road dam. While the least value was gotten from the gills of

samples caught from Damba Dam. It was lowest in the bones of Tilapia fish caught from Damba dam. Every consumer wants to obtain a good quality nutrient especially protein from fish. Fish like any other animals show preferential bio-accumulation of nutrients in the various organs of the body. From this study, it has been observed that protein is more concentrated in the flesh than other parts of the body under investigation, followed by gills and lastly the bones. The result of this study is in concordance with that of Abolude and Abdullahi (2005) where protein was more concentrated in the flesh of *Bargus filamentous* and *hydrocynus brevis*. The values of protein obtained from the parts of the two fish species are within range (21.62-60.57%) reported by Effiong and Fakule (2011). These values indicated that these fish species are a rich source of protein to consumers. The protein contents in fish range with species due to certain factors such as the season of the year, effect of spawning, migration, and availability food etc. (Abdullahi, 2001).

Crude Lipid: Lipid content of the fish samples ranged from 1.0 ±0.00% to 10.05±0.01%. The lipid concentration in this report is higher than the value (5.21%) of *Gymnarchus niloticus* (Adeyeye and Adamu, 2005). This shows that the fish species might be very good sources of fish oil. This is required for food therapy in humans (Oyebanmiji *et al.*, 2008).

3.2.2 Mineral Content of the Fish Samples

Table 3.2 and 3.4 show the mean values of triplicate determinations for the mineral content of

the fish samples caught from the Damba and Wanke road Dams

The following minerals were determined using standard procedures: Na, K, Ca, Mg, and P in the flesh, bones and gills of the fish samples (Tilapia and catfish).

All the fish parts examined contained appreciable concentrations of sodium, potassium, calcium, magnesium and phosphorus. This suggested that these fishes could be used as good sources of minerals. Potassium was observed to dominate other minerals in all samples. This is followed by sodium, phosphorus, calcium and magnesium. The concentration of these elements in the fish parts of either the tilapia or catfish were in the following order Flesh > Bones > Gills. Catfish have higher concentrations of the elements than Tilapia Fish of each of the Dams.

The variations recorded in the concentration of the different elements in the fish parts examined could have been as a result of the rate in which these elements are available in the water body (Yeannes and Almandos, 2003) and the ability of the fish to absorb and convert the essential mineral 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 calcium and magnesium) varied in concentration among the three fish parts 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). The result of the mineral analysis of the two fish species showed abundance of calcium in the bone of the fish species. The significant concentration of calcium observed in the bone of two fish species is expected because of its deposit in the bone. These findings suggest that bones could be a veritable source of calcium to reduce the risk of

osteoporosis and osteomalacia in adults and infants respectively, if transformed into high valued products for human consumption (Adeyemi *et al.*, 2013). The highest concentration of magnesium was recorded in the gills. The highest levels of magnesium in the fish species may be attributed to the rate in which they are available in the water body and the ability of the fish to absorb these inorganic elements from their diet and the environment where they live (Ibiyo *et al.* 2006). Eyo (2001) reported that the mineral content of fish makes fish unavoidable in the diet as it is a source of different minerals that contribute greatly to good health.

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). This study has shown that these fish species from Damba dam and Wanke road Dams are good source of nutrients to the consumers and within the limits required by the body for healthy growth and development. The study has also provided an insight into the mineral content of these species in line with food safety when consumed.

4.0 CONCLUSION

The study has shown that these fish species from Damba and Wanke road Dams- Gusau Zamfara State, Nigeria contain nutrients which are within the limits required by the body for healthy growth and development; as they were within the permissible limits set by WHO/FAO (2004). The study has also provided an insight into the mineral content of these species in line with food safety when consumed. The results obtained from this work also confirmed that nutrients needed for body growth when different fishes are consumed are not only concentrated in the flesh alone, but also in other body parts like the bones and the gills. Hence, these body parts are recommended for consumption to fully obtain nutrients that are present in fish.

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