



Comparative Assessment of Nutrient Composition of Aquacultured and Wild Catfish (*Clarias gariepinus*) in Cross Rivers State Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Author COO, principal investigator, conceptualized and designed the study, prepared the draft of the manuscript and reviewed the manuscript. Author EO advised on the data analysis and interpretation and reviewed the manuscript. Author JOU conducted the study, data analysis and interpretation and assisted in drafting of the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Aim: Aquafarming of catfish has become very popular in Nigeria recently, raising concerns about the nutritional benefits of this fish to consumers especially when compared to the wild catfish.

Study Design: Fishes were obtained from Calabar Cross Rivers State Nigeria. A total of 30 catfishes were harvested, 15 aquacultured and 15 wild. The fishes weighed between 150 – 200 g at the time of harvest.

Place and Duration of Study: The study was carried out at the central laboratory of the University of Calabar, Nigeria and lasted for a period of 6 months.

Methodology: Fishes were cleaned and dried under the sun for a period of 14 days. Dried fishes were eventually ground into fine powder which was used for the nutrient analysis. The proximate, mineral and vitamin contents of aquacultured and wild catfish were investigated. The results revealed that aquacultured catfish contained significantly higher amounts of protein than the wild catfish.

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Conclusion: While the aquacultured fish may be preferable for children, young adults and pregnant women who require a lot of protein for body-building, growth and development, the wild catfish may be more suitable for the maintenance of general health, water and electrolyte balance and optimum productivity being richer in most minerals.

Keywords: Comparative; nutrient; mineral; aquaculture; nutritional, assessment; *Clarias gariepinus*.

1. INTRODUCTION

Fish is a major source of animal protein and an essential food item in the diet of many Nigerians. It is suitable for complementing high carbohydrate diets typical of the low income majority group in Nigeria [1]. Estimated global consumption of fish has continued to increase over the years, reaching 19 kg/capita/year in 2011 from 9 kg/capita/year in 1961 [2]. It is expected to increase to 22 kg/capita/year in 2024 [3]. In some Asian countries particularly China, fish production from aquaculture exceeds that from captured fishes [4].

A meta-analysis by Zhao et al. [5] showed that consumption of 60 g of fish daily is associated with a 12% reduction in mortality. Fish consumption in United States of America has also been associated with long term weight loss [6]. The benefits of fish are associated in part with high concentrations of bioavailable minerals, vitamins, essential fatty acids and protein [7,8]. Fish consumption enhances proper mental development and improves immunity against diseases in growing children [9]. Fish has no cultural or religious restrictions which makes it more advantageous than pork, beef and mutton [10].

Clarias gariepinus, also known as African sharp-toothed catfish is a large, eel-like fish that is often dark gray or black in colour. It belongs to the kingdom: animalia, phylum: *chordata*, class: *Actinopterygii*, order: *Siluriformes*, family: *Clariidae*, genus: *Clarias* and specie: *gariepinus* [11]. This fish specie has slender body, a flat bony head and broad terminal mouths with four pairs of barbells. *C. gariepinus* have large accessory breathing organs made of modified gill arches [11]. *C. gariepinus* is an important part of many commercial and subsistence fisheries and is a major source of protein for people across Africa [12]. It inhabits calm fresh water ranging from lakes, streams, rivers and swamps many of which are subject to seasonal drying. The fish has an almost Pan-African distribution, ranging from the Nile to West Africa and from Algeria to South Africa [13]. The growth potential of catfish

depends on environmental factors such as optimum temperature, water quality and nutrients [14]. Aquacultured fishes are grown in pens that are often submerged in ponds, lakes, and salt water. Wild fish on the other hand are caught in their natural environment [15]. In Nigeria, the specie is of great interest to fish farmers because of their fast growth rates and efficient feed conversion [16], the use of pelleted floating feed has made a big difference to aquaculture development in Nigerian as *C. gariepinus* is being raised to maturity within 6 months. Artificial propagation of *C. gariepinus* is now carried out in hatcheries with hormonal induction [17]. Despite the growing interest in aquacultured catfish production, not much has been documented on its nutritional capacity compared to that of the wild cat fish. The aim of this study is to compare the nutrient composition of aquacultured and wild catfish obtained from Calabar metropolis, Cross Rivers State Nigeria. This will be achieved by comparing the proximate, mineral and vitamin composition of aquacultured and wild catfish. This study will guide the public in making nutritional choices between aquacultured and wild catfish.

2. MATERIALS AND METHODS

2.1 Equipments

Weighing balance (Ohaus U.S) Jenway, UV visible spectrophotometer (Keison UK), Water bath. HH.1042-0 (Germany), Dessicator (Fisher Scientific U.S.A), Soxhlet apparatus (B.BRAN-England), Digestion unit (Kjeldahl, VELP Scientifica-Malaysia), reflux condenser, muffle furnace, thermostatic oven.

2.2 Chemicals/Reagents

All chemicals used were of analytical grade and produced by ELITECH Clinical systems France, they include: methanol, n-hexane, potassium hydroxide, diethyl ether, hydrochloric acid, sodium hydroxide, boric acid, potassium sulphate and sulphuric acid.

2.3 Methods

Domestic catfish was obtained from a fish farm located at Lagos Street while the wild catfish was obtained from Beach Market Marina River all in Calabar Cross Rivers State Nigeria. A total of 30 catfishes were harvested, 15 aquacultured and 15 wild. The fishes weighed between 150 – 200 g at the time of harvest. They were cleaned by removing the innards and scraping out the slimy skin, after which they were rinsed with clean water. They were thereafter dried under the sun for a period of 14 days. Dried fishes were eventually ground into fine powder which was used for the nutrient analysis. One thousand five hundred grams and one thousand four hundred and seventy five grams of fish powder were obtained from wild and aquacultured catfishes respectively. Each analysis was performed in triplicated and the mean recorded.

2.4 Determination of Moisture Content

Moisture content was determined by the gravimetric method as described by James [18].

Procedure: Five grams (5 g) of fresh sample was weighed into a clean vessel, the vessel with the content was dried in the oven at 105°C for 3 hours. After this it was cooled and reweighed. The weight was recorded while the sample was retained in the oven for further drying. The drying, cooling and weighing was continued until a constant weight was obtained. The weight of the lost moisture was determined and expressed in percentage as shown below:

$$\% \text{ Moisture} = \frac{W_2 - W_3}{W_2 - W_1} \times 100/1$$

Where:

W_1 - weight of empty can
 W_2 = weight of can + sample before drying
 W_3 = weight of can+ sample after drying to a constant weight.

2.5 Determination of Total Ash

This was done using the incineration gravimetric method of AOAC [19].

Procedure: Five (5) grams of sample was put in a previously weighed porcelain crucible. The sample in the crucible was then put in a muffle furnace; set at 550°C and allowed to burn for 2 hours until light grey ash was obtained. The

sample in the crucible was carefully removed from the furnace and cooled in a desiccator and weighed, the weight of ash was obtained and calculated in percentage as shown:

$$\% \text{ ash} = \frac{W_3 - W_2}{W_1} \times 100/1$$

Where:

W_1 = weight of sample
 W_2 = weight of empty crucible +sample
 W_3 = weight of crucible + crucible content after ashing

2.6 Determination of Fat Content

Fat content of sample was determined by the continuous solvent extraction method using a soxhlet apparatus as described by James [18].

2.6.1 Procedure

A soxhlet extractor with a reflux condenser and a small round bottom flask (250 mls) was prepared. Five gram (5 g) of each sample was wrapped in a porous paper (Whatman No 1 Filter paper) and the wrapped samples were put in a soxhlet reflux flask containing 200 mls of petroleum ether. The upper end of the reflux flask was connected to a condenser. The solvent contained in the flask was heated through electro thermal heater; it vaporised and condensed into the reflux flask. Gradually, the wrapped sample became completely immersed in the solvent and remained in contact with it until the flask filled up and siphoned over thus carrying oil extract from sample down to the boiling flask. This process was allowed on repeatedly for 4 hours before the sample was removed. The solvent was recovered and the extracting flask with its oil content was dried in the oven at 60°C for 3 minutes to remove any residual solvent. After cooling in dessicator, the flask was re-weighed. The weight of fat was determined and expressed as a percentage of the sample weight as shown:

$$\% \text{ fat} = \frac{W_2 - W_1}{\text{weight of sample}} \times 100/1$$

Where:

W_1 = weight of empty extraction flask
 W_2 = weight of flask + oil extract.

2.7 Determination of Protein

This was determined by Kjeldahl digestion method described by James [18].

The total nitrogen was determined and multiplied with the factor 6.25 to obtain the protein content.

2.7.1 Procedure

Exactly 0.5 g of each sample was accurately weighed into a kjedhal digesting flask and mixed with 10 mls of concentrated sulphuric acid (H₂SO₄) in a Kjeldahl digestion flask. A tablet of selenium catalyst (containing 1 g Na₂SO₄ and 0.05 g selenium) was added to it and the mixture was digested (heated) under a fume cupboard until a clear solution was obtained in a clean flask. The acid and reagents were digested (without sample) to form the blank control. All the digests were carefully transferred to a 100 ml volumetric flask and made up to mark in the flask. A 100 ml portion of each digest was mixed with equal volume of 45% NaOH solution in Kjeldahl distilling unit. The mixture was distilled and the distillate collected into 10 mls of 4% boric acid solution containing three drops of mixed indicator (bromocresol green and methyl red) with the release of ammonia gas. Fifty (50) mls of the distillate was obtained and titrated against 0.02 N H₂SO₄ solution. The end point was from the initial green colour to a deep red point. The nitrogen content was calculated as:

$$\%N = \{100/W \times N \times 14/100 \times V_f/V_a\} T$$

Where:

W= weight of sample analysed
 N= Normality of H₂SO₄ titrant
 V_f = Total volume of filtrate
 V_a = volume of digest distilled
 T= titre value-Blank
 % CP =% N x 6.25

2.8 Determination of Carbohydrates

The carbohydrate (sugar) content was determined by the method of Lane and Eynon [20] where the samples are dissolved in water to undergo hydrolysis with enzymes to release the sugars.

Principle: The test sample is dispersed in water and hydrolysed to release the sugars. The resulting sugars are then determined by titration with Fehling solution to produce a brick red precipitate. The sugar content was calculated as follows:

$$\text{Carbohydrate (\%)} = \% \text{Total sugars} \times 0.9 \times W_2 / W_3 \times 1 / W_1$$

where:

W₁ = weight of sample
 W₂ = weight of carbohydrate extracted
 W₃ = weight of carbohydrate taken for hydrolysis

2.9 Determination of Minerals

The mineral elements were determined using appropriate methods as described by Pearson [21] and modified by Zhou and Yu [22], James [18] and AOAC [19]. The samples for the determination of mineral elements were subjected to acid digestion using concentrated perchloric acid prior to the analysis.

2.10 Acid Digestion of Samples

One milligram (1 mg) of each powdered sample was put in a digesting tube and 12 mls of HNO₃ was added to the samples, the mixtures were kept overnight at room temperature. Thereafter, four mls of perchloric acid (HClO₄) was added to the mixture and kept in the fume block for digestion. Temperature was increased gradually from 50°C up to 250°C. Digestion lasted for 1 hour, 25 minutes as indicated by white fumes. The mixture was allowed to cool after which the contents were transferred to a 100 ml volume flask; the volume was made up to 100 ml with distilled water. The digested solution was transferred to clean bottles and labelled appropriately. This was used for mineral determination.

2.11 Determination of Calcium and Magnesium

Calcium and magnesium contents of the digested test samples were determined using the Ethylene diamine tetraacetic acid (EDTA) complexometric titration method as described by Pearson [21] modified by Zhou and Yu [22]. Sodium and Potassium were determined by flame photometry method [19].

2.12 Determination of Vitamins

Vitamin B₁ was determined by the spectrophotometric method described by Liu et al. [23]. While vitamins A and E were determined by the HPLC methods described by Brubacher et al. [24].

2.13 Statistical Analysis

Each sample was analysed in triplicates and data expressed as mean ± Standard deviation. The

data was analysed by one way ANOVA with post hoc corrected two tailed t-tests using the IBM SPSS statistic software version 22 (SPSS: Statistical Package for Social Sciences). Differences at $p < 0.05$ were considered significant.

3. RESULTS

The aquacultured catfish was significantly ($P=0.05$) higher in crude protein as compared to the wild catfish. While the wild catfish was richer in total carbohydrate content. There was no significant ($P=0.05$) difference in the amount of all the other nutrients analysed.

There was no significant ($P=0.05$) difference in calcium and iron contents of both fishes. However, the wild catfish contained significantly ($P=0.05$) higher amounts of sodium, potassium and magnesium.

There was no significant difference ($P=0.05$) in the vitamin content of the domestic catfish and the wild catfish.

4. DISCUSSION

Results from this study reveal that aquacultured catfish contain significantly higher amounts of protein than the wild catfish (Table 1), while the wild catfish contained significantly higher amounts of sodium, potassium and magnesium (Table 2). There was no significant ($P=0.05$)

difference in the vitamin content of the fishes (Table 3).

The higher protein content observed in the aquacultured catfish relative to the wild catfish is likely as a result of the composition of the artificially made feed which is usually fortified with appropriate nutrients to suit the growth and development of the fish [25]. The composition of fish feed can affect the nutrients composition found in the body of catfish. The more balanced the fish feed composition, the more their nutritional value is balanced [25].

Lehman, [15] reported minor nutritional differences between aquacultured and wild fish. According to his report, wild channel catfish had more vitamin D, potassium and protein, while the aquacultured fish had more polyunsaturated fats. This report agrees in part with findings from the current study. However, his report that wild catfish had a little more protein than the aquacultured catfish does not agree with findings from this research. There is no doubt that specie differences and environmental factors may have contributed to the disparities in various reports as may be the case here. In another study, David et al. [26] reported higher amounts of crude protein, carbohydrate and energy in cultivated *C. gariepinus* than in the wild one thus encouraging the consumption of the cultivated *C. gariepinus* over the wild one. This also agrees with findings from the current study especially with regards to protein content.

Table 1. Proximate Composition of aquacultured and wild catfish

Parameter (%)	Aquacultured catfish	Wild catfish
Moisture content	8.50±3.39 ^a	7.05±1.34 ^a
Ash content	5.15±0.35 ^a	5.78±1.87 ^a
Percentage fat	11.00±1.41 ^a	12.00±2.83 ^a
Crude protein	38.92±3.37 ^a	28.14±0.79 ^b
Total carbohydrate	36.43±1.80 ^a	47.04±1.32 ^b

Data is presented as mean ± SD of triplicate determinations. Values on the same row with different superscripts are significantly different ($P=0.05$).

$n = 3$

Table 2. Mineral composition of domestic and wild catfish

Minerals (mg/100 g)	Domestic catfish	Wild catfish
Calcium	17.26±1.07 ^a	19.10±1.27 ^a
Sodium	29.00±1.41 ^a	50.50±0.71 ^b
Potassium	101.00±1.41 ^a	109.00±1.41 ^b
Iron	12.90±0.85 ^a	17.3±1.56 ^a
Magnesium	57.5±3.54 ^a	82.50±3.54 ^b

Data is presented as mean ± SD of triplicate determinations. Values on the same row with different superscripts are significantly different ($P=0.05$).

$n = 3$

Table 3. Vitamin composition of domestic and wild catfish

Vitamins	Domestic catfish	Wildlife catfish
Vitamin B ₁ (mg/100g)	0.07±0.01 ^a	0.09±0.01 ^a
Vitamin A (IU/g)	17.10±1.56 ^a	19.15±1.20 ^a
Vitamin E (IU/g)	0.44±0.14 ^a	0.53±0.11 ^a

Data is presented as mean ± SD of triplicate determinations. Values on the same row with different superscripts are significantly different (P=0.05).

n = 3

Ibhadon et al. [27], reported higher amounts of total amino acids in aquacultured catfish, while there was no significant difference in moisture, protein and ash content. Since the nutrition quality of seafood largely depends on what the fish eats, the wild catfish which eats natural diet tend to be slightly lower in saturated fat than farm-raised varieties. Aquacultured fish can be slightly higher in omega-3 fatty acids, presumably due to the farms' fortified feed [28]. Also, aquacultured varieties can be higher in contaminants, and tend to have a higher instance of disease due to farming conditions [28].

Ukagwu et al. [29] also reported significantly higher amounts of fibre, fat, moisture and energy in the wild catfish relative to the pond-raised fish, while the pond-raised fish had significantly higher amounts of ash and carbohydrate contents. Domestically reared catfish are fatter since they do not spend their strength vigorously swimming through cold oceans waters or leaping in rocky streams. The aquacultured fishes were found to contain more fat than their wild counterparts. Cultivated catfish had nearly 5 times as much fat as wild fishes [30]. In the current study, the wild catfish was richer in sodium, potassium and magnesium probably as a result of exposure to a wide variety of vegetables and feed in the water, this group obviously have a wider range of feed to choose from unlike their domestic counterparts whose feed are already made from available raw materials. The exposure to more varieties of feed may likely be responsible for the higher amount of most minerals in the wild catfish. Considering the importance of fish feed composition to the nutritional value of African catfish, there should be proper regulations governing the large scale production of fish feed, to ensure they are up to standard before releasing it to fish farmers [25]. According to Nwali et al. [31], both farmed and wild *Claria gariepinus* are good sources of nutrients for human consumption.

Since the differences in most nutrients between the aquacultured and wild catfish were non-significant, both fishes could be considered

nutritionally beneficial to consumers. However, the aquacultured fish may be preferred for children for the purpose of body building and tissue repairs and in all cases where there may be urgent need for protein diet.

5. CONCLUSION

Asides crude protein which was more in the aquacultured catfish, the wild catfish was richer in most essential minerals while there was no significant difference in the vitamin content of both fishes. Thus both fishes may be considered nutritionally relevant and the choice of which to consume may depend on age, as well as the nutritional needs of the consumer at a particular point in time. There is also no doubt that the nutritional intake of a fish, contributes significantly to the nutritional quality of the fish.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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