African Journal of Agriculture and Food Science
ISSN: 2689-5331
Volume 5, Issue 2, 2022 (pp. 32-40)
www.abjournals.org

COMPARATIVE ASSESSMENT OF MINERAL, PROXIMATE AND AMINO ACIDS COMPOSITION OF WILD AND CULTURED *OREOCHROMIS NILOTICUS* AND *CLARIAS GARIEPINUS*

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Cite this article:

Hammed A.M., Awe F.A., Mekuleyi G.O., Adeleye A.A. (2022), Comparative Assessment of Mineral, Proximate and Amino Acids Composition of Wild and Cultured Oreochromis niloticus and Clarias gariepinus. African Journal of Agriculture and Food Science 5(2), 32-40. DOI: 10.52589/AJAFS-1JMN7OUM.

Manuscript History

Received: 5 April 2022

Accepted: 20 April 2022

Published: 5 June 2022

ABSTRACT: *Investigation was conducted on the comparative analysis on mineral, proximate and amino acid composition of wild and cultured Tilapia (Oreochromis niloticus) and African catfish (Clarias gariepinus). Internationally accepted methods of AOAC were used for the AAS analysis while data were tested with ANOVA. Moisture content of wild Clarias gariepinus (21.71±0.07%) and Oreochromis niloticus (12.72±3.00%) were significantly different ($p<0.05$) from that of cultured C. gariepinus (19.19±0.02%) and O. niloticus (14.13±0.03%). Carbohydrate and ash contents of the fish were not significantly different ($p>0.05$). Protein content in C. gariepinus and O. niloticus ranged from 38.61±0.19% (in wild C. gariepinus) to 50.03±0.19% (in cultured O. niloticus). There were significant differences ($p<0.05$) for crude protein, crude fibre, crude fat, Na, Mg and K in the fish species but none for Fe, Pb, Cd and Ca. The highest Na (80.07±0.55mg/100g) was recorded in wild C. gariepinus and the least Na (27.43±0.50mg/100g) in cultured O. niloticus. Cultured O. niloticus had the highest Mg (92.48±0.50mg/100g) while the highest K (44.03±0.50mg/100g) was recorded in wild C. gariepinus. The contents of alanine (4.12±0.12 g/100g), serine (5.77±0.11 g/100g), and aspartate (8.71±0.05g/100g) of wild O. niloticus were higher ($p<0.05$) than those of other fishes. Cultured O. niloticus (5.55±0.05g/100g) had the highest value in proline, while wild C. gariepinus had the highest value in phenylalanine (5.28±0.50 g/100g), but cultured C. gariepinus had the highest isoleucine (4.80±0.03g/100g) and threonine (6.24±0.24g/100g). The proximate composition, amino acid and mineral contents of both cultured and wild fishes vary. Therefore, consumption of fish from both sources is recommended to meet diet requirements.*

KEYWORDS: Fish, proximate, amino acid, minerals, environment, safety.

Article DOI: 10.52589/AJAFS-1JMN7OUM
DOI URL: https://doi.org/10.52589/AJAFS-1JMN7OUM

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INTRODUCTION

As opined by Osibona *et al*. (2009), about 60% of people in many developing countries rely on fish for their animal protein supplies. Fish became an important foodstuff in developing countries due to its high nutritional value and protein content with unsaturated fatty acid (Effiong & Fakunle, 2012). It is also widely acceptable because of its high palatability, tender flesh and low cholesterol (Eyo, 2001). In Nigeria alone, fish supplies 5.6% of total protein and 38.2% of animal protein (FAO, 2016). Because fish food has antimicrobial peptides, it has been divulged that regular consumption of fish promotes the defense mechanism for protection against invasion of human pathogens (Ravichandra *et al.,* 2011). At times, the appreciated values accrued to fish as one of the cheapest and healthiest source of protein is also elated due to its essential amino acids (such as methionine, lysine, cysteine, threonine and tryptophan), micro and macro elements (such as phosphorus, sodium, magnesium, potassium, calcium, fluorine, and iodine), fats and vitamins, to mention but a few (Ismail, 2005; Mohanty *et al*., 2014). The functions of amino acids in both fishes and humans cannot be over emphasized. For instance, amino acids represent the building blocks of protein and act as precursors of different hormones, enzymes, neurotransmitters, nucleic acids and other molecules that are very essential for life (Mohanty *et al*., 2014).

Studies have shown that the nutritional value of fish could be influenced by the environment, species, muscle localization, condition of production, sexual cycle, stage of maturity, diet, age and organs (Saad & Alim, 2015). Therefore, the need to crave better knowledge of fish nutritional constituents that could be associated with fish species and could contribute to the understanding of variability in quality of different species of freshwater fish species in Nigeria cannot be undermined. On this note, this study aimed to investigate the proximate, mineral, metal and amino acid compositions of farmed and wild *Clarias gariepinus* and *Oreochromis niloticus* from Epe in Lagos State, Nigeria.

MATERIALS AND METHODS

Collection of Fish Samples

The samples of wild fishes (*Oreochromis niloticus* and *Clarias gariepinus*) were collected from the landing site of Epe Lagoon, while cultured fish species were obtained from a fish farm within Epe Local Government Area. After collection, all fish specimens were packaged in separate labeled polythene bags and immediately conveyed to the Biochemistry Teaching Laboratory, Lagos University Teaching Hospital (LUTH), Idi-Araba, Lagos, Nigeria, for laboratory analysis.

Procedures of Proximate and Mineral Analysis of the Fish Samples

The percentage of proximate composition of fish was determined by conventional method of AOAC (2000). Duplicate determinations were carried out on ash content, crude fat, crude protein, crude fibre and moisture content. Carbohydrate content of samples was obtained in the form of difference between 100 and the sum of moisture content, protein content, fat content, crude fibre and ash content values. Mineral Contents (Na, Ca, Mg and K) were analyzed using

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DOI URL: https://doi.org/10.52589/AJAFS-1JMN7OUM

AOAC (2000) and Pearson (1976) procedures, while values were quantified using an Atomic Absorption Spectrophotometer.

Procedures of Heavy Metal in the Fish Samples

Four samples of each fish species from each source were weighed and oven-dried at 105ºC for 28 hours. Dried samples were ground into powder with ceramic mortar and pestle and 3 g of each sample was digested (APHA, 1998; Mekuleyi *et al.*, 2021). The values of each metal (Fe, Pb, Cd and Ni) were examined via Atomic Absorption Spectrophotometer.

Procedures for the Determination of Amino Acids

The amino acids in the fish species were determined by following the methods of AOAC (2000) and Saad and Alim (2015), with little modification. 0.5 g of each sample was digested in 5 ml of 6 N HCl for 24 hours and then filtered. 200 µg of filtrate was evaporated and dried in a 140ºC oven for 1 hour. 1 ml of diluting buffer (0.15 M sodium hydrogen carbonate, pH 8.6 with NaOH) was added to each sample and then mixed by vortex. The resulting solutions were incubated at 70°C in a water bath for 15 min. The reaction was stopped by placing the vials in an ice bath for 5 min. A total of 400 µL of the dilution buffer [mixture of 50 ml of acetonitrile, 25 ml of ethanol, and 25 ml of 9 mM sodium dihydrogen phosphate; 4 % dimethylformamide; and 0.15 % triethylamine (pH 6.55 with phosphoric acid)] was added, followed by thorough mixing and centrifugation (5 min, 5000 rpm). 20 µL of the clear supernatants were then injected into the HPLC. Dabsyl derivatives of free amino acids were separated on an Agilent 1100 HPLC system, using a reversed-phase Spherisorb ODS 2 column (25.0 cm × 0.46 cm; 5 µm particle size).

Detection was achieved with a UV detector set at 254 nm. Free amino acid quantification was accomplished by the absorbance recorded in the chromatograms relative to external standards. Under the assay conditions described, a linear relationship between the concentration of amino acids and the absorbance at 254 nm was obtained in the tested range. Finally, samples were injected into the amino acid analyzer model (SYKAM 57130) and the profiles of each sample were determined.

Statistical Analysis

Values of the parameters of the fishes were computed by SPSS (Version 20) and tested by one-way Analysis of Variance (ANOVA) while Duncan's Multiple Range Test (DMRT) at 95% ($p \leq 0.05$) confidence level was used to separate the means.

RESULTS

Table 1 shows the variations in proximate parameters (moisture, protein, carbohydrate, crude fat, ash and crude fibre) of *Oreochromis niloticus* and *Clarias gariepinus* collected from Farm and Epe Lagoon in Lagos, Nigeria. The moisture content of the wild *Clarias gariepinus* (21.71±0.07%) and *Oreochromis niloticus* (12.72±3.00%) were significantly different ($p<0.05$) from that of cultured *C. gariepinus* (19.19±0.02%) and *O. niloticus* (14.13±0.03%). However, *O. niloticus* and *C. gariepinus* from Epe Lagoon had the least and highest moisture contents respectively. The values of carbohydrate contents of wild *C. gariepinus* and cultured

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www.abjournals.org

C. gariepinus, and the values of carbohydrate contents of cultured and wild *O. niloticus* were not significantly different (p>0.05). Similarly, the ash contents of both wild and cultured *C. gariepinus* and *O. niloticus* did not vary significantly (p>0.05).

The protein content in *C. gariepinus* and *O. niloticus* ranged from 38.61±0.19% (in wild *C. gariepinus*) to 50.03±0.19% (in cultured *O. niloticus).* On the other hand, while wild *O.niloticus* had protein content of 46.98±0.19%, cultured *C. gariepinus* had 45.46±0.19% of protein. All the values of crude protein in these fish species were significantly different (p<0.05). While the crude fibre of *C. gariepinus* from the Lagoon (7.35±0.04%) was significantly (p<0.05) higher than crude fibre in other fishes, crude fat of all the fishes varies significantly (p<0.05) with the highest (10.42±0.04%) recorded in wild *C gariepinus* and least in cultured *O. niloticus* (8.27±0.04%).

Table 1: Proximate Composition of *Oreochromis niloticus* and *Clarias gariepinus* Collected from Farm and Lagoon in Epe, Lagos, Nigeria

Parameters (%)	**Wild** *Clarias gariepinus*	**Cultured** *Clarias gariepinus*	**Wild** *Oreochromis niloxticus*	**Cultured** *Oreochromis niloticus*
Moisture	21.71±0.07^{a}	19.19±0.02^{b}	12.72±3.00^{aa}	14.13±0.03^{ab}
Protein	38.61±0.19^{a}	45.46±0.19^{b}	46.98±0.19^{aa}	50.03±0.19^{ab}
Carbohydrate	18.15±0.03^{a}	18.51±0.05^{a}	19.61±003^{a}	20.53±0.05^{a}
Crude fat	10.42±0.04^{a}	8.66±0.03^{b}	9.70±0.02^{a}	8.27±0.04^{b}
Ash	3.77±0.02^{a}	3.61±0.04 ^{a}	3.48±0.06 ^{a}	3.32±0.04 ^{a}
Crude fibre	7.35±0.04 ^{a}	4.58±.16 ^{b}	4.58±0.12^{b}	3.73±0.18^{b}

Mean value with different superscripts in the same row are significantly different at p<0.05 using Duncan's Multiple Range Test (DMRT)

The level of heavy metals (Fe, Pb, Cd and Ni) and minerals (Na, Ca, Mg and K) in both farmed and wild *Clarias gariepinus* and *Oreochromis niloticus* was shown in Table 2. The highest values of Fe (2.22±0.01mg/100g), Pb (0.24±0.04mg/100g) and Cd(0.52±0.02mg/100g) were recorded in wild *O. niloticus*, cultured *O. niloticus* and wild *O. niloticus* respectively. However, the amount of Fe, Pb, and Cd recorded in both farmed and wild *C. gariepinus* and *O. niloticus* were not significantly different (p<0.05) and Ni was not detected in any of the fish samples. For the mineral content, values of Na in all the fishes were significantly different (p<0.05); the highest Na (80.07±0.55mg/100g) was recorded in wild *C. gariepinus*, followed by Na in cultured *C. gariepinus* (82.61±.07mg/100g), while the least Na (27.43±0.50mg/100g) was obtained in cultured *O. niloticus.* The contents of Ca in the fishes did not differ significantly (p>0.05); however, K and Mg contents in the examined fishes were significantly different (p<0.05). Cultured *O. niloticus* had the highest Mg (92.48±0.50mg/100g) while the highest K (44.03±0.50mg/100g) was recorded in wild *C. gariepinus.* On the other hand, cultured *C. gariepinus* had the least K (25.21±0.10mg/100g) while the wild *C. gariepinus* had the least Mg(74.55±1.00mg/100g) contents.

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Table 2: Mineral Compositions and Metals in *Oreochromis niloticus* and *Clarias gariepinus Collected* from Farm and Lagoon in Epe, Lagos, Nigeria

Parameters (mg/100g)	Wild *Clarias gariepinus*	Cultured *Clarias gariepinus*	Wild *Oreochromis niloticus*	Cultured *Oreochromis niloticus*
Na	80.07±0.55[a]	82.61±.07[b]	80.09±0.54[a]	27.43±0.50[ab]
Ca	0.56±0.05[a]	0.32±0.01[a]	0.63±0.02 [a]	0.19±0.00 [a]
Mg	74.55±1.00 [b]	85.98±0.55[a]	76.05±0.50[aa]	92.48±0.50[ab]
K	44.03±0.50[a]	25.21±0.10[b]	44.01±0.50[a]	29.21±0.04[ab]
Fe	2.18±0.04[a]	1.32±0.01[a]	2.22±0.01[a]	1.15±0.5[a]
Pb	0.20±0.00[a]	0.20±0.05 [a]	0.21±0.01 [a]	0.24±0.04 [a]
Cd	0.51±0.02[a]	0.38±0.05[a]	0.52±0.02[a]	0.48±0.05[a]
Ni	ND	ND	ND	ND

Mean value with different superscripts in the same row are significantly different at p<0.05 using Duncan's Multiple Range Test (DMRT)

As divulged in Table 3, 18 amino acids (glycine, alanine, serine, proline, valine, threonine, iso-leucine, leucine, aspartate, lysine, glutamate, methionine, phenylalanine, histidine, arginine, tyrosine, tryptophan and cysteine) were recorded in cultured *Oreochromis niloticus* and *Clarias gariepinus* as well as in wild *O. niloticus* and *C. gariepinus.* However, only values of alanine, serine, proline, threonine, Isoleucine, aspartate, phenylalanine and tryptophan were significantly different (p<0.05) among the examined fishes from the two sources. Contents of alanine (4.12±0.12 g/100g), serine (5.77±0.11 g/100g), and aspartate (8.71±0.05 g/100g) of wild *O. niloticus* were higher (p<0.05) than that of other fishes. For the proline, values of cultured *O. niloticus* (5.55±0.05 g/100g) and wild *O. niloticus* (5.26±0.38 g/100g) were higher than values of both cultured and wild *C. gariepinus.* While the least tryptophan (0.04±0.01 g/100g) was recorded in wild *C. gariepinus*, it had the highest value in phenylalanine (5.28±0.50 g/100g), but cultured *C. gariepinus* had the highest isoleucine (4.80±0.03g/100g) and threonine (6.24±0.24g/100g) when compared with fish from other sources.

Table 3: Amino Acid Profile of *Oreochromis niloticus* and *Clarias gariepinus* from Farm and Lagoon in Epe, Lagos, Nigeria

Amino acid (g/100g)	Wild *Oreochromis niloticus*	Cultured *Oreochromis niloticus*	Wild *Clarias gariepinus*	Cultured *Clarias gariepinus*
Glycine	3.26±0.05[a]	3.71±0.06[a]	3.68±0.02[a]	2.80±0.04[a]
Alanine	4.12±0.12[a]	3.72±0.05[a]	2.87±0.11[b]	2.92±0.06[b]
Serine	5.77±0.11[a]	5.41±0.01[a]	3.46±0.07[b]	3.38±0.04[db]
Proline	5.26±0.38[a]	5.55±0.05[a]	2.72±0.07[b]	2.38±0.04[b]
Valine	3.88±0.11[a]	3.83±0.39[a]	4.21±0.11[a]	3.30±0.05[a]
Threonine	6.11±0.13[a]	5.67±0.05[a]	3.95±0.03[b]	6.24±0.24[a]
Isoleucine	2.79±0.05[a]	2.72±0.05[a]	3.51±0.03[a]	4.80±0.03[b]
Leucine	8.48±0.49[a]	8.17±0.17[a]	8.49±0.05[a]	7.46±0.40[a]

Article DOI: 10.52589/AJAFS-1JMN7OUM
DOI URL: https://doi.org/10.52589/AJAFS-1JMN7OUM

Aspartate	8.71±0.05[a]	7.49±0.51[b]	6.93±0.04[b]	7.25±0.35[b]
Lysine	8.04±0.04[a]	8.04±0.04[a]	7.49±0.09[a]	8.49±0.11[a]
Glutamate	13.29±0.02[a]	13.61±0.06[a]	13.28±0.06[a]	14.24±0.13[a]
Methionine	2.82±0.10[a]	2.79±0.05[a]	2.50±0.05[a]	2.89±0.02[a]
Phenylalanine	3.88±0.12[a]	4.02±0.01[a]	5.28±0.50[ab]	3.90±0.03[a]
Histidine	2.61±0.10[a]	2.72±0.06[a]	2.52±0.02[a]	3.01±0.01[a]
Arginine	4.80±0.03[a]	4.87±0.07[a]	5.79±0.55[a]	4.88±0.05[a]
Tyrosine	2.92±0.03[a]	3.02±0.02[a]	2.55±0.05[a]	3.04±0.03[a]
Tryptophan	2.09±0.02[a]	2.16±0.02[a]	0.04±0.01[ab]	1.65±0.05[a]
Cysteine	1.38±0.08[a]	1.40±0.05[a]	1.22±0.03[a]	1.50±0.04[a]

Mean value with different superscripts in the same row are significantly different at p<0.05 using Duncan's Multiple Range Test (DMRT)

DISCUSSION

The observation of the highest and lowest moisture contents in wild *C. gariepinus* and *O. niloticus* respectively imply that *O. niloticus* from the wild would likely be the least susceptible to microbial spoilage. Oparaku and Nwaka (2013) opined that the higher the moisture of fish, the greater its susceptibility to spoilage. However, all the moisture contents recorded for both cultured and wild *O. niloticus* and *C. gariepinus* in this study were below the moisture value reported in fishes from India's estruary (Vijayakumar *et al*., 2014). The protein content in both wild and cultured *C. gariepinus* and *O. niloticus*, being far greater than 15%, affirmed that the two fishes from both sources belong to the high protein fish category (Njinkoue *et al.,* 2016; Fakoya *et al*., 2019). The protein values recorded in wild and cultured *C. gariepinus* and *O. niloticus* were above that reported in cultured and wild *Clarias gariepinus* in Aliero, Kebbi State, Nigeria (Obaroh *et al.,* 2015). However, the crude fats in this study for both *C. gariepinus* and *O. niloticus* from the wild and farm were lower than those reported by Obaroh *et al.* (2015), but were higher than those reported by Vijayakumar *et al.* (2014). Generally, the cultured *C. gariepinus* and *O. niloticus* in this study had higher protein when compared with those from the wild. The differences in protein content could be as a result of different varieties of food being fed to these fishes by fish farmers. According to the Association of Official Analytical Chemists (AOAC. 1988), proteins are a major constituent when evaluating the nutritional value of fish. Thus, high protein obtained in the evaluated fishes makes them important candidates of good dietary protein sources.

The crude fibre and fat of *C. gariepinus* from Epe Lagoon, being significantly higher than fishes from the farm, could indicate that *C. gariepinus* is naturally endowed with fat. Low values of carbohydrate in the sampled fishes in comparison with protein could be attributed to the fact that carbohydrate contributes little percentage to the biochemical makeup of fish. However, values of carbohydrates in this study were above those reported by Vijayakumar *et al.* (2014). The ash content of the fishes examined in this study are low and this could be as a result of none or low level of exoskeleton in the examined fishes, or an indication of dilution of the food with substances having lower inorganic level (Adeyeye, 2002). However, values of ash in this study were higher than those reported by Vijayakumar *et al.* (2014)**.**

All the values of metals (Fe, Cd, Pb) obtained in this study were lower than the maximum allowable limits recommended in food fish by the World Health Organization (2008).

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Similarly, Na, K, Ca and Mg obtained in the wild and cultured *C. gariepinus* and *O. niloticus* were lower than the recommended permissible limits in fish, and the implication of these attributes is that all the examined fishes are rich in minerals and are safe for consumption. The contributions of minerals to human health cannot be overlooked. For instance, Na is required for balance of extracellular body fluids while calcium is responsible for the formation of bones (Ogungbenle, 2003). Deficiency of Ca and K could lead to a disease common among women called Osteomalacia (bone thinning) and Osteoporosis (Adult ricket) (Adeyeye, 2002). Mg ions regulate several biochemical reactions in the body through their role as enzyme cofactors. They also play a vital role in the reactions that generate and use ATP, which is the fundamental unit of energy within the body's cells (Ogungbenle *et al.*, 2018). Also, the ratio of sodium to potassium (Na/K) in the body is of great concern for the prevention of high blood pressure. A minimum Na/K ratio of 0.6 is recommended for humans (Nieman *et al.*, 1992). In the present study, all Na/K ratios calculated for wild and cultured *C. gariepinus* and *O. niloticus* were above the recommended minimum value of 0.6. For instance, the highest (3.27) of NA/K was found in cultured *O. niloticus*.

Out of 18 amino acids recorded in cultured and wild *O. niloticus* and *C. gariepinus*, only values of eight namely alanine, serine, proline, threonine, isoleucine, aspartate, phenylalanine and tryptophan were significantly different. This observation indicated that both species regardless of their sources have similar amino profiles. Various functions of all the amino acids detected in this study abound in different works of literature such as Mischoulon and Fava (2002), DeBondt and Cynober (2006), Richard *et al*. (2009), Liao *et al*. (2013) and Mohanty *et al.* (2014).

The amino acids detected in *O. niloticus* and *C. gariepinus* for this study were in consonant with those of *Labeo niloticus, Bagrus bayad, Clarias gariepinus* and *Synodontis schall* from Sudan (Mohammed & Alim, 2012; Saad & Alim, 2015)**.** In contrast, the values of amino acid in this study were lower than those reported in carps (*L. rohita*) and catfishes (*Channa striatus*) (Mohanty *et al.*, 2014). However, these variations may be attributed to differences in species and/or catch locality.

CONCLUSION

This study has elucidated that the cultured *C. gariepinus and O.niloticus* had more protein than the wild species. However, both fish species from the wild and farm are also excellent sources of minerals especially Na, K, Ca and Mg. They are rich in amino acids, with heavy metals (Pb, Cd and Fe) that do not exceed recommended permissible limits. Based on the findings in this study, the two fish species are judged safe for consumption and thus recommended for both adults and children in order to meet their nutritional requirements.

Article DOI: 10.52589/AJAFS-1JMN7OUM
DOI URL: https://doi.org/10.52589/AJAFS-1JMN7OUM

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Article DOI: 10.52589/AJAFS-1JMN7OUM
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