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Comparative Study of the Flesh Quality of *Clarias gariepinus* in Farm-raised and Wild Populations

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Authors' contributions

This work was carried out in collaboration among all authors. Author POM designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. As well as managed the analyses of the study. Author FEA read the draft of manuscript with the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aim. Nutrients analysis of wild and farmed raised African catfish (*Clarias gariepinus*, Burchell, 1822) were studied. The comparative work was carried out to find out if habitat could affect the nutrient composition of the fish.
Study design: Five live *C. gariepinus* were obtained for three wild location and three fish farm each (n=30). One-way analysis of variance was use to examine the nutrients composition across the study locations.
Methodology: Five individual fishes were randomly selected from the forty individuals in a population obtained from six locations. They were sacrificed and cut into three (tail, middle and trunk) chunks. These were oven dried at a constant temperature of 105ºC using oven model LCON53CF. The samples were later blend using electric blender and kept in airtight nylon for further analysis. Standard methods were employed in the analysis of body nutrients.
Results: A significant difference was observed in proximate composition of *C. gariepinus* on dry matter bases. The moisture and lipids content were lower in wild *C. gariepinus* (5.16±0.07;15.27+0.08%) than farm raised (5.25±0.10%;18.54+0.08%). The average protein and ash contents in farm-raised *C. gariepinus* were significantly ($p<0.05$) lower (66.23+0.08%;

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5.00+0.07%) than wild *C. gariepinus* (67.24+0.09%;9.06+0.07%). Organoleptic study revealed differences in taste between wild and farm raised *C. gariepinus* (p<0.05). The amino acids profile showed little disparity in quantity in wild and farm raised *C. gariepinus*. No significant difference (p>0.05) was noticed in the mean values of amino acids in wild (4.21) and farmed raised (4.16) *C. gariepinus.* The percentage of saturated fatty acids was higher (56.24%) in farmed raised *C. gariepinus* than the wild stocks (44.53%) unlike the unsaturated fatty acids that was higher in wild (79.46%) than the farmed raised (54.03%).

Conclusion: The study revealed that wild fish possess some nutritional advantages over the culture *C. gariepinus.*

Keywords: Body nutrients; proximate compositions; fatty acids; amino acids; wild; farmed raised; catfish.

1. INTRODUCTION

The constant increase in human population and tremendous awareness of the unique nature of fish nutrients in human diets has led to an unprecedented increase in the demand for fish [1]. Eating fish is recommended for all age groups because it is easy to digest and contains omega-3 fatty acids, vitamins and minerals [2], and is valued for its high nutritional qualities. Flesh quality has gained high preference among consumers and in the aquaculture industry because it is directly related to human health and nutrition. It is influenced by numerous endogenous and exogenous factors [3] and consists of different characteristics such as organoleptic properties, nutritional values, and freshness. The quality dimensions mainly rely on the chemical composition of the species; age, sex, season, feeding, and environmental factors [4] The difficulty to define nature of diet and environmental history of free-living fish makes contrast of sensory attribute of wild and farm raised fish difficult. However, existing literature clearly indicates that significant organoleptic differences always occur when comparing wild and farm raised counterparts of the same species [5].

This has not been documented on Clariid catfish, especially in Nigeria. Although there are findings on the proximate composition of the world's food fish, there is little information on the organoleptic differences of wild and farm raised catfish in Nigeria.

Farmed and wild fish had been reported to differ in proximate composition, colour, texture, fatty acids and free amino acids (FAAs) profiles [6].

Proximate composition is used as an indicator of fish quality. It varies with diet, feed rate, genetic strain and age [7].

The family, *Clariidae* is the most important tropical fish farm raised in ponds. Due to their unique qualities in culture systems, hardiness, resistance to diseases and parasites, tolerance of environmental conditions in captivity, fast growth, good table size and palatability [8,9]. The evaluation of the flesh quality of different populations can result in a genotype suitable for aquaculture. Thus, this study is principally aimed to evaluate and compare the flesh quality (biochemical composition, nutritional value and carcass traits) of both the wild and farm raised populations of *Clarias gariepinus,* with a view to finding out if there is any difference in their nutritional status, which will help the consumers to make a good choice in catfish consumption.

2. MATERIALS AND METHODS

2.1 Study Area

The study area is presented in Fig. 1. The farm raised samples were obtained from fish farms in Federal University of Technology Teaching and Research Farm (Akure), Leventis Agricultural training school, Ilesa (Osun State), Ekiti State Ministry of Agriculture, Ado-Ekiti (Ekiti State), while the wild counterparts were obtained from fishermen at Oluwa River, Agbabu (Ondo State), River Osun, Esa-Odo (Osun-State), Owena River, Owena (Ondo State).

2.2 Samples Collection and Preparation

Two hundred and forty individual samples of *C. gariepinus* of farm raised and wild with average weight of 675±0.35 g were obtained from six different locations. The fish were kept in six different concrete tanks to acclimated for 48 hours at the teaching and research farm of the Federal University of Technology, Akure.

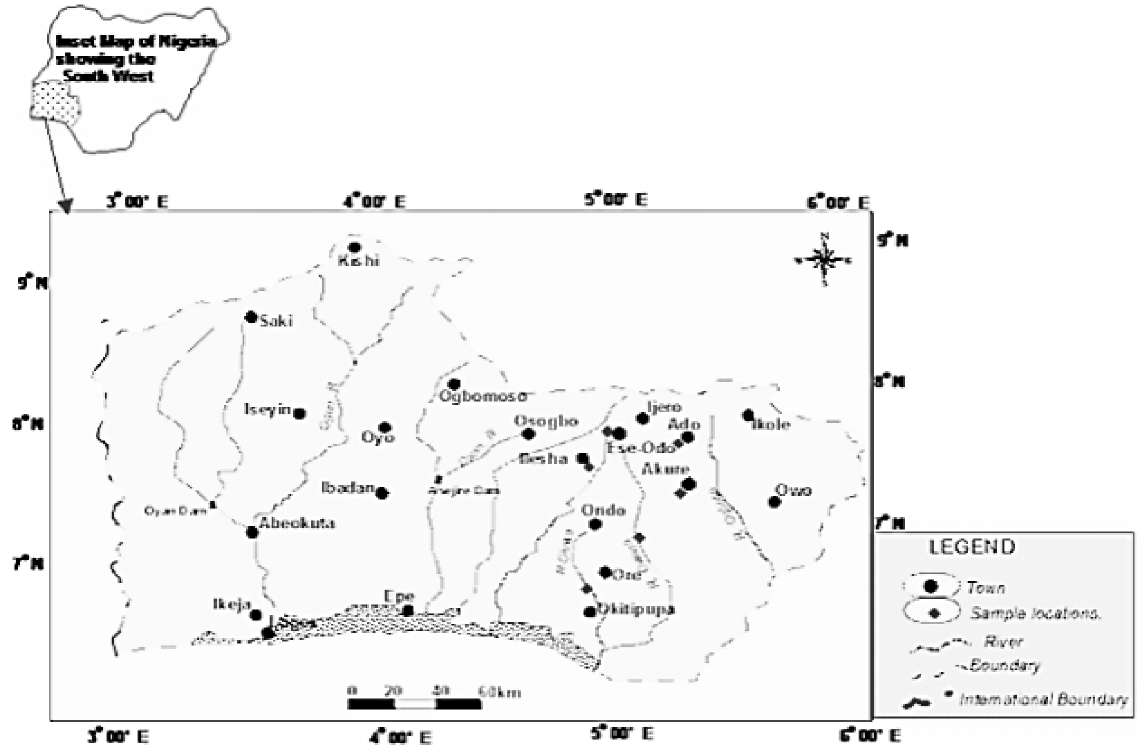

Fig. 1. Map of South West Nigeria show the study areas (Current study)

2.3 Samples Preparation

Five individual fishes were randomly selected from the forty (40) population of fish obtained from the different sources after acclimation. The selected fish samples from each source (5 per location) were weighed, sacrificed and eviscerated before cutting into chunks. Three chunks from each of the samples were selected and dried in the oven (model: LCON53CF) at a constant temperature 105ºC. Thereafter, they were grinded with mortar and pestle. The pulverized samples were kept in airtight nylon for proximate analysis.

2.4 Proximate Analysis of Wild and Culture *C. gariepinus*

The proximate analysis was carried out using facilities of the Department of Fisheries and Aquaculture, Federal University of Technology, Akure Using AOAC methods [10].

2.5 Determination of Minerals in Wild and Culture *C. gariepinus*

Minerals were analyzed using BUCK 2000 AAS (Atomic Absorption Spectrophotometer) using facilities of central laboratory, Institute of Agricultural Research and Training, MOOR plantation Ibadan (IAR and T). The digest of each of the sample (5 from each location) was washed into 100 ml volumetric flask with de-ionized water and made up top mark. These diluents were aspirated into BUCK 2000 AAS through the suction tube. Each of the mineral elements was read at their respective wavelength with their respective hollow cathode lamps using appropriate fuel and oxidant combination.

The ash sample obtained from burnt sample was treated with 2 M HCl solution. 10ml of the filtrate solution was pipette into 50ml standard flask and 10 ml of Vanadate yellow solution was added and the flask was made up to mark with distilled water, stopper and left for 10 minutes for full yellow development. The concentration of phosphorus was obtained by taking the absorbance of the solution on a Spectronic 20 colorimeter at a wavelength of 470 mm. The percentage phosphorus was calculated using the formula

$$\text{\% of Phosphorus} = \frac{Absorbance x Slope x Dilution factor}{100}$$

2.6 Amino Acids profile determination in Wild and Culture *C. gariepinus*

Amino acids were determined using the modified method of [11]. Seven mililitres of 6N-HCl were added to 2 ml deffated sample in a glass ampoule. Nitrogen gas was bubled in to prevent oxidation during hydrolysis. The samples were then hydrolysed at 100 ± 5ºC for 22 hours. After cooling, the hydrosylate was filtered and 4 ml of the filtrate were then vacuum dried. Citrate buffer ($_P$H 2.2) was used in reconstitution the samples. 1 ml of each sample solution was used in loading the Technicon TSM 50 Amino acid- analyzer.

2.7 Statistical Analysis

The values obtained by the analysis of different fish samples of *C. gariepinus* are given as the means ± SE. The differences between the mean values of the studied parameters were calculated using single factor analysis of variance in SPSS ver.14. When there were significant differences between means groups ($p < 0.05$), Duncan's Multiple Range Test was used to separate the means [12].

3. RESULTS

3.1 Proximate Composition

The concentration and percentage of proximate composition (protein, lipid, Ash and moisture contents) of samples analyzed is presented in Table 1. The result of the proximate analysis shows that there were significant differences ($P < 0.05$) in all the parameters under consideration. The mean protein and ash content from the wild samples are significantly higher than the farm raised samples. The higher proportion were recorded for moisture and crude lipid in farm raised samples (Table 1).

3.2 Comparison of means for minerals contents in muscle from wild and farmed *Clarias gariepinus*

The result for the proportion of mineral composition in each of the fish samples analyzed is shown in Table 2. There was significant difference in the proportion of the minerals analyzed when comparing wild and farm raised *C. gariepinus*. From table 3, samples from wild had significantly ($p<0.05$) higher value in Mn, Cu and Mg. The mean value for S, Ca, P, Na and K were significantly ($p<0.05$) higher in farm raised samples than the wild samples. No significant ($p>0.05$) difference was observed for Zn and Co between the farm raised and the wild fish.

3.3 Amino Acids Profile of *C. gariepinus* from Wild and Farm Raised Environment

The result of the amino acid profile of the wild and farm raised *C. gariepinus* is shown in Table 3. Seventeen amino acids were identified and the degrees of variability of different amino acids in percentages of total amino acids in each sample were compared. In amino acids identified, the mean value for threonine was significantly ($p<0.05$) higher in wild compare with farmed stocks. Similar observation was noticed for valine, methionine, leucine, serine, tyrosine, phenyalanine, arginine, alanine, praline and glutamic acid. The mean values recorded for histidine were the same in both wild and farm raised *C. gariepinus*. It was also noticed that some amino acids have higher mean values in farmed *C. gariepinus* compared to wild stocks. These include taurine, isoluecine, cystine, asparagines and aspartic acid.

4. DISCUSSION

4.1 Proximate Composition

The nutritional elements showed variable values in the fish samples analyzed with crude protein recording the highest values and moisture recording the lowest on dry matter bases. This relatively high to moderate percentage of crude protein could be attributed to the fact that fishes are good source of pure protein, and was similar to the observations of Duncan [13] who reported that protein forms the largest quantity of dry matter in fish. The high protein contents and the moderate lipids levels in wild and farm raised *C. garieppinus* are similar to that found in other species such as sardine, horse-mackerel and sarda [14,15,16] However, the differences observed, in the values could be attributed to the fish's consumption or absorption capability, and the rate in which these components are available in the water body as observed by Yeannes and Almandos [17]. This could also be linked with the conversion potentials of essential nutrients from their diet or their local environment into such biochemical attributes needed by the organisms' body [18,19,20]. The difference between the crude protein in farm raised and wild catfish could also be attributed to the fact that in addition to natural supply of protein source from zooplankton in ponds, fish under intensive or

Table 1. Comparison of means (% ± S.E.) for protein, lipid, ash, and moisture contents in muscle from wild and farmed *Clarias gariepinus*

Weight category	**Protein content**			**Lipid content**			**Ash content**			**Moisture content**		
	Wild	**Farm raised**	**Mean SE**	**Wild**	**Farm raised**	**Mean SE**	**Wild**	**Farm raised**	**Mean SE**	**Wild**	**Farm raised**	**Mean SE**
W1 (3-5g)	69.60±0.07^{d}	67.65±0.07^{b}	68.63±0.11 ^{a}	15.62±0.10^{a}	18.73±0.11^{d}	17.18±0.11 ^{c}	9.29±0.08^{d}	8.01±0.11^{a}	8.65±0.10 ^{a}	5.49±0.09^{c}	5.61±0.08^{c}	5.55**±**0.09 ^{a}
W2 (6-8g)	68.99±0.05^{a}	67.52±0.08^{d}	68.26±0.05 ^{b}	16.48±0.05^{b}	18.36±0.09^{c}	17.42±0.07 ^{a}	8.93±0.08^{b}	8.73±0.05^{c}	8.83±0.07 ^{a}	5.60±0.09^{c}	5.39±0.08^{a}	5.50**±**0.09 ^{a}
W3 (9-10g)	69.45±0.08^{e}	66.52±0.08^{c}	67.99±0.06 ^{c}	15.98±0.10^{b}	18.74±0.09^{d}	17.36±0.10 ^{b}	9.23±0.08^{d}	8.50±0.06^{a}	8.87±0.07 ^{a}	5.43±0.11^{b}	6.24±0.10^{d}	5.84**±**0.11 ^{b}
	69.35±0.08^{a}	67.23±0.07		16.03 ±0.08b	18.61 ±0.09^{a}		9.15±0.07^{a}	8.41±0.08^{b}		5.57**±**0.10^{a}	5.75**±**0.07^{b}	

Table 2. Comparison of mineral profile of farm raised and wild *C. gariepinus*

Mineral (Mg/g fish muscle)	**Wild**				**Farm raised**			
	Agbabu	**Esaodo**	**Owena**	**Mean±SE**	**Ado-Ekiti**	**Akure**	**Ilesa**	**Mean±SE**
Mn	2.03±0.03	1.70±0.06^{b}	2.12±0.05^{a}	**1.95±0.04** ^{a}	1.18±0.04^{c}	1.78±0.06^{b}	2.19±0.06^{a}	**1.72±0.05** ^{b}
Cu	2.39 ±0.05^{c}	1.25±0.05^{a}	1.42± 0.04^{ab}	**1.69±0.05** ^{a}	1.47 ±0.06^{b}	1.37± 0.05^{ab}	1.30±0.06^{ab}	**1.38±0.04** ^{b}
Co	0.01 ±0.00^{a}	0.01 ±0.00^{a}	0.01 ±0.00^{a}	**0.01±0.00** ^{a}	0.01± 0.00^{a}	0.01± 0.00^{a}	0.01 ±0.00^{a}	**0.01±0.00** ^{a}
Zn	0.63 ± 0.06^{a}	0.60± 0.05^{a}	0.64± 0.04^{a}	**0.62±0.51** ^{a}	0.59 ±0.05^{a}	0.68 ±0.06^{a}	0.57 ±0.06^{a}	**0.61±0.03** ^{a}
S	0.38 ±0.05^{c}	0.16 ± 0.03^{a}	0.28 ±0.04^{abc}	**0.27±0.36** ^{a}	0.35 ±0.04^{bc}	0.38 ±0.04^{ac}	0.22 ±0.04^{ab}	**0.32±0.04** ^{a}
Ca	2.21 ±0.06^{a}	2.27± 0.04^{a}	3.23± 0.05^{c}	**2.57±0.50**	2.55± 0.05^{b}	2.58 ±0.06^{b}	3.10 ±0.06^{c}	**2.74±0.06** ^{a}
Mg	1.47 ±0.04^{a}	1.53 ± 0.05^{ab}	2.46 ±0.04^{d}	**1.82±0.43** ^{a}	1.57± 0.06^{ab}	1.67± 0.04^{b}	1.97 ±0.05^{c}	**1.74±0.03** ^{b}
P	0.28 ± 0.04^{a}	0.36 ± 0.05^{ab}	0.49 ± 0.05^{b}	**0.38±0.46** ^{b}	0.43 ±0.07^{ab}	0.41± 0.05^{ab}	0.47 ±0.06^{b}	**0.44±0.06** ^{a}
Na	3.98± 0.04^{a}	4.20± 0.06^{b}	6.06 ± 0.06^{e}	**4.75±0.53** ^{b}	4.92 ± 0.05^{c}	5.06± 0.05^{c}	5.26 ±0.05^{d}	**5.08±0.05** ^{a}
K	4.98 ±0.06^{a}	5.06 ±0.05^{ab}	5.49 ±0.04^{c}	**5.18±0.50** ^{b}	5.15 ±0.04^{b}	5.38 ± 0.06^{c}	6.16 ± 0.04^{d}	**5.56±0.04** ^{a}

Means within a row with the same superscript do not differ (P > 0.05)

Table 3. Comparison of amino acids profile of wild and farm raised *C. gariepinus*

Amino acids	Wild				Farm Raised			
	Agbabu	Owena	Esa- Odo	Mean	Ilesa	Ado – Ekiti	Akure	Mean
Threonine	2.74 ± .04[a]	3.22±.05[b]	3.16±.06[b]	**3.04±0.6**[a]	2.69±.05[a]	3.65±.05[c]	2.65±.04[a]	**3.00±0.7**[a]
Valine	3.91± .05[c]	3.86±.04[a]	3.89±.05[b]	**3.89±0.8**[a]	3.46±.04[b]	3.79±.05[c]	3.93±.05[c]	**3.73±0.7**
Taurine	0.53 ± 0.03[a]	0.65± 0.05[b]	0.52± 0.07[a]	**0.57±0.7**[b]	0.71± 0.04[c]	0.66± 0.05[b]	0.65± 0.02[b]	**0.67±0.4**[a]
Methionine	2.76± .06[b]	2.85±.05[ab]	2.77±.03[b]	**2.79±0.8**[a]	2.72±.04[ab]	2.82±.05[a]	2.77±.06[b]	**2.77±0.6**[a]
Isoleucine	3.72± .06[b]	3.63±.06[b]	3.44±.04[a]	**3.60±0.6**[b]	3.67±.03[b]	3.74±.04[b]	3.71±.04[b]	**3.71±0.5**[a]
Leucine	4.49±.05[d]	3.41±.04[a]	3.31±.04[a]	**4.40±03**[a]	3.85±.05[b]	4.17±.05[c]	4.42±.01[d]	**4.15±0.6**[b]
Serine	4.98 ±0.24[b]	4.93±0.26[a]	5.01±0.28[c]	**4.97±0.2**[a]	4.73±0.24[b]	4.84±0.27[b]	5.23±0.26[c]	**4.93±0.5**[a]
Tyrosine	1.42±.01[a]	1.65±.05[a b]	1.39±.05[ab]	**1.49±0.6**[a]	1.28±.04[b]	1.55±.06[ab]	1.14±0.01[a]	**1.32±0.6**
Phenylalanine	3.50±.04[b]	3.38±.06[bc]	3.33±.06[ab]	**3.40±0.7**[a]	3.16±.06[a]	3.53±.05[c]	3.17±.05[a]	**3.29±07**
Cystine	4.02± .06[a]	4.22±.06[b c]	4.06±.04[ab]	**4.10±0.7**[a]	4.24±.04[b c]	4.26±.06[c]	3.95±.07[a]	**4.15±1.2**[a]
Histidine	1.18± .06[a]	1.14±.04[a]	1.16±.055[a]	**1.16±0.8**[a]	1.11±.04[a]	1.21±.04[a]	1.17±.06[a]	**1.16±0.6**[a]
Arginine	2.45± .05[b]	2.56±.03[a]	2.72±.06[ab]	**2.58±0.6**[a]	2.15±.05[a]	2.70±.04[ab]	2.22±.05[ab]	**2.36±0.3**[b]
Asparagine	1.24± .05[a]	1.17±.05[a]	1.17±.05[a]	**1.19±0.2**[a]	1.26±.06[a]	1.19±.05[a]	1.17±.05[a]	**1.21±0.5**[a]
Alanine	1.47± .05[a]	1.32±.05[ab]	1.48±.06[b]	**1.42±0.2**[a]	1.43±.06[ab]	1.37±.05[ab]	1.30±.08[ab]	**1.37**±0.6[a]
Proline	3.81 ±0.21[a]	3.92±0.23[b]	4.05±0.25[c]	**3.93±0.4**[a]	3.67±0.26[a]	3.95±0.25[b]	4.10±0.21[c]	**3.91±0.3**[a]
Glutamic acid	17.81 ±0.9[b]	17.76±0.7[a]	18.12±0.8[c]	**17.90±0.9**[a]	17.82±0.9[b]	17.69±0.5[a]	17.58±0.9[a]	**17.70±0.5**[b]
Aspartic acid	11.35 ±0.61[d]	11.27±0.41[c]	10.95±0.63[a]	**11.19±0.5**[b]	11.17±0.71[b]	11.26±0.60[c]	11.36±0.71[d]	**11.26±0.9**[a]

Means within a row with the same superscript do not differ (P > 0.05) semi-intensive culture are fed with high-quality diet. These diets are usually compounded with protein rich feed ingredients such as soybean meal, fishmeal, groundnut cake, among others in addition to energy rich sources of feed ingredient, while wild fishes rely solely on protein source from zooplankton within the water column and they expend a lot of energy while hunting for the food [21]. This state of scarcity resulted in the decreased growth of fish due to restricted food supply to fish.

There was significant difference between the ash content in the wild and farm raised fish with the exception of fish from Esa-odo and Akure. Fish from the wild had the highest ash content, and could be linked to the level of minerals available in the water body or the materials they feed on. The ash content from Akure samples was quite high, and might be due to the fact that the fish from Akure (FUTA) were raised in an earthen pond while that of Ado - Ekiti and Ilesha were exclusively raised in concrete tanks. The highest ash content recorded from Agbabu in Ondo State compared to those from Ado - Ekiti could be as result of the differences in the materials they fed on.

The high lipid content obtained in farm raised sampled from this study was in line with Tahir [22] who observed high lipid content in farmed grass carp and farmed *Labeo rohita* when compared with its wild counterpart. Jankowska et al. [23] observed that contents of water, protein and fats in the fillets of cultivated and wild perch (*Perca fluviatilis*) differed significantly. Farmed fish muscle showed a higher total lipid content than its wild counterparts. They were of the opinion that feed offered to farmed specimen has direct impact on the body fat increments. This was also similar to the report of Orban et al. [24] who found similar results on European seabass (*Dicntrarchus labrax*) and wild yellow perch (*Perca flavescens*). The result from this study agreed with Olapade et al. [25] and Onyia et al. [26] who worked on wild and farm raised *C. gariepinus* and reported that the proximate composition values were higher in wild *C. gariepinus* when compared to farm raised.

4.2 Minerals

Mineral contents in fish depend on its availability in their environment followed by diet absorptive capability and preferential accumulation of same by the fish. The higher proportion of minerals from wild had compared with farm raised *C. gariepinus* observed in the this study could be as a result of age differences in the samples used for the analysis. This was supported by Boyd and Davis [27] who reported that there is increase in the proportion of bone to flesh as the fishes grow.

The variations recorded in the concentration of minerals in fish muscles examined could have been as a result of the rate in which they were available in the water body and the ability of the fish to absorb these inorganic elements from their diets and the water bodies where they live [28]. The result obtained from this study, agrees with the findings of Lindsay [29] on yellow perch. He reported that farmed yellow perch contained higher magnesium, phosphorus and potassium, while wild yellow perch had significantly higher concentrations of sodium and sulfur.

4.3 Amino Acids

There was significant difference in amino acids both between and within the locations from which the stocks were obtained (wild and farm raised environment). Eight essential amino acids namely Arginine, leucine, isoleucine, valine, methionine, phenylalanine, histidine, and threonine that are extremely important for human body were present in *C. gariepinus*. The amino acids are present in the order as shown. Glutamic acid> Aspartic acid> Serine> Cysteine> Leucine> Isoleucine> Proline> Phenylalanine> Methionine> Threonine> Arginine> Alanine> Asparagine> Tyrosine> Histidine> Taurine. The dominance of glutamic acid as a major amino acid reported in this study is similar to earlier reports on amino acids by Ibhadon et al. [30]. Histidine and Taurine had the least amount, and the effects cannot be ignored since low amount of the former can lead to chemical sensitivity, and can even cause food allergy while that of the former can aggravate rheumatoid, anemia and imbalance of intestinal bacterial flora.

Ibhadon et al. [31] reported that when amino acid profile of *C. gariepinus* was compared in two different habitats, farmed fishes had better amino acid balance and significantly higher concentrations than their wild counterparts. This finding disagreed with the result of this study, in which the fish from the wild had the higher concentration of some of the Amino acids analyzed. This might be the reason why preference was given to the wild stock by the taste panelists. This could also be from genetic make-up as reported by Gjerd and Schaeffer [32] who observed a genetic influence on the body protein content of rainbow trout.

5. CONCLUSION

This study shows that there is significant difference in proximate composition, minerals and amino acids of farm-raised and wild sourced cat fish *Clarias gariepinus*. This might be as a result of variety of factors including size, weight, type of food and feeding pattern.

ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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