



# Comparative Evaluation of the Nutritional Profiles of Wild and Pond Reared Catfish (*Clarias gariepinus*) in Obubra LGA, Cross River State, Nigeria

Inyang, U. A. <sup>a</sup>, Essien, E. A. <sup>b\*</sup>, Essien, U. B. <sup>c</sup>,  
Akinjogunla, V. F. <sup>d</sup> and Ekpenyong, E. A. <sup>c</sup>

<sup>a</sup> Department of Fisheries and Aquatic Environmental Management, Faculty of Agriculture, University of Uyo, Akwa Ibom State, Nigeria.

<sup>b</sup> Department of Animal and Environmental Biology, Faculty of Biological Science, University of Uyo, Akwa Ibom State, Nigeria.

<sup>c</sup> Aegis One Consults Limited, Port Harcourt, Rivers State, Nigeria.

<sup>d</sup> Department of Fisheries and Aquaculture, Faculty of Agriculture, Bayero University, Kano, Kano State, Nigeria.

## Authors' contributions

This work was carried out in collaboration among all authors. Authors IUA, EEA, EUB, AVF and EEA did the collaboration. Authors IUA and EEA designed the study. Authors IUA, EEA and EUB did the data collection. Author EEA reviewed and edited the manuscript. Authors IUA, EEA, EUB, AVF and EEA did the manuscript funding. All authors read and approved the final manuscript.

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## ABSTRACT

Fish is a good source of rich protein regardless of its source of habitation. However, there are notable variations in the nutritional composition. Thus, this study was conducted to compare the nutritional composition of wild and pond raised African Catfish (*Clarias gariepinus*). Twenty samples

\*Corresponding author: E-mail: emeritusessien49@gmail.com;

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of *Clarias gariepinus* each were collected from Ahaha Beach, Obubra LGA and University of Calabar fish farm for the study. Standard methods were employed in the analysis of body nutrients, for samples from both habitats. The results revealed that pond raised samples had higher values of crude protein ( $59.23 \pm 2.86$ ), carbohydrates ( $9.37 \pm 0.75$ ), fat ( $20.01 \pm 1.01$ ) and energy ( $464.74 \pm 0.03$ ) than samples from the wild. Although, moisture contents ( $64.05 \pm 0.23$ ), crude fibre ( $10.10 \pm 0.06$ ) and ash content ( $16.40 \pm 0.08$ ) were higher in wild samples, moisture contents and crude fibre were not significant ( $p < 0.05$ ). However, for crude protein, carbohydrates, ash content and energy (kcal), there were significant difference ( $p < 0.05$ ) between both samples. There was a weak positive correlation between protein and carbohydrate and carbohydrates and energy (kcal). Nonetheless, crude protein had strong negative correlation between other variables. Conclusively, pond raised system for Catfish is encouraged for commercial and nutritional purpose (consumption).

**Keywords:** Comparison; nutritional profile; wild and pond raised; African Catfish (*Clarias gariepinus*); Cross River State.

## 1. INTRODUCTION

In Africa and other developing countries in the globe, fish is an important economic species contributing to food security and income sustainability. "It is estimated that over 2.6 billion people consume 20% of their animal protein from fish, and over 400 million people in Asia and Africa consume at least 50% of their animal protein from fish. However, only 13% of animal protein consumption is provided in developing countries" [1]. Fish is a good source of inexpensive yet quality protein required in human diets [2] and contains all of the essential amino acids. "It is a widely accepted good source of protein and other elements necessary for the maintenance of a healthy body" [3]. "Fish provides 22% of protein intake and exceeds 50% in the poorest countries. It also provides a good source of vitamins and minerals. More than one third of the sub-Saharan African population is under nourished" [1]. "It is a widely consumed agricultural product in Nigeria. It is cheap and highly acceptable, with little or no religious bias, which gives it an advantage over pork or beef" [4,5]. "Fish is a highly perishable commodity that undergoes spoilage as soon as it is harvested. Once spoilage sets in, the odor/flavor, texture, color and chemical composition change" [6]. Eyo [4] "pointed out that in the coastal countries of West Africa the proportion of dietary protein from fish is extremely high" (47% in Senegal, 67% in Gambia and 63% in Ghana). "The importance of fish in the diets of infants, young children and pregnant women cannot be over-emphasized" [7]. "Fish products are very important in human diet because of their high digestibility and high nutritional values, mostly characterized by the presence of high proteins, rich and amino acids. This latter quality makes frozen food a valuable protein source to populated countries" [8].

"Mineral elements like selenium, iodine (in marine species) phosphorus and zinc are present in a significant amount in many fish species. Fatty acid stores Vitamin A and E in the muscle tissue, while low fat fish accumulates fat soluble vitamins in the liver. Shellfish have chemical composition similar to that of low fat fish. All fish species have specific nutritional profiles. However, there have been several reports of variations in results from the same species over time. These are most times a function of food and external factors" (environmental factors) [9]. Pollution and anthropogenic activities have also been reported to cause a change in the nutritional profile of aquatic species that inhabit the affected water bodies [10]. Silas et al. [11] reported significant variation in the prevalence of gastrointestinal parasite between wild and pond raised *Clarias gariepinus*. This can also cause changes in the nutritional profile. Hence, the need to compare the nutritional and sensory qualities between wild and pond reared Catfish (*Clarias gariepinus*) in Cross River State.

## 2. MATERIALS AND METHODS

### 2.1 Study Area

This study was carried out in the Laboratory of the Department of Fisheries and Aquatic Science, Cross River University of Technology, Obubra Campus, Cross River State, Nigeria.

### 2.2 Experimental Fish

A total of 40 matured *Clarias gariepinus* were obtained. Twenty samples were purchased from the Ahaha Beach, Obubra LGA and carried to the laboratory in ice boxes to maintain their freshness and the other twenty live samples

were purchased from the University of Calabar Fish Farm and transported to the laboratory of Faculty of Agriculture, University of Calabar for proximate analysis.

### 2.3 Analysis of Proximate Composition of Samples

30 samples from each; pond raised and wild *C. gariepinus* were sent to the Department of Biochemistry, University of Calabar for determining proximate composition according to method of Association of Official Analytical Chemists [12].

### 2.4 Statistical Analysis

The data obtained from chemical analysis were subjected to one-way analysis of variance (ANOVA) to test for significant differences among means of proximate parameters of pond reared cultured and wild samples of *C. gariepinus*. Statistical significances were tested at  $P < 0.05$  level of significance

## 3. RESULTS

Result of the proximate composition in the wild and pond raised samples of *C. gariepinus* during the study are presented in Table 1. The correlation coefficient amongst composition parameters of the wild and pond raised *C. gariepinus* is revealed in Table 2. Results showed significant differences ( $P < 0.05$ ) in proximate composition parameters among wild and pond raised *C. gariepinus* except values for carbohydrate ( $C_6H_{12}O_6$ ). The crude protein content in wild and pond raised were  $48.77 \pm 1.00$  and  $59.23 \pm 2.86$  respectively. Carbohydrate content recorded in wild and pond raised were  $7.55 \pm 0.44$  and  $9.37 \pm 0.75$  respectively. The values for moisture content were higher in wild than pond raised samples at  $64.05 \pm 0.23$  and  $63.20 \pm 1.53$  respectively. Fat

contents for wild and raised pond samples were  $18.12 \pm 0.82$  and  $20.01 \pm 1.01$  respectively. Fibre and Ash contents for wild and raised pond samples were significant ( $P < 0.05$ ) with at  $10.10 \pm 0.06$  and  $7.88 \pm 0.31$  and  $16.40 \pm 0.08$  and  $6.63 \pm 0.58$  respectively. Energy values were also significantly ( $P < 0.05$ ) higher in the pond raised ( $464.74 \pm 0.03$ ) than the wild ( $401.20 \pm 0.03$ ) samples.

Comparison between the wild and pond raised samples of *C. gariepinus* showed higher level of crude protein, carbohydrate and energy content recorded in the pond raised samples, while higher level of moisture, crude fibre and ash. However, fat content in both were the same in the wild and pond raised samples of *C. gariepinus*.

The seventeen (17) statistically significant associations were revealed out of the 28 associations that existed among the parameters. The significant negative associations (inverse relationships) were those between protein and moisture ( $r = -0.684$ ), protein and fat ( $r = -0.637$ ) protein and crude fibre ( $r = -0.899$ ), protein and ash content ( $r = -0.900$ ), carbohydrate and moisture ( $r = -0.196$ ), carbohydrate and fat ( $r = -0.509$ ), carbohydrate and crude fibre ( $r = -0.404$ ), carbohydrate and ash ( $r = -0.453$ ), energy and moisture ( $r = -0.684$ ), energy and fat ( $r = -0.578$ ), energy and crude fibre ( $r = -0.684$ ) and energy and ash ( $r = -0.684$ ). The positive relationships between carbohydrate and crude protein ( $r = 0.154$ ) and carbohydrates and energy ( $r = 0.394$ ) were not significant ( $p < 0.05$ ). The positive relationship between moisture content and fat ( $r = 0.444$ ), moisture content and crude fibre ( $r = 0.577$ ), moisture and ash content ( $r = .698$ ), fat and crude fibre ( $r = 0.686$ ), fat and ash content ( $r = 0.621$ ), crude fibre and ash ( $r = .958$ ) were statistically significant ( $p < 0.05$ ). Other associations were statistically insignificant ( $p > 0.05$ ).

**Table 1. Proximate composition of wild and pond reared *Clarias gariepinus***

Parameters	Wild (% Mean $\pm$ SE)	Pond (% Mean $\pm$ SE)
Crude protein	$48.77 \pm 1.00$	$59.23 \pm 2.86$
Carbohydrate	$7.55 \pm 0.44$	$9.37 \pm 0.75$
Moisture content	$64.05 \pm 0.23$	$63.20 \pm 1.53$
Fat	$18.12 \pm 0.82$	$20.01 \pm 1.01$
Crude fibre	$10.10 \pm 0.06$	$7.88 \pm 0.31$
Ash	$16.40 \pm 0.08$	$6.63 \pm 0.58$
Energy kcal	$401.20 \pm 0.03$	$464.74 \pm 0.03$

**Table 2. Correlation matrix among proximate composition**

Parameters	Crude protein	Carbohydrate	Moisture content	Fat	Crude Fibre	Ash	Energy kcal
Crude protein	1.000						
Carbohydrate	.154	1.000					
Moisture content	-.684*	-.196	1.000				
Fat	-.637*	-.509*	.444*	1.000			
Crude fibre	-.899*	-.404	.577*	.686*	1.000		
Ash	-.900*	-.453*	.698*	.621*	.958*	1.000	
Energy (kcal)	.951*	.394	-.684*	-.578*	-.998*	-.993*	1.000

Correlation coefficient values with \* indicate significance values ( $p < 0.05$ )

#### 4. DISCUSSION

The nutritional components showed variable values amongst wild and pond reared fish samples. These relatively high levels of crude protein could be attributed to the fact that fishes are evidently good source of pure protein, and was similar to the observations of Isangedighi et al. [13] who reported that protein forms the largest quantity of dry matter in fish. The high protein contents in wild and pond raised *C. gariepinus* samples were similar to that found in Ondo and Osun States [14].

“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 different water body” Adeyemi and Akande [15]. “This could also be attributed with the conversion potentials of essential nutrients from their diet or their local environment into such biochemical attributes needed by the organisms’ body” [16]. “The difference between the crude protein in pond 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 semi-intensive culture are fed with high-quality diet. Preys in the wild that are accessible to samples from the wild are rich protein sources, compared to the compounded man-made feeds. However, depending on the commercial fish feeds examples; Coppens and Bluecrown” [9]. Their constitute includes ingredients such as soybean meal, fishmeal, groundnut cake, among others in addition to energy rich sources of feeding 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 [17]. The low value of CP in wild compared to the pond raised samples could also be a state of food scarcity; as preys may not be also available. This could also lead to cannibalism.

This result is in agreement to reports from Isangedighi et al. [13] in Uyo, Akwa Ibom State that record higher CP value in pond raised than samples from the wild. However, reports from Ukagwu et al. [18] did not support this result; they were no significant difference between samples from both the pond raised and the wild.

Carbohydrates is a member to a group of compounds that includes starch, sugars, starches, celluloses, and other closely related substances that are among the most abundant organic compounds found in nature [19]. It is the origin of ATP creation in all animals. For catfish and other simple-stomached animals, carbohydrate can be broadly divided into an indigestible fraction (fibre) and a digestible fraction sugars and starched as an energy source differs among fish species [19]. Carbohydrate content of pond raised samples was higher ( $9.37 \pm 0.75$ ) than the wild samples ( $7.55 \pm 0.44$ ). This was strongly similar to Isangedighi et al. [13]. However, it varied with report of Emmanuel et al. [20]. Higher value of  $C_6H_{12}O_6$  value in pond raised samples is indicative of efficient utilization of the metabolic energy in the feed given them. Feeding is not regulated in the wild. This could influence the amount of nutrient available to fish in the natural environment. Thus, quality feeds given to the pond raised specimens must have encouraged that. In the wild, fish compete for food, expending energy before securing their meals. In contrast, pond-raised fish are fed under controlled conditions, unlike samples in the ponds that were regulated in feeding.

The moisture content is the principle component (over 80%) of the edible portions of fish. Usually, the oil and water content together is about 80% [21]. Water retention is higher in fresh fish.

Moisture content of food is an important factor that has a functional effect on some quality characteristics such as texture. Previous studies have revealed moisture level obtained to be similar for wild catfish ( $58.9 \pm 0.01$ ) [22] and Azuka and Goodnesschinwe [23] "70.3" for *C. gariepinus* from markets in Nigeria. Higher percentages of 71.7 and 70.35% for *C. gariepinus* fish were also recorded by Olopade et al. [24] and Oladipo and Bankole [25], respectively. Adeniyi et al. [26] and Ayelaja et al. [27] also had related results for moisture content. However, the moisture content recorded in this study for *C. gariepinus* cultured sample is higher than report of Emmanuel et al. [20]. The result also showed that there was significant difference ( $P < 0.05$ ) in the moisture content between the wild and cultured *C. gariepinus*. However, Emmanuel et al. [20] stated that, moisture content in fish may not be different in respect to environment since the animals from the two sources have access to constant source of water.

According to Murray and Burt [28], fat content in fish varies more than protein or mineral contents. The results for lipids between both samples were similar to the report of Olopade et al. [29], Onyia et al. [30] and Ayelaja et al. [27] who reported higher lipid content in pond raised samples. However, Onyia et al. [30] reported significant difference ( $p < 0.05$ ) in the lipid content between wild and pond raised *C. gariepinus*. The higher values of lipid observed in the pond raised and wild samples are indicative of the availability of a variety of food materials rich in fat and oil in their immediate environment of which they utilized effectively and in the formation of the feeds respectively.

Lipids are important component in fishes which consist of fats, oils and waxes making up the fish tissues and organs. Lipids in catfish can be stored in the muscles, liver and skin in different forms. Studies have reported fats content to be generally higher in pond raised than wild fish [29,27,30]. Diet and activity levels are essential factors in sustaining and building up fat content in fish. The higher results in pond raised catfish are likely attributed to the high-caloric feed which promote rapid growth. High activity of fish (in search of food, mating partner, competition to survive) uses up the energy accumulated by the fish; thus could have contributed to the higher result in pond raised than the wild samples. However, lipid level for the wild sample was commendable.

Crude fibre in fish refers to the indigestible portions of plants/food materials that is remained after the fish has digested the available nutrients. Crude fibre is an important component of fish feed, as it helps to maintain the health of the digestive system and regulates the digestion process [31]. This result agrees to Isangedighi et al. [13] who reported higher crude fibre in wild than pond raised catfish. This is likely attributed to the diversity of food material (plants) in the wild compared to the pond. However, Catfish are not herbivores, but in the wild they could feed on herbivorous animals rich in plants. This contributed to the higher crude fibre contents in the wild.

Ash content in fish refers to the inorganic mineral component that remains after the fish has been subjected to high temperature which includes It includes metal salt which are important for processes requiring ions such as  $\text{Na}^+$  (sodium),  $\text{K}^+$  (potassium), and  $\text{Ca}^{2+}$  (calcium). It also includes trace minerals, such as chlorophyll and haemoglobin. It is typically expressed as a percentage of the fish's total weight which varies depending on the fish diet and environmental condition. There was significant difference between the ash content in the pond raised and wild fish samples. 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. This is in agreement to Onyia et al. [30], Isangedighi et al. [13] and Michael and Adedayo [14] results that reported higher ash content in wild samples. Miroslav et al. [32] and Adeosun et al. [22] reported a positive correlation between crude fibre and ash, which was evident in this result.

The caloric value of the catfish had a weak positive correlation with carbohydrates, which implies that both variables are dependent on each other; the higher the carbohydrates, the higher the caloric values, however, the correlation was a weak one. According to Pyz-Łukasik and Paszkiewicz [33] meat from *C. gariepinus* males and females had a low calorific value, averaging 496.59 kJ/100 g on average. This report is also supported by Sayed Abd-Allah [34].

## 5. CONCLUSION

This study shows that there is significant difference in higher content of crude protein, carbohydrate and energy between the pond raised and wild Catfish (*Clarias gariepinus*). This is attributed to a variety of factors including type of food and feeding pattern, environment,

enclosure etc. Thus, the consumption of the pond raised samples fed with rich commercial feeds should be encouraged because of their higher nutritional quality.

### DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (Chat GPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

### DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author (EEA) upon request.

### COMPETING INTERESTS

Authors have declared that no competing interests exist.

### REFERENCES

1. FAO. FAO Fisheries and Aquaculture-Chemical Elements of Fish; 2018. Available: [Http://Www.Fao.Org/Fishery/Topics/14820/En](http://www.Fao.Org/Fishery/Topics/14820/En)
2. Bello MM, Mohammed AM, Jajere BA, Ayo-Dada OB. Quality and appearance of *Clarias gariepinus* (Burchell, 1822) and *Oreochromis niloticus* (Linnaeus, 1758) Smoked with Sugarcane Bagasse. NIWARD 2018 Conference Proceedings. 2018;173-184.
3. Adebayo-Tayo BC, Odu NN, Anyamele LM, Igwiloh NJPN, Okonko IO. Microbial quality of frozen fish sold in Uyo Metropolis. Nature and science. 2012;10(3):71-77.
4. Eyo AA. Fish processing Technology in the tropics. University of Ilorin press. 2001;135-190.
5. Ligia VAS. Hazard analysis critical control point (HACCP), microbial safety and shelf life of smoked blue catfish ("*Ictalura furcatus*") M.Sc. thesis. 2002;48-93.
6. Omoruyi K, Owolabi KE, Oghoje AE. Comparative analyses of fish processing, marketing and distribution in Warri-South and sapele local government areas of Delta state, Nigeria. International Journal of Fisheries and Aquatic Studies 2016;4(6):425-433.
7. Affognon H, Mutungi C, Sanginga P, Borgemeister C. Unpacking postharvest losses in sub-Saharan Africa: a meta-analysis. World development. 2015;66:49-68.
8. Silva JJ, Chamul RS. Composition of marine and fresh water in fish and shell fish species and their products. In: Martin, R. E., Carter, E. P., Flick, E. J., and Davis, L. M. (Eds). Marine and freshwater products handbook, Lancaster. Pennsylvania USA Technomic Publishing Company. 2000;31-46.
9. Okon AO, Udoinyang EP, Essien EA. Growth performance of the African Catfish, *Clarias gariepinus* fingerlings fed four commercial feeds. Journal of Wetlands and Waste Management. 2020;4 (1):51-55.
10. Akpabio JU, Okon AO, Ebong GA, Udoinyang EP, Essien EA, Josiah IU, Akpan AW. Perturbation of road construction and inorganic sedimentation on the macroinvertebrate fauna in the midstream segment of Qua Iboe River, Nigeria. Asian Journal of Advanced Research and Reports. 2024;18(4): 24-33.
11. Silas II, Essien EA, Anietie HN, Inyang SX, Akpan AE. Comparative study on the prevalence of gastrointestinal parasite between wild and pond raised african sharptooth catfish *Clarias gariepinus* in Akwa Ibom State. South Asian Journal of Parasitology (SAJP). 2024;7(2): 133-140.
12. AOAC (Association of Official Analytical Chemists) International official methods of analysis, 18<sup>th</sup> edn., Washington DC, Association of Official Analytical Chemists; 2005.
13. Isangedighi I, Ofonmbuk O, Ofonime U, Gift D. Comparative study of the nutrient contents of cultured and wild African Catfish (*Clarias gariepinus*, Burchell 1822). International Journal of Agriculture, Environment and Bioresearch. 2017; 2:50. ISSN: 2456-8643
14. Michael PO, Adedayo FE. Comparative study of the flesh quality of *Clarias gariepinus* Farm-raised and Wild Populations. Asian Journal of Fisheries and Aquatic Research. 2019;4(4):1-9, 2019; Article no. AJFAR.51220
15. Adeyemi RS, Akande GR. Thermo-physical properties of farmed African freshwater catfish (*Clarius gariepinus*) fillet for process design and optimization. Nigerian Food Journal. 2011;29(1): 34-42.

16. Ukagwu JI, Onuoha GUC, Asonye NC, Ojulam GC. Water quality characteristics of nworie river for fish survival: A wet season study. International Journal of Science, Environment and Technology. 2014;3(5):1817-1825.
17. Effiong BN, Fakunle JO. Proximate and mineral composition of some commercially important fishes in Lake Kainji, Nigeria. J. Basic Appl. Sci. Res. 2011;1(12):2497-2500.
18. Ukagwu JI, Anyanwu DC, Offor JI, Nduka CO. Comparative studies of nutrient composition of wild caught and pond reared african catfish, *Clarias gariepinus* (2017). International Journal of Research in Applied, Natural and Social Sciences (IMPACT: IJRANSS). 2017;5(7): 63-68.
19. Robinson EH, Li MH. Composition and formulation of channel catfish feeds. Mississippi Agriculture and Forestry Experimental Station Bulletin. 2012; 1200:1-10.
20. Emmanuel BE, Oshionebo C, Aladetohun NF. Comparative analysis of the proximate compositions of *Tarpon atlanticus* and *Clarias gariepinus* from culture system in south western Nigeria. African Journal of Food, Agriculture, Nutrition and Development. 2011;11(6):5344-5359.
21. Olele NF. Nutrient composition of *Gnathonemus tamandua*, *Chrysichtys nigrodigitatus* and *Anchenoglanis bisculatus* caught fro river Niger. Nig. J. Environ. 2012;8(2):21-27.
22. Adeosun O, Olaifa FE, Akande GR. Chemical composition, microbial content and sensory evaluation of smoked farmed catfish *Clarias gariepinus* (Burchell, 1822) raised under different culture systems in Ibadan, Nigeria. Food Sci. Quality Manag. 2015;46:33-43.
23. Azuka IW, Goodnesschinwe U. Microbial and chemical evaluation of parts of fresh and smoked Tilapia (*Oreochromis niloticus*) and Catfish (*Clarias gariepinus*). The Pharmaceutical and Chemical Journal. 2018;5(2):119-128.
24. Olopade OA, Taiwo IO, Agbato DA. Effect of traditional smoking method on nutritive values and organoleptic properties of *Sarotherodon galilaeus* and *Oreochromis niloticus*. Int. J. Applied Agri. Api. Res. 2013;9(1-2):91-97.
25. Oladipo IC, Bankole SO. Nutritional and microbial quality of fresh and dried *Clarias gariepinus* and *Oreochromis niloticus*. Int. J. Applied Microb. Biotech. 2013; 1:1-6.
26. Adeniyi SA, Orjiekwe CL, Ehiagbonare JE, Josiah SJ. Nutritional composition of three different fishes (*Clarias gariepinus*, *Malapterurus electricus* and *Tilapia guineensis*). Pakistan Journal of Nutrition. 2012; 11(9):891-895.
27. Ayeloja AA, George FO, Dauda TO, Jimoh WA, Popoola MA. Nutritional composition of captured *Clarias gariepinus* and *Oreochromis niloticus*. International Research Journal of Natural Sciences. 2013;1(1):9-13.
28. Murray J, Burt JR. The composition of fish; 2001. Retrieved from May, 17, 2017. Available:<http://www.fao.org/wairdocs/tan/x5916e/x5916e01.htm>
29. Olapade OA, Sanwo SK, Oyekola AA. Comparative studies on the proximate composition of nutrients in *Clarias gariepinus* wild and cultured. Internet Journal of Food- Safety. 2011;13: 130-133.
30. Onyia LU, Michael KS, Manu JM, Sabo M. Comparison of nutrient values of wild and cultured *Heterobranchus bidorsalis* and *Clarias gariepinus*. Nigerian Journal of Fisheries and Aquaculture. 2013; 1(1):7-12.
31. Okereke OC, Ejiola MT, Yinka OF. Comparative cost structure and yield performance analysis of upland and mangrove fish farms in southwest, Nigeria. International Journal of Agricultural Management & Development. 2013;2(3): 187-198.
32. Miroslav Ć, Dejana T, Dragana L, Vesna Đ. Meat quality of fish farmed in polyculture in carp ponds in Republic of Serbia. Tehnologija mesa. 2011;52(1): 106–121.
33. Pyz-Łukasik R, Paszkiewicz W. Species variations in the proximate composition, amino acid profile, and protein quality of the muscle tissue of grass carp, bighead carp, siberian sturgeon, and wels catfish. Journal of Food Quality. 2018;12(9): 12-19.

34. Sayed Abd-Allah SM. Profile of nutritional and quality aspects of wild African catfish, *Clarias gariepinus* (Burchell, 1822) in Assiut, Egypt. International Journal for Research in Agricultural and Food Science. 2019;5(12):1-17.

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