PROXIMATE AND MINERAL COMPOSITIONS OF *SCHILBE MYSTUS* (LINNE 1758) AND *HETEROTIS NILOTICUS* (CUVIER 1829)

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ABSTRACT

The nutrient composition of fish has been established to vary with species and growing environment. Hence, the proximate composition and mineral contents of Schilbe mystus and Heterotis niloticus in Lake Alau were investigated to determine their nutritive value. A total of 10 fresh samples of each species obtained from fishermen catch (weight: 315.20 – 436.10 g) were separately stunted, de-gutted, washed, grounded and analyzed for moisture, crude protein, fat, ash, carbohydrate, calcium, iron, sodium, potassium and magnesium following standard procedures. Mean moisture (62.95 ± 1.97 %) and ash (2.40 ± 0.21 %) contents were higher in H. niloticus, while crude protein content (35.20 ± 1.48 %) was significantly higher (p<0.05) in S. mystus. Also, the fat content was significantly higher in H. niloticus (12.20 ± 1.08 %) than in S. mystus (3.97 ± 0.39 %). Carbohydrate value was higher (p>0.05) in S. mystus (2.20 ± 0.33 %) than in H. niloticus (1.85 ± 1.01 %). Values of iron (1.16 ± 0.35 %) and potassium (5.50 ± 0.50 %) were marginally higher in S. mystus, while sodium (85.10 ± 12.81 %) was significantly higher (p<0.05) in S. mystus. This study thus provides baseline information on the present nutritive status of the two freshwater finfish species in Lake Alau.

Keywords: Nutritive value, *Schilbe mystus*, *Heterotis niloticus*, Fish food, Lake Alau

INTRODUCTION

African butter catfish *Schilbe mystus* and African bony tongue *Heterotis niloticus* are widespread in aquatic systems of tropical Africa and constitute an important animal food protein. These fishes are among the dominant species in Lake Alau and constituted more than 40 % of the total annual landings of artisanal fishermen (Bankole *et al*., 2004). According to Adekoya and Miller (2004), fish and fish products constitute more than 60 % of the total protein intake in adults especially in rural areas. In recent times, increase in population coupled with growing knowledge of the value of fish has greatly increased its demand. Consequently, there is an undue pressure on wild fish stock with fishermen resulting into the use of obnoxious method of fishing. Most of these unscrupulous fishing activities do not only destroy fish habitats but also undermine the quality of fish meat supplied from the inland waters. This thus, establishes the need to understand the nutritional composition of fish species from different sources.

According to Romharsha *et al*. (2014), information concerning the chemical composition of the fishes is necessary to ensure that they meet the requirements of man's diet. Biochemical composition of fish flesh is also, a good indicator for quality (Hernandez *et al*., 2001), physiological condition and habitat conditions (Ravichandran *et al*., 2011). The major components of fish flesh that serve as nutritive value are moisture, dry matter, protein and fat with vitamins and minerals occurring in trace amounts (Steffens, 2006). Fish of various species do not provide the same nutrient profile to their consumer (Saoud *et al*., 2008). According to Pearson and Cox (1976), most fish species have moisture content between 60 – 80 %, protein between 15 – 26 % and fat 2 – 13 %. However, Love (1980) reported that in composition of live-weight, the whole body fish is 70 – 80 % water, 20 – 30 % protein and 2 – 12 % lipid. FAO/WHO (1991) also reported that normally fish contains 72% water, 19 % protein, 8 % fat, 0.5 % calcium, 0.25 % phosphorus and 0.1 % vitamin A, D, B and C.

Studies on the biochemical profile of several tropical fish species have been documented. Some of these include those of Adewumi *et al*. (2014) on *Clarias gariepinus*, *Parachanna obscura*, *Tilapia zilli* and *T. galilaeus;* Kefas *et al*. (2014) on *Oreochromis niloticus* and *Synodontis clarias*; Ama-Abasi and Ogar (2013) on *P. obscura*; Fawole *et al*. (2013) on *Hemichromis fasciatus, Siluranodon auritus, Sarotherodon galileaus, T. zilli*, *Chrysichthys nigrodigitatus,* and *Hepsetus odoe*; Udo (2012) on *Heterobranchus longifilis*, *C. gariepinus* and *C. nigrodigitatus*; Fawole *et al*. (2007) on *O. niloticus, S. galilaeus, C. gariepinus* and *H. niloticus;* Abolude and Abdullahi (2005) on *C. gariepinus* and *Synodontis schall*; Adeyeye and Adamu (2005) on *Gymnarchus niloticus* and Abdullahi (2001) on *C. nigrodigitatus*, *Bagrus filamentous* and *Auchenoglanis occidentalis*. Information on *S. mystus* and *H. niloticus* is however scarce especially in Lake Alau, Nigeria.

MATERIALS AND METHODS

Study Area: Lake Alau, the second largest Lake in Borno State, Nigeria is located between Latitude 10°43'N and Longitude 13°17'E (Wakil *et al.,* 2014). With a total surface area of 56km^2, the Lake was created in 1987 by damming Ngadda River about 22 km from Maiduguri, along Bama road (Bankole *et al*., 1994). According to Sagua (1991), the area is within the conventional Chad Lake Basin. The annual inflow into Lake Alau was calculated to be 329,000 m^3 (Mshelizah, 1986). It has two distinct wet and dry seasons; a raining season with mean annual rainfall of about 600 mm from July to October, and a hot dry season from March to July. The dry season is preceded by a period of dry harmattan with very low temperature and dry harmattan wind between November and February (Bankole *et al*., 1994). Lake Alau has a mean depth of 9.5 m, temperature of 28.6 ^{o}C, pH of 7.28 and total alkalinity of 38.4 mg/l characterized with loamy soil (Idowu, 2004; Gwari *et al*., 2014). It sustains a thriving artisanal fisheries industry and serves as a source of water for domestic and industrial use (Gwari *et al*., 2014).

Sample Collection: A total of 20 live specimens comprising 10 samples each of fresh *S. mystus* and *H. niloticus* (weight: 315.2 – 436.1 g) were procured from artisanal fisher's at their landing site between October and December, 2015 and immediately rinsed in clean water to remove debris. The specimens were kept in plastic bags and transported in an insulated icebox to the Biochemistry Laboratory, University of Maiduguri Teaching Hospital, Maiduguri. Thereafter, samples were stunted, gutted and washed with distil water until free of bloodstain. The edible portion of the muscle tissues was removed, wrapped in cellophane bags, sealed, labelled and kept in freezer at -20 °C for subsequent biochemical analysis.

Proximate Composition Analysis: Proximate composition of the flesh was determined following AOAC (2005). For moisture content determination, 10 g of sample was placed individually in a moisture dish and dried in a hot air oven (Technico, Chennai, India) at 105°C until constant weights were obtained. Analysis of crude protein was carried out using Kjedahl apparatus (N x 6.25), crude lipid was determined by extraction with ether using Soxhlet apparatus. Crude fibre was determined using trichloroacetic acid method (0.225 NH_2SO_4, 0.313 NaOH and acetone as reagents), while ash content was by incineration in muffle furnace. Total carbohydrate was also estimated by Anthrone method (Hodge and Hofreiter, 1962). Approximately two (2) gram of wet fish homogenate was taken individually and homogenized with known volume of 5 % TCA. The homogenate was then centrifuged at 2500 rpm in a centrifuge (Hettich Zentrifugen D-78532, Germany) for 10 minutes and the supernatant filtered. Anthrone reagent was added to the filtrate and placed in a serological water bath (InlabEquipments, Chennai, India) for 10 minutes for colour development. The distilled water served as the control. The coloured end product was measured for their optical density at 620 nm in a UV – VIS Spectrophotometer (JASCO, V-530, and Japan). D-glucose was used as the standard for computation of the results.

Mineral Analysis: A known weight of fish sample was ash dried at 550 ^{0}C for 6 hours in an electric muffle furnace. The ashed sample was diluted in 5 ml of 10 % HCl. This was later filtered and made up to 50 ml. The filtrate was analysed for percentage mineral concentration using Atomic Absorption Spectrophotometer (Buck Scientific, Model 200-A) (AOAC, 2005).

Statistical Analysis: The SPSS statistical software for windows, version 20.0 (SPSS Inc., Chicago, USA) was used for analysis of variance, while variations were compared using Duncan's Multiple Range Test at $p<0.05$.

RESULTS

The proximate composition of *S. mystus and H. niloticus* flesh were as presented in Table 1. In *H. niloticus,* moisture content varied between 59.05 – 65.33 %, ash 2.13 – 2.82 %, protein content 19.69 – 21.63 %, fat 11.23 – 14.35 % and carbohydrate 0.93 – 3.87 %. However, moisture content in *S. mystus* ranged from 54.93 – 59.32 %. The ash content showed a minimum value of 1.56 % and maximum value of 2.16 %. The fat content ranged from 3.37 – 4.70 %. The protein content varied between 32.26 and 37.00 %. The least carbohydrate value was 1.56 % and highest was 2.66 %.

The moisture content in the flesh was higher in *H. niloticus* (62.95 ± 1.97 %) than in *S. mystus* (56.83 ± 1.30 %). Similarly, the ash content in *H. niloticus* (2.40 ± 0.21 %) was higher than that in *S. mystus* (1.78 ± 0.20). However, there were no significant difference ($p>0.05$) between the values obtained for moisture and ash in the two species. On the other hand, protein content in *S. mystus* (35.20 ± 1.48 %) was significantly higher ($p<0.05$) than that of *H. niloticus* (20.60 ± 0.56 %). Also, *H. niloticus* (12.20 ± 1.08 %) had significantly more fat content than *S. mystus* (3.97 ± 0.39 %). The carbohydrate was not significantly higher in *S. mystus* (2.20 ± 0.33 %) when compared with that of *H. niloticus* (1.85 ± 1.01 %).

The mineral composition of *S. mystus* and *H. niloticus* is as presented in Table 2. *S. mystus* was superior in iron (1.16 ± 0.35 %), sodium (85.10 ± 12.81 %) and potassium contents (5.50 ± 0.50 %) than *H. niloticus*. However, calcium (1.68 ± 0.18 %) and magnesium content (0.68 ± 0.15 %) were higher in *H. niloticus* when compared with *S. mystus*.

DISCUSSION

Fish provides important nutrients to large number of people worldwide and thus makes a very significant contribution to nutrition (Adewumi *et al*., 2014). Owing to the nutritional benefits associated with fish consumption, it has become important to assess its biochemical composition to ensure conformity with food regulatory and commercial specifications (Waterman, 2000) and establish the safety level of each fish species. From this experiment, the average moisture, fat and ash content in *H. niloticus* were different from the findings of Udo (2012). These variations could be attributed to the whole specimen examined by the latter as against only fillet used in this study. Also, the result contradicts Alfa *et al*. (2014) who studied proximate composition and mineral components of some fish species sold in Bida fish market. The authors established comparably higher crude protein, ash carbohydrate, fat and moisture content in *H. niloticus.*

Table 1: Ranges and mean values of the proximate composition of *S. mystus* and *H. niloticus* fleshes sampled from Lake Alau, Nigeria

Composition	Fish species		P value	Reference limit (USDA, 2010)
	S. mystus	*H. niloticus*		
Moisture Content	54.93 – 59.32	59.05 – 65.33		78.0 – 90.0
Mean	56.83 ± 1.30^{a}	62.95 ± 1.97^{a}	0.06	
Ash	1.56 – 2.16	2.13 – 2.82		-
Mean	1.78 ± 0.20^{a}	2.40 ± 0.21^{a}	0.10	
Protein Content	32.26 – 37.00	19.69 – 21.63		15.0 – 28.0
Mean	35.20 ± 1.48^{a}	20.60 ± 0.56^{b}	0.00*	
Fat	3.37 – 4.70	11.02 – 14.35		15.0 – 18.0
Mean	3.97 ± 0.39^{b}	12.20 ± 1.08^{a}	0.00*	
Carbohydrate	1.56 – 2.66	0.93 – 3.87		2.0 – 5.0
Mean	2.20 ± 0.33^{a}	1.85 ± 1.01^{a}	0.76	

Values are mean ±SD from ten replicates. Values within the same row with different superscript differ significantly at $p<0.05$

Table 2: Ranges and mean values of mineral composition of the fillets of *S. mystus* and *H. niloticus* collected from Lake Alau, Nigeria

Composition	Fish species		P value	Reference limit (USDA, 2010)
	S. mystus	*H. niloticus*		
Calcium	1.32 – 1.58	1.32 – 1.88		19.0 – 881.0
Mean	1.47 ± 0.08^{a}	1.68 ± 0.18^{a}	0.36	
Iron	0.48 – 1.60	0.42 – 0.77		1.0 – 5.6
Mean	1.16 ± 0.35^{a}	0.65 ± 0.12^{a}	0.23	
Sodium	59.80 – 101.20	12.83 – 23.00		30 – 134
Mean	85.10 ± 12.81^{a}	16.54 ± 3.24^{b}	0.01*	
Potassium	4.50 – 6.10	2.70 – 8.20		19.0 – 502.0
Mean	5.50 ± 0.50^{a}	5.00 ± 1.65^{a}	0.79	
Magnesium	0.29 – 0.50	0.48 – 0.96		4.5 – 452.0
Mean	0.38 ± 0.06^{a}	0.68 ± 0.15^{a}	0.13	

Values within the same row with different superscript differ significantly at $p<0.05$

This could be due to differences in habitat and location. Protein and fat values for *H. niloticus* in this study were however, slightly higher than that of *C. gariepinus* and *O. niloticus* (Ayeloja *et al*., 2013). The crude protein value obtained by Adeniyi *et al*. (2012) in *T. guineensis* is close to the value obtained for *H. niloticus* in this study. However, the protein content of *H. niloticus* was found to be higher than *P. obscura* (Fapohunda and Ogunkoya, 2006), *Heterobranchus bidorsalis* (Keremah and Amakiri, 2013) and *Malapterurus eletricus* (Adeniyi *et al*., 2012). There were also variations in the moisture content of *H. niloticus* in this study when compared with that of Adeniyi *et al*. (2012) who reported higher values for *C. gariepinus*, *M. eletricus* and *T. guinensis*.

The ash content of *H. niloticus* in this study is comparable to the observation of Keremah and Amakiri (2013) who reported similar ash content values for *H. bidorsalis* and *C. gariepinus* from water bodies in Yenagoa, Nigeria. The mean fat content of *H. niloticus* is however, high (Ackman, 1989). Similar observation was made by Adeniyi *et al*. (2012) for *C. gariepinus* and *M. eletricus* and Ama-Abasi and Ogar (2013) for *P. obscura*. The value of carbohydrate in *H. niloticus* was similar to value obtained in *C. gariepinus* (Keremah and Amakiri, 2013).

The protein and ash content of *S. mystus* in this study were lower than those reported by Ayoade (2012) in African butter catfish, *S. mystus* from two tropical man-made lakes in South-western, Nigeria.

According to Hofman *et al*. (2002), the ash content is generally used as a measure of quality for the assessment of the functional properties of foods. The result obtained for carbohydrate in *S. mystus* in this study is comparatively higher than the value reported by Ayoade (2012) for *S. mystus* from Oyan and Asejire Lake. However, the maximum fat content of *S. mystus* from Oyan and Asejire Lake reported by Ayoade (2012) and that of the present study, confirmed that *S. mystus* belong to the category of low fat fishes as classified by Ackman (1989).

Compared with most freshwater fishes in Nigeria, the crude protein content of the African butter catfish was higher than *H. niloticus* (Udo, 2012), *C. gariepinus* and *O. niloticus* (Ayeloja *et al*., 2013), *P. obscura* (Fapohunda and Ogunkoya, 2006) and *H. bidorsalis* (Keremah and Amakiri, 2013), but lower than *G. niloticus, O. niloticus and Protopterus anectens* (Alfa *et al*., 2014). The crude fat content was higher in African butter catfish than *C. gariepinus* and *O. niloticus* (Ayeloja *et al*., 2013; Job *et al*., 2015) and *Clarias lazera* (Egbal *et al*., 2010). The crude fat content of African butter catfish was however, significantly lower than that of *G. niloticus* (Alfa *et al*., 2014), *O. niloticus* (Udo, 2012), *T. mosambis* (Adefemi, 2011), *C. nigrodigitatus* and *H. bidorsalis* (Keremah and Amakiri, 2013), *S. clarias* and *O. niloticus* (Kefas *et al*., 2014), *Hepsetus odoe, H. fasciatus and S. galilaeus* (Fawole *et al*., 2013), *P. obscura* (Ama-Abasi and Ogar, 2013), *M. electricus* and *T. guineensis* (Adeniyi *et al*., 2012). The crude ash content was considerably higher in *S. mystus* than *H. niloticus* and *O. niloticus* (Udo, 2012), *G. niloticus* and *H. niloticus* (Alfa *et al*., 2014) but comparable to wild and culture tilapia (Job *et al*. 2015). The moisture and carbohydrate values in this study are lower than what were recorded for *P. anectens and G. niloticus* (Alfa *et al*., 2014), *C. gariepinus*, *M. electricus* and *T. guineensis* (Adeniyi *et al*., 2012).

The range of mineral contents in *H. niloticus* indicates that the species is a good source of minerals such as sodium, calcium, potassium, iron and magnesium. These mineral products are the essential elements important for proper functioning of blood (Hays, 1989). According to Talat *et al*. (2005), sodium, potassium, calcium and magnesium are very important mineral elements and found in the form of soluble salts in the sarcoplasm of the muscular cells and intercellular fluid, blood and plasma. Udo (2012) reported higher mineral concentration in *H. niloticus* from Cross River at Calabar. This disparity could be attributed to source of the fish. Also, higher calcium and lower magnesium, potassium and iron contents were obtained in this study when compared to values reported by Alfa *et al*. (2014). The calcium contents for *S. clarias* and *O. niloticus* by Kefas *et al.* (2014) were similar to the value obtained in the present study. The value of iron content in *S. clarias* reported by Kefas *et al.* (2014) is comparable with the present results however; iron content of *H. niloticus* is slightly higher. Contrary to this result, Job *et al*. (2015) recorded higher level of magnesium, potassium and sodium in *O. niloticus* from Great Qua Rivers flood plain at Calabar. Generally, this variation is attributable to habitat, season, sex and size as well as food and feeding habit of the fish.

According to Ako and Salihu (2004), these micro elements are required in trace amounts while they tend to become harmful when their concentrations in the tissues exceed the metabolic demands. Adefemi (2011) reported higher mineral content in *T. mossambicus* from major dams in Ekiti State, Nigeria. The value of calcium obtained in this study was similar to that of *Synodontis macrodon* but higher than that of *O. niloticus* reported by Kefas *et al*. (2014). The iron concentration in this report is higher than iron concentration obtained in *S. macrodon* but slightly lower than iron concentration in *O. niloticus* (Kefas *et al*., 2014). Job *et al*. (2015) also observed higher magnesium and potassium levels in wild and cultured *O. niloticus*. Udo (2012) reported higher sodium levels for *H. niloticus* and *O. niloticus* obtained from Cross River at Calabar which were higher than values obtained in the current study. Alfa *et al*. (2014) posited that variation in concentrations of mineral elements from one species to another was due to the chemical forms of the elements and their concentration in the local environment of the fish.

Conclusion: This study revealed that *S. mystus* have high nutritive value than *H. niloticus* of the same size and habitat. Both species compares favourably with most commercially available freshwater fish species in terms of nutritional value. Therefore, both species have high nutrients content that can enhance growth and good development in human being. Based on this finding, the two species are recommended for human consumption but preferably *S. mystus* due to its superior nutritive quality over *H. niloticus*.

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