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Nutritive Value of Commercially Important Fish Species from Selected Lakes in Ethiopia

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Abstract: Knowledge on nutrient content of important foods is a vital tool in understanding the associations between production, access, and nutrient intakes. Fish is one of such foods considered important for food and nutrition security in Ethiopia's national nutrition strategy. However, limited studies are conducted on nutritional profiles of fish species found in the country. This study was conducted to generate information on the nutritional profile of commercially important fish species. Proximate composition and some mineral content of six fish species obtained from four lakes (Tana, Ziway, Chamo, and Abaya) were analyzed. The moisture content varied between 78.05 to 81.18 mg/100g. The protein content was in the range between 15.87 to 18.92 mg/100g. The fat content varied from 0.87 to 3.48 mg/100g. the ash and carbohydrate contents varied significantly between the different species in all the lakes. Calcium content ranged from 52.34 to 250.43 mg/100g. The phosphorous content was in a range from 490 to 960 mg/100g. The range of sodium content was between 41.37 to 164.28 mg/100g, while the range of potassium content was 389.75 to 1887.44 mg/100g. The finding indicated the nutritional significance of commercially important fish in Ethiopia. Besides, *C. gariepinus* species from all water bodies have shown high energy content compared to other species, indicating the necessity to consider this species as a primary candidate species in nutrition-sensitive aquaculture. Further study is necessary to profile other fish species, and to include all indicator parameters of fish nutritional value.

Keywords: Fish Species, Nutrition, Proximate Analysis, Ethiopia, Nutrition-sensitive

1. Introduction

Fish and fish products, as they are a valuable source of nutrients and micronutrients of vital importance for diversified and healthy foods, play a critical role in nutrition and global food security [1, 2]. The importance of fish as a food group is greater in lower-income countries due to its compositions such as vitamins and minerals needed to address some of the most serious and prevalent nutritional deficiencies. Particularly for pregnant women and very young children, the role of fish as a component in a healthy diet is enhanced since it contributes to neurodevelopment during the most critical stages of the growth of an unborn or young child. Fish may provide a much-needed means of nutritional diversification that is relatively cheap and locally available in low-income communities that rely heavily on a limited range of calorie-dense staple foods. Although the yearly average consumption of fish per person may be low, even small amounts of fish may offer essential amino acids, fats, and micronutrients, such as iron, iodine, vitamin D, and calcium, which are often deficient in staple diets of the poor [1].

In Ethiopia, a moderately exploited fishery sector exists with a high diversity of close to 180 freshwater fish species [2]. Fishing is carried out in almost all water bodies in Ethiopia. However, most of the catch is contributed from Chamo, Ziway, Tana, and Abaya lakes [4]. Although the country has an estimated fish production capacity of 94,500 tonnes/year [4], the fish consumption per person is low at a mere 0.5 Kg per year, while 12 to 17 Kg of fish per capita per year is recommended.

Malnutrition, largely caused by inadequate micronutrient intake, remains prevalent in Ethiopia with 37% stunted, 7% wasted and 21% underweight children below the age of five; and 23% women of the reproductive age (15-49 years) reside [5]. Even though the current contribution of the fishery sector to the food and nutrition security is low, it has been recognized as an important resource in the country's national nutrition strategies [6].

Information on the nutrient content of important foods is a vital tool in understanding the associations between production, access, and nutrient intakes. Besides, the knowledge can be used to devise policies and programs such as the development of improved production systems [7], to ensure that food supply optimally satisfies population nutrient demands [8]. Despite the potential importance of fish in a diet, only some fragmented studies were performed on the nutrient composition profiling of Ethiopian fish species [9-15]. The objective of this study was to assess proximate composition and mineral profiles of commercially important fish species from four major fish producing lakes in Ethiopia.

2. Materials and Methods

2.1. Fish Collection

A detailed description of each sample including local name, scientific name, and the number of each composite sample is given in Table 1. A total of 84 fish were collected from the landing sites in three rift valley lakes: Ziway, Chamo, and Abaya, and one highland lake, Tana. A varying number of fish were collected depending on the size (total length) of each fish. For those fish with a total length (*TL*) less than 40 cm, nine individual fish were taken as one composite sample. On the other hand, six individual fish were combined into one sample for those with a *TL* greater than 40 cm. After grouping, the edible portion of each fish was packed into a polyethylene plastic bag and transported to the National Fishery and Aquatic Life Research Center (NFALRC) in an insulated icebox within twelve hours.

Table 1. *Sample description.*

Lake	Species name	Local name	Total length (cm)/average	Number of fish
Tana	Tilapia	*Koroso*	17-40 /28.5	9
	Barbus	*Barbe*	29-53/41	6
	Catfish	*Ambaza*	34-72/53	6
Ziway	Tilapia	*Koroso*	22-33/ 27.5	9
	Catfish	*Ambaza*	39-51/45	6
	Common carp	*Dabe*	31-45/38	9
	Crucian carp	*Bilcha*	26-35/30.5	9
Chamo	Tilapia	*Koroso*	34-38/36	9
	Nile perch	*Nech asa*	40.7-57.5/49.1	6
Abaya	Tilapia	*Koroso*	18-26/22	9
	Nile perch	*Nech asa*	52-60/56	6

2.2. Determination of Nutritional Value

2.2.1. Determination of Protein Content

Crude protein was determined by the Kjeldahl method according to AOAC procedure [16]. One gram of sample was weighed and added to the digestion flask. In the digestion flask, 12 ml of concentrated H_2SO_4 and 1g of catalyst was added. It was digested at 400°C for $2^{1/2}$ hours. After digestion was completed, the content in the flask was diluted by 50 ml of water and neutralized using 40% of 40ml NaOH. Upon addition of NaOH, the ammonium was distilled off using steam distillation apparatus and trapped into a 2% boric acid and solution containing methyl blue and methyl red indicators. Finally, titration of the ammonium attached to borate anion was titrated with standardized 0.1 N HCl, and the amount of HCl. consumed was recorded and total crude protein was calculated as total nitrogen.

$$\%\,N = \frac{(ml\ titrated - blank) \times N \times Eq.wt\ of\ Nitrogen}{1000 \times \mathrm{Wt}} \times 100$$

$$\%\,Crude\ Protein = \%N \times 6.25$$

Where; Wt= weight of the sample, N= concentration of sulfuric acid

2.2.2. Determination of Moisture Content

The sample moisture content was analyzed following AOAC procedure [17]. A drying dish was dried in an oven at 105°C for 1 hour and placed in a desiccator to cool. The weight of the drying dish (W_1) was recorded. Five grams of sample was weighed in the dry dish (W_2) and oven-dried at 105°C for 3 hours. After cooling in a desiccator to room temperature, it was again weighed (W_3) and brought to constant weight by putting it again in an oven for an extra one hour.

$$Moisture\ (\%) = \frac{W2 - W3}{W2 - W1} \times 100$$

2.2.3. Determination of Fat Content

Total lipid was extracted by a diethyl ether solvent system [18]. A five gram of the sample was weighed and extracted into a 250 ml round-bottom flask with 50 ml diethyl ether for about 4 hours at 110°C in the Soxhlet extractor. Then, the organic solvent was removed at 40-60°C under reduced pressure using a rotary evaporator. Finally, the weight of fat was calculated using the following formulae.

Weight of fat = (weight of container + extracted fat) − (weight of container)

and

$$Fat\ content\ (\%) = \frac{Mass\ of\ fat\ extracted\ (g)}{Weight\ of\ original\ sample\ (g)} \times 100$$

2.2.4. Determination of Ash Content

Clean crucibles were placed under a muffle furnace at 550°C for one hour. Crucibles were moved from the furnace to desiccators and cooled to room temperature. These crucibles were weighed quickly to prevent moisture absorption, and 5g of the sample was added. The crucibles, containing the sample were placed in a muffle furnace and heated at 550˚C overnight. Then, crucibles were taken to desiccators and cooled to room temperature. After cooling, crucibles were weighed quickly to prevent moisture absorption [17].

$$Ash\ (\%)\ = \frac{Wt.of\ ash}{Wt\ of\ sample} \times 100$$

2.2.5. Determination of Mineral Content

The mineral content determination was carried out following AOAC procedure [19]. About 5 grams of homogenized fillet sample was digested in a concentrated HNO_3 and quantitatively transferred to a 50 ml volumetric flask. Then the volume was adjusted using a distilled water. A blank digest was prepared in the same way. After preparation of the digest, Na, K, Ca, and P were determined using flame photometer.

2.3. Statistical Analysis

Statistical analysis was done using J.M.P. Pro version 13 software. One-way analysis of variance (ANOVA) was used to compare the mean composition between species in each lake. The level of statistical significance was considered at $p< 0.05$.

3. Results and Discussion

3.1. Proximate Composition

The proximate composition of muscle tissues of six fish species collected from four freshwater lakes in Ethiopia is shown in (Table 2). Results of some mineral analysis are presented in (Table 3). Constituent data were compared between different species of each lake using a one-way analysis of variance.

Table 2. *Proximate composition.*

Lake	Species	Nutrient content per 100 g raw edible portion					
		Moisture (g)	**Protein (g)**	**Fat (g)**	**Ash (g)**	**Carbohydrate (g)**	**Energy (kcal)**
Tana	*O. niloticus*	78.43 ± 1.25	18.32 ± 1.68	1.62 ± 0.17	1.15 ± 0.01^{a}	0.48 ± 0.29	97.18 ± 7.72^{b}
	L. intermidious	78.76 ± 0.36	17.31 ± 0.30	2.25 ± 0.24	1.12 ± 0.03^{a}	0.56 ± 0.44	115.04 ± 2.08^{ab}
	C. gariepinus	79.42 ± 0.15	15.97 ± 0.18	2.60 ± 0.99	1.05 ± 0.02^{b}	0.96 ± 0.64	125.08 ± 12.56^{a}
Ziway	*C. carp*	81.18 ± 0.77	16.21 ± 0.65	1.29 ± 1.10	0.79 ± 0.02^{b}	0.54 ± 0.25	76.42 ± 12.37
	C. carpio	80.34 ± 0.47	16.45 ± 0.73	2.12 ± 0.29	0.71 ± 0.01^{b}	0.38 ± 0.32	93.88 ± 4.11
	C. gariepinus	79.45 ± 0.83	15.87 ± 0.98	3.48 ± 1.56	0.77 ± 0.03^{b}	0.44 ± 0.05	109.83 ± 25.55
	O. niloticus	78.87 ± 1.39	16.92 ± 0.60	1.51 ± 0.70	1.07 ± 0.05^{a}	1.63 ± 1.32	94.64 ± 7.99
Chamo	*L. niloticus*	78.12 ± 1.27	17.06 ± 0.34	2.13 ± 0.36	1.13 ± 0.01	1.56 ± 1.14	87.41 ± 4.57
	O. niloticus	78.05 ± 1.03	18.92 ± 0.62	1.53 ± 0.35	1.04 ± 0.03	0.31 ± 0.18	89.42 ± 0.82
Abaya	*L. niloticus*	78.34 ± 0.36	18.17 ± 0.38	0.86 ± 0.87	1.17 ± 0.01*	1.46 ± 0.55*	80.42 ± 3.03
	O. niloticus	78.74 ± 0.78	18.43 ± 0.38	1.42 ± 0.39	1.08 ± 0.05*	0.33 ± 0.12*	86.47 ± 3.03

The result showed a significant variation ($p<0.05$) in ash and carbohydrate content between the fish species from all Lakes. The water content varied between 78.05 ± 1.03% in *O. niloticus* species of the Lake Chamo to 81.18 ± 0.77% in *C. carp* species of Lake Ziway. Protein content was in the range between 15.87 ± 0.98% in *C. gariepinus* species of the Lake Ziway to 18.92 ± 0.62% in *O. niloticus* species from lake Chamo. The least fat content was 0.86 ± 0.87%, which was recorded from *L. niloticus* species of Lake Abaya, while the highest fat content was 3.48 ± 1.56 which was recorded from *C. gariepinus* species of Lake Ziway. Ash content of the fish species from all lakes except Chamo showed statistically significant variation. The range in ash content falls between 0.71 ± 0.01 in *C. carpio* species from lake Ziway to 1.17 ± 0.01 in *L. niloticus* species from lake Abaya. The calculated carbohydrate content ranged between 0.31 ± 0.18 to 1.63 ± 1.32 in *O. niloticus* species from lake Chamo and Ziway respectively.

The finding showed that most of the proximate composition parameters didn't show significant variation depending on species. However, due to high-fat content in *C. gariepinus* species, the energy value of this species exceeds other species under the study. This means, in alleviating energy deficiency, which is one of the prevailing forms of malnutrition in the country, *C. gariepinus* can contribute better than other species. The fact that *C. gariepinus* has better energy content may have to shift the insight of aquaculture strategies to be nutrition-sensitive, and should prioritize catfish as a candidate species in aquaculture. Besides the higher energy content, farming *C. gariepinus* in aquaculture has several advantages, one of which its ability to grow in poor water quality with little effort of pond management.

3.2. Mineral Composition

The phosphorous, calcium, sodium, and potassium composition of the six fish species from five Ethiopian lakes are presented in mg per 100 g unit in (Table 3). Calcium content ranged from 52.34 to 250.43 mg/100g, which is consistent with previous findings [20]. The phosphorous content in species analyzed under the study was from 490 to 960 mg/100g of the fillet. The range was in agreement with earlier report [20], and a narrower range was found compared to Bogard *et al.*, [8], who obtained a phosphorous content 110 to 1000 mg/100 g. The range of sodium content (41.37 to 164.28 mg/100g) was comparable with other studies on various fish species [8, 20]. The range of potassium content (389.75 to 1887.44 mg/100g) was varied from previously reported findings in different fish species [8, 20].

Table 3. *Mineral content of six fish species from four lakes in Ethiopia.*

Source	Species	Ca (mg/100g)	P (mg/100g)	Na (mg/100g)	K (mg/100g)
Tana	*O. niloticus*	66.42 ± 18.68	820 ± 40	61.37 ± 3.35	1572.14 ± 4.93
	L. intermedious	110.85 ± 0.28	770 ± 20	62.63 ± 8.80	1485.41 ± 3.07
	C. gariepinus	75.52 ± 14.95	710 ± 10	164.28 ± 16.64	1407.19 ± 31.34
Ziway	*O. niloticus*	85.35 ± 4.95	720 ± 40	41.37 ± 5.02	389.75 ± 81.02
	C. gariepinus	192.24 ± 6.73	490 ± 10	47.45 ± 4.25	950.43 ± 85.14
	C. carpio	172.97 ± 52.97	570 ± 30	60.45 ± 10.74	1887.44 ± 889.53
	C. carp	250.43 ± 7.43	700 ± 20	53.66 ± 2.41	1118.00 ± 143.28
Chamo	*O. niloticus*	52.34 ± 20.31	870 ± 30	70.34 ± 7.36	1606.07 ± 20.25
	L. niloticus	166.95 ± 11.54	500 ± 20	71.05 ± 3.96	1638.00 ± 4.96
Abaya	*O. niloticus*	136.97 ± 8.68	960 ± 30	118.35 ± 8.44	1699.16 ± 51.24
	L. niloticus	94.73 ± 1.75	850 ± 40	71.05 ± 1.22	1638.00 ± 22.46
RDA		1000 mg	1000 mg	1500 mg	4700 mg

4. Conclusion

The data presented in this research indicated the nutritional significance of commercially important fish species in four Ethiopian lakes. Proximate composition and some mineral content were evaluated. The finding indicated the potential of commercially important fish species in contributing to the daily nutrient requirement. Besides, the importance of nutrition-sensitive prioritization of candidate fish species for aquaculture should be taken into account. Based on the total energy content, catfish surpasses other species under this study, and thus a priority should be given in selecting candidate species for aquaculture farms.

5. Recommendations

A comprehensive study is recommended to address species other than those with commercial importance and to include all indicator parameters of nutritional value. Despite the limitations, this paper expands the current knowledge on the proximate composition and mineral content of commercially important fish species in Ethiopia since it incorporates the four major fish-producing lakes in the country. It would be important to determine all the micronutrients that have public health significance.

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