Proximate composition of commercially important fish species in southern Gulf of Lake Tana, Ethiopia

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ABSTRACT

The aim of the study was to determine the proximate composition of each sex of *Oreochromis niloticus, Clarias gariepinus and Labeobarbus intermedius* fish species from the southern Gulf of Lake Tana, Ethiopia. The fish samples were collected during the dry season of 2014 from the three fish landing sites, i.e., Bata, Micheal and Giorgis, where local fishermen sell their catches. Species were identified via morphological examination and color. Sexes were identified by observing genital papilla and gonads after dissection. After measuring weight and length of young fish species, fish weighing 201-310 g were selected for the study. A total of 72 fish, eight and four fish per species and sexes were selected, respectively, for each site. The sample size was determined using "resource equation" method. Only edible fillet was labeled and transferred to plastic bags according to species and sex. Then the sample was transported for proximate analysis to Addis Ababa Food Science and Nutrition laboratory using icebox at about 4 °C. Fish sample composites were prepared by taking the fish samples from the three fish landing sites for each sex and species. Samples were thawed at room temperature and oven-dried at 60 °C for 72 h, then ground into a fine powder. Proximate composition was determined following the procedure of Association of Official Analytical Chemists (AOAC). Data analysis was conducted using analysis of variance (ANOVA). Nutrient content significantly varied among fish species; more protein was recorded from *O. niloticus* and fat from *L. intermedius*. Also, fat, ash and gross energy content were different between sexes; female fish contained significantly more fat and gross energy than males. In conclusion, consumers are advised to consume these species to obtain required nutrients.

Keywords: Fish species, Lake Tana, Proximate composition.
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INTRODUCTION

In Ethiopia, household food insecurity, hunger and under nutrition remain critical issues; the poor nutritional status of women and children has been a consistent problem (Ali *et al*., 2013). Protein malnutrition is severe because the intake of foods from animal sources was low in the country (Herrador *et al*., 2015). Fish are good source of protein, polyunsaturated fatty acids particularly omega-3 fatty acids, Calcium, Zinc and Iron. Next to other animal meat, fish is the only protein source that contains all the essential amino acids in the right proportion, so-called complete protein. It is also the sole accessible and affordable source of animal protein for the poor (Thilsted *et al*., 2014). Fish in developing countries like Ethiopia provide important nutrients to a large number of people and contribute for nutrition security. Fish are considered high nutrient sources for humans that contribute for low blood cholesterol and reduce the risk of stroke and heart diseases (Aberoumand, 2012). Determination of some proximate profiles such as protein, lipid, ash and other nutrient contents is often necessary to make sure that they are within the range of dietary requirement and commercial specifications. Different researches done in Ethiopia lakes revealed that fish are good source of protein, fat and ash (Kassahun Asaminew *et al.,* 2012; Alemu Lema *et al.,* 2013; Tsegay Teame *et al*., 2015). Lake Tana is home of 28 fish species including 17 endemic *Labeobarbus* species. Current fish production of Lake Tana was 1,454 tons per year (Asefa Mitike, 2014). However, there was no study conducted in Lake Tana on the proximate composition of commercially important fishes. Therefore, the present study was carried out to investigate the nutritional value of commercially important fish species of each sex of fish species from the southern Gulf of Lake Tana.

MATERIALS AND METHODS

The study was conducted in Lake Tana, Bahir Dar, Amhara Regional State (about 565 km North West of Addis Ababa), situated at an altitude of 1800 meters above sea level. It is located at 11°29′ N Latitude and 37°29′ E longitudes (Tesfahun G/Michael and Demissie Sewmehon, 2004). Lake Tana, the largest lake in Ethiopia and the

source of Blue Nile River, has a surface area of *ca*. 3200 km^2. It is situated in the northwestern highlands at an altitude of approximately 1800 m. It is a shallow lake (maximum depth 14 m, mean 8 m). More than 60 small seasonal tributaries and seven perennial rivers (Gumara, Ribb, Megech, Gelgel Abbay, Gelda, Arno-Garno, and Dirma) feed the lake. The potential for fish production of Lake Tana is estimated to be 10,000 tons per annum. However, the current production is only about 1,454 tons per year (Asefa Mitike, 2014). Nile tilapia (*Oreochromis niloticus*), African catfish (*Clarias gariepinus*) and species flock of endemic, large *Labeobarbus* spp. were the three main species targeted by commercial gillnet fishery of Lake Tana and these forms 65%, 20% and 15% of the annual catch compositions of fish species (Dereje Tewabe, 2015).

Collection of samples

The fish samples were collected from Southern Gulf of Lake Tana which is southern part of the Lake in Northwestern Ethiopia. The study was conducted in the dry season of the year 2014. Fish samples were collected from the three fish landing sites, i.e., Bata, Micheal and Giorgis, where local fishermen sell their fishes. The three commercially important fish species *Oreochromis niloticus*, *Clarias gariepinus* and *Labeobarbus intermedius* were selected for this study. Identification of fish species and sexes were done by the help of an expert from Fisheries and Other Aquatic Life Research Center, Bahir Dar, Ethiopia. Fish species were identified via morphological examination and color. Sexes for *C. gariepinus*, *O. niloticus* were identified based on their genital papilla before dissection. For *L. intermedius* sexes were identified by observing gonads after dissection. The length and weight of the fish was measured using weighing balance and measuring board (Table 1). Young fish weighing 201-310 g were used for this study (Allumma and Idowu, 2011). A total of 72 fish were bought from the three fish landing sites (Bata, Micheal and Giorgis). Then, 24 fish were collected for each species from the three fish landing sites. This means eight fish and four fish for every species and sexes, respectively. The sample size was determined through “resource equation" method (Charan and Kantharia, 2013) and calculated as follows. The value of E should lie between 10 and 20.

E = Total number of animals − Total number of groups

E=72-3=69, which was more than 20 hence sample size in this study was more than necessary.

Selected fish samples were immediately cut up and only edible fillet was labeled and transferred to plastic bags according to sexes of each species. The samples were kept in an icebox at about 4 °C, then transported to Addis Ababa, Food Science and Nutrition Laboratory for proximate analysis.

Table 1. Weight and length of the studied fish species in southern gulf of Lake Tana.

Species	Local name	Mean weight (g)	Mean length (cm)
O. niloticus	Kereso	243.5±45.2	23.71±1.2
C. gariepinus	Anbasa	280.3±31.2	34.14±1
L. intermedius	Niche assa	252.1±50.1	28.95±2.3

Preparation of samples

In order to obtain representative fish sample composites were prepared by taking the fish sample from the three fish landing sites (Bata, Micheal and Giorgis) for each sex of fish species. Fillets of each sex of fish species were thawed at room temperature and samples were oven-dried at 60 °C for 72 hrs. Each sex of fish species samples was dried then ground into a fine powder using porcelain mortar and pestle. Then powdered fillets were kept in polyethylene bags for proximate analysis. Proximate analysis was done in triplicate for each sex of fish species.

Proximate composition analysis

Moisture content

Moisture content was determined by oven drying method following the procedure of AOAC (1995). Empty dishes were dried using air drying oven for 1 hour at 105 °C, transferred to the desiccators (with granular silica gel), cooled for 30 minutes, and were weighed. Replicates of the minced samples were mixed thoroughly and 5 g of composite fresh fillet was transferred to the dried and weighed dishes. The dishes and their contents were placed in the drying oven and dried for 3 h at 105 °C in an oven until constant weights were obtained, and

then the dishes and their contents were cooled in desiccators to room temperature and reweighed. The moisture content was determined by measuring the weight of a sample before and after the water was removed by evaporation:

$$MC = \frac{(WWS - WDS) \times 100}{WWS}$$

Where, MC = Moisture content, WWS = Weight of wet sample, WDS = Weight of dried sample

Crude protein

Crude protein in the sample fish fillets was quantified following the procedure of AOAC (1995) by Kjeldahl methods; 0.5 g of powdered fish fillet was weighed into Kjeldahl digestion flask and then digested by heating at 370 °C for four hours in the presence of 6 ml Sulfuric acid, 3.5 ml H_2O_2, 3 g of catalyst Copper Sulfate ($CuSO_4$) and Potassium sulfate (K_2SO_4). After digestion was completed, the clear solution formed was cooled for 30 minutes and neutralized by adding 25 ml NaOH (40%) and diluted using 25 ml distilled water. Twenty-five ml distilled water, 25 ml Boric acid and 3 drops of Methyl blue were added to a receiving 250 ml capacity flask connected to the distiller by tube. The distillation process was terminated when the volume of receiving flask reached between 200 to 250 ml. Note: all reagents were added to the blank except the sample. The nitrogen content was estimated by titration of the borate anion formed with 0.1N HCl. The amount of Nitrogen was calculated using the formula:

$$\% N = \frac{N\ HCl \times (Vol\ HCl\ TS - Vol\ HCl\ TB) \times 14\ g \times 100}{Gram\ of\ sample\ mole}$$

Where, TS = titrates sample, TB = titrates blank.

Crude protein = 6.25 × N.

Crude fat

Crude fat was determined following the procedure of AOAC (1995) by semi continuous solvent extraction method (Soxhlet method). Accordingly, for all sample categories, 2 g of dried and ground sample was placed in a porous cellulose extraction thimble and thimble was covered with fat free cotton. The thimble was placed in

an extraction chamber which was suspended above a flask containing the solvent (50 ml of diethyl ether) and below a condenser. The flask which was dried in drying oven at 105 °C containing boiling chips was placed inside the extraction chamber and heated at 55 °C and the solvent evaporated and moved up into the condenser where it was converted into a liquid that trickled into the extraction chamber containing the sample. At the end of the extraction process, which typically lasted for 3 hours, the flask containing the solvent and lipid was removed, the solvent was evaporated in drying oven at 70 °C and the mass of lipid remaining was quantified gravimetrically and calculated from the difference in weight of the extraction flask before and after extraction as percentage. The crude fat in the initial sample was calculated as:

$$Fat\ content = \frac{Weight\ of\ fat\ \times 100}{Weight\ of\ sample}$$

Ash content determination

To determine the ash content, AOAC method (AOAC, 1985) was used. Briefly, duplicates of 2.50 g of homogenized samples were placed in pre-washed, dried, weighed and marked crucibles, to be ash at 550 °C in Muffle Furnace for eight hours. Then, samples were cooled in desiccator and weighed again. The ash content was calculated as follows:

$$\%\ Ash\ (wet\ basis) = \frac{(WAA - TWC)\ \times 100}{Original\ sample\ weight}$$

Where, WAA = weight after ashing, TWC = tare weight of crucible.

Eventually proximate composition in wet base was recalculated from dry base using the formula:

$$\%\ Proximate\ in\ wet = \frac{\%\ PID\ \times (100 - MC)}{100}$$

Where, PID = Proximate in dry, MC = Moisture content.

Gross energy value

Gross energy values (kcal/g) was calculated by overall addition of the protein content multiplied by 4 and the total lipids content multiplied by 9 and using Atwater's conversion factors (Atwater & Benedict, 1902). The result was expressed as kcal per 100 g.

Gross energy value= (4 × protein content) + (9 × fat content)

Statistical analysis

Variation in nutrient content among species and between sexes was analyzed using two-way ANOVA and means separated using Duncan's Multiple Range test.

RESULTS AND DISCUSSION

Nutrient content in relation to fish species

Proximate composition significantly varied among the fish species (Table 2). *O. niloticus* gave significantly more protein (18.82%) and *L. intermedius* more fat (2.36%). *C. gariepinus* gave significantly less protein (15.2%), fat (1.76%) and ash (1.3%) compared to the other two fish species.

Table 2. Mean ± SE proximate composition in percent and gross energy (GE) content in kcal/100 g of *O. niloticus*, *C. gariepinus* and *L. intermedius* fillet in wet basis (N=24 each).

Protein	Moisture	Fat	Ash	Gross energy
O. niloticus				
18.8±0.01^{a}	79.0±0.03^{b}	0.6±0.02^{c}	1.4±0.01^{a}	79.8±0.07^{b}
C. gariepinus				
15.2±0.01^{c}	80.5±0.03^{a}	1.8±0.02^{b}	1.3±0.01^{b}	76.7±0.07^{c}
L. intermedius				
15.4±0.01^{b}	80.4±0.03^{a}	2.4±0.02^{a}	1.4±0.01^{a}	83.1±0.07^{a}

Means within a column with the same letter(s) are not significantly different from each other at $\alpha = 0.05$.

The protein content in this study was above 15% in all studied fish species. That indicates they were a rich source of protein (Stancheva and Merdzhanova, 2013). Similar protein content of *O. reochromis (18.5%)* was reported before in Lake Ziway (Erkihun Massresha *et al.*, 2017). In the current study, moisture content (80.45%) was higher than previous reports in other lakes of Ethiopia (Alemu Lema *et al.,* 2013; Tsegay Teame *et al*., 2016; Erkihun Massresha *et al*., 2017). High moisture makes fish products vulnerable to microbial spoilage, oxidative degradation of polyunsaturated fatty acids and therefore lowers quality and shelf life (Olagunju *et al.,* 2012). According to (Ackman, 1989) fish can be grouped into four categories based on their fat content: lean fish (< 2 %), low fat (2 to 4 %), medium fat (4

to 8%), and high fat (> 8%). Based on the present study, *O. niloticus* and *C. gariepinus* were classified as lean, whereas *L. intermedius* was low fat fish species. Gross energy value was higher on *L. intermedius* as compared to the other two fish species. This is because *L. intermedius* contained significantly higher fat than others. In general, proximate composition was significantly varied among the studied fish species. This may be due to consumption or absorption capability and conversion potentials of essential nutrients from their diets or their local environment (Adewoye and Omotosho, 1997; Tsegay Teame *et al.,* 2016).

Nutrient content in relation to species and sex interaction

Fat, ash and gross energy contents of fish fillet varied significantly between sexes (Table 3), but not moisture and protein contents. Females contained significantly more fat and gross energy than males. In contrast, amount of ash was significantly more in males.

Table 3. Mean ± SE proximate composition in percent and gross energy (GE) content in kcal/100 g of fish species and sex of fish fillet in wet basis.

Species /Sex	Moisture^{NS}	Protein^{NS}	Fat	Ash	Gross energy
O. niloticus					
Male	79.1±0.46	18.9±0.58	0.5±0.05^{a}	1.5±0.07^{a}	80.0±2.4^{a}
Female	77.6±0.46	19.9±0.58	0.7±0.05^{b}	1.0±0.07^{b}	85.8±2.4^{b}
C. gariepinus					
Male	81.4±0.46	14.0±0.58	0.8±0.05^{a}	0.7±0.07^{a}	63.6±2.4^{a}
Female	80.0±0.46	14.7±0.58	2.3±0.05^{b}	0.9±0.07^{b}	79.9±2.4^{b}
L. intermedius					
Male	81.0±0.46	14.5±0.58	1.5±0.05^{a}	1.0±0.07^{a}	71.8±2.4^{a}
Female	80.0±0.46	16.0±0.58	3.2±0.05^{b}	1.1±0.07^{b}	94.0±2.4^{b}

Values with different superscripts with in the column of parameters were significantly different ($p<0.05$), NS stands for not significant.

According to previous studies, nutrient content of female fish was higher than male fish (Ayas *et al.*, 2012; Alemu Lema *et al.,* 2013; Pereira *et al*., 2013). Exogenous factors affect fish body composition. However, intrinsic factors like sex greatly affect fish body composition since they have various influences on physiological processes (Huss, 1995; Naeem *et al.*, 2011; Tsegay Teame *et al*., 2016).

CONCLUSION

From the present study it can be concluded that there was significant variation among fish species and sexes in proximate composition. *O. niloticus* had significantly more protein compared to both *C. gariepinus* and *L. intermedius* fish species. Female fish contained significantly more fat and gross energy as compared to male fishes. From a nutritional point of view, the three fish species demonstrated acceptable quality particularly *O. niloticus* showed the highest protein and ash content compared to other species. Consumers could secure their nutrition by consuming these fish species. Generally, further study is required to investigate other chemical and biological parameters to ensure the quality and the safety of those fishes.

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