Journal of Fisheries & Livestock Production

Tsegay et al., J Fisheries Livest Prod 2016, 4:2
DOI: 10.4172/2332-2608.1000172

Research Article | Open Access

Analysis of Diet and Biochemical Composition of Nile Tilapia (*O. niloticus*) from Tekeze Reservoir and Lake Hashenge, Ethiopia

Tsegay T[1]*, Natarajan P[2] and Zelealem T[1]

[1]*Tigray Agricultural Research Institute (TARI), Mekelle, Ethiopia*
[2]*Ambo University, Department of Biology, Ambo, Ethiopia*

Abstract

A study was conducted to investigate the biochemical composition and diet type of Nile tilapia (*Oreochromis niloticus*) collected from Tekeze reservoir and Lake Hashenge, Ethiopia between December, 2014 and March, 2015. A total 100 fishes were collected from the two water bodies 50 from each by gill nets of 10, 12 and 14 cm stretched mesh size. The stomach contents were analyzed using frequency of occurrence and numerical methods. The food items in the stomach covered a wide variety, ranging from various types of phytoplankton to zooplankton and macrophytes. The food composition of *O. niloticus* showed that, there was variation within the fish species across the study areas. The major food items in terms of frequency of occurrence collected from the stomach of *O. niloticus* in Tekeze reservoir were Pediastrum (68.85%), Microcystis (60.45%), Peridinium (59.70%) and Staurastrum (41.56%) and from Lake Hashenge were Daphnia (63.12%), *Copepods* spp (56.90%), Nauplii (52.11%), and Macrophytes (45.56%).The contribution of zooplankton (Daphnia, copepods and Nauplii) was higher in case of Lake Hashenge but *Pediastrum* spp., *Microcysts* spp. and *Peridinium* spp. which were phytoplankton type were the dominant food items of the fish in Tekeze Reservoir.

The fish species from the water bodies were transported to the laboratory for the estimation of biochemical composition such as crude protein, crude fat, moisture, ash, carbohydrate and some minerals. The chemical analysis revealed that the crude protein content of the fish species collected from the two water bodies were ranged from 15.31-16.32% of wet weight. The crude fat content and ash ranged between 1.20 and 2.45, 0.81 and 1.16% of the wet weight, correspondingly. The concentrations of some elements were significantly different ($P<0.05$) between sexes and location were the fish was collected. The analyzed mineral content in each species was in the order K>Na>Ca>Mg>P>Fe>Zn>Cu>Mn. This investigation is an important measure towards the data needed to create information of the relationship between food type and biochemical composition. As the present study revealed that the fish species are good sources proteins and fats, there is need to investigate in detail the types of amino acids and fatty acids of the sampled fishes.

Keywords: Daphnia; Food items; Lake Hashenge; Nile tilapia; proximate composition

Introduction

Nile tilapia *(Oreochromis niloticus*) [1] is widely distributed in tropical and subtropical Africa in the Volta, Gambia, Senegal, Niger Rivers and the Nile River basin and is native to Lakes Chad, Tanganyika, Albert, Edward, and Kivu [2,3].

Ethiopia has relatively large area of inland water bodies that contain diverse aquatic ecosystems giving great scientific interest and economic importance. There are different economically and ecologically important species of fish that are found in these water bodies. Adult *O. niloticus* have a high degree of plasticity and opportunism in their feeding behaviour and are hence classified as omnivorous [4]. They are capable of consuming a wide variety of feed items including phytoplankton, zooplankton detritus and macrophyts [5]. *O. niloticus* is one of the most known members of the tropical and subtropical freshwater fishes. It is recommended by the FAO as a culture fish species because of its importance in aquaculture and its capability in contributing to the increased production of animal protein in the world. Therefore, it is now globally distributed and has become very popular through the advances in the cultivation techniques.

In Ethiopia it is widely distributed in the lakes, rivers, reservoirs and swamps which contribute about 60% of total landings of fish [6]. It is reported that *O. niloticus* from Lakes of Hawassa, Ziway and Chamo mainly feeds on phytoplankton, macrophytes and detritus [7-9].

Fish and shell fish are important animal protein and have been widely accepted as a good source of protein and other elements for the maintenance of healthy body [10]. Most developing countries are located in tropical or sub-tropical areas, and fish is a vital component of food security for these countries. Rivers and lakes in these countries were more accessible and kinder sources of fish, and also carry over 40% of the world's known fish species [11]. A recent study found evidence that, contrary to popular belief, size dimorphism between the sex's results from differential food conversion efficiency rather than differential amounts of food consumed. Hence, although males and females eat equal amounts of food, males tend to grow larger due to a higher efficiency of converting food to energy [12].

The body composition of fish has recently received attention in studies on nutrition, genetics, and health [13] because of the increasing interest in the quality and safety of fish products [14]. Body composition is an important aspect of nutritional quality [15] and affects the nutritional value and consumption quality of fish [16]. Fish fillet consists of several components, such as moisture, protein, fats, vitamins and minerals, all of which contribute to the overall meat composition. Fish body composition is affected by both exogenous and endogenous factors [17]. Exogenous factors that affect fish body composition include the diet of the fish (composition, frequency) and the environment in which it is found (salinity, temperature). The main

***Corresponding author:** Teame T, Tigray Agricultural Research Institute (TARI), Mekelle, Ethiopia, Tel: (+251) 34 440 2801; E-mail: tsegayteam331@yahoo.com

Received December 24, 2015; **Accepted** February 22, 2016; **Published** March 15, 2016

Citation: Tsegay T, Natarajan P, Zelealem T (2016) Analysis of Diet and Biochemical Composition of Nile Tilapia (*O. niloticus*) from Tekeze Reservoir and Lake Hashenge, Ethiopia. J Fisheries Livest Prod 4: 172. doi: 10.4172/2332-2608.1000172

exogenous factor affecting proximate composition is diet. Various studies have examined the effects of temperature, light, salinity, pH and oxygen concentration on the proximate composition of fish but these factors would seem to have very limited effects. On the other hand, endogenous factors are genetic and linked to the life stage, age, size, sex and anatomical position in the fish [17]. These endogenous factors govern the majority of principles that determines the composition of fish [17]. Proximate composition of body muscles of *Puntius stigma* (male and female) analyzed shows that the moisture content was found to be higher in female, while protein, fat, ash, carbohydrate and minerals contents were higher in male. Moreover, different sexes were observed to have varying chemical composition [18].

Literature on biochemical analysis of *O. niloticus* includes those of [12,19-24]. None of these studies however reports on the biochemical analysis of the species collected from two different water bodies which the present study is designed.

Materials and Methods

Description of study areas

Tekeze reservoir: Tekeze reservoir is a hydropower reservoir constructed on 2009 over the Tekeze River. Tekeze River is a major river in Ethiopia and it is a Nile tributary. Tekeze reservoir is with a maximum length of 75 km and maximum width of 6 km, and covering an area of about 160.4 km^2. According to National Statistics of Agency (NSA) (2008) Tekeze River is 608 kilom long. Mana, Tsilare, Seletsa, Avera and Ariqua rivers are the main tributaries of the Tekeze River joined in to the reservoir. The canyon which it has created is the deepest in Africa and one of the deepest in the world, at some points having a depth of over 2000 m. Tekeze River originates in the central Ethiopian Highlands near Mount Qachen within Lasta, at 14°11 N 37°31.7 E and 14.18.3°N 37.52 83°E. The reservoir is located at an elevation of 1107 m above sea level. It is approximately 155 km from Mekelle city. The capacity of the reservoir is about 9.293 billion m^3 (9.293 km^2) of water. Although Tekeze reservoir is constructed entirely in Tigray region, the water of the reservoir is shared by Amhara region. The reservoir is communal for five districts (Tanqua Abergelle district from Tigray region and Abergelle, Zikuala, Sahla and Tselemti districts from Amhara region). The main aim of constructing of the Reservoir was to produce electricity, but the reservoir fisheries were later recognized as a significant socio-economic importance to Tigray and Amhara people. The reservoir also facilitates the transportation of goods and passengers and the provision of services for Tigray and Amhara people found on both sides of the reservoir.

Lake Hashenge: In addition to Tekeze Reservoir, the study was extended in Lake Hashenge. Lake Hashenge is one of the highland lakes of Ethiopia found in Tigray region. It is located in Ofla district Southern Tigray Administrative Zone, about 628 km North of Addis Ababa and about 152 km South of Mekelle and 8 km North of Korem town in the coordinates of 12°34′50″N and 39°30′00″E and at an elevation of 2440 m above sea level. It is one of the crater lakes in the country and not associated with the East African rift system; instead it is the result of volcanism. This lake has no outlet to drain its water. Hashenge Lake is 5 km long and 4 km wide, with a surface area of 20 km^2 and maximum depth of 25 m. Its drainage area is 129 km^2.

Methods

Physico-chemical param of the water

Physico-chemical param of the water like temperature, pH, conductivity, TDS, dissolved oxygen and transparency were monitored monthly in the field using the methods as described in APHA (1998). Temperature, DO, Conductivity and TDS were measured using portable digital water quality multi m model CO 411 and pH was measured with portable pH m model CP 401.

Food analysis

100 matured fishes were collected from each water body for stomach content analysis. The stomach content analysis was carried out in the laboratory by using preserved stomach contents in 5% formalin. The stomach contents were examined using dissection microscope (Leica MS5) and also compound microscope (Leica DME).

Frequency occurrence of food items

The number of stomach samples contains one or more of a given food item was expressed as a percentage of all non-empty stomachs examined. The proportion of the population that feeds on particular food item was estimated and the frequency of occurrence was calculated [25,26].

$F_i = 100^* n_i/n$

Where, F_i: Frequency of occurrence of the *i* food item in the sample

n_i: Number of stomachs in which the *i* item is found

n: Total number of stomachs with food in the sample

Proximate Analysis

A total of 80 fishes, 20 from each sex and each water body were examined for proximate composition and mineral contents. 20 males and 20 females were collected each water body (from Tekeze reservoir and Lake Hashenge) landing sites. 50 gm of dorsal fillet were taken from each fish and make a composite to each sample. The proximate composition and mineral content were analyzed based on standard procedures of AOAC (2000). The moisture content of the fillet of the fish was determined by oven drying at 105°C overnight, ash by incineration of 2 g of each sample in a muffle furnace at 600°C for 2 h, crude protein by the Micro-Kjeldahl method then (N x 6.25), crude fat was extracted with n-hexane in a soxhlet extractor, while available carbohydrate was calculated by difference. The result of the proximate composition were analyzed in triplicate and reported as mean on percentage wet weight basis.

Mineral Analysis

The mineral content (Calcium, Potassium and Sodium) were determined using Flame photometric method (Jenway Digital Flame Photom: PFP7 model). Phosphorus was estimated using Vanadomolybdate colorimetric method while other mineral elements such as Iron, Zinc, Manganese, Magnesium and Copper were determined using Atomic Absorption Spectrophotometric method. The content of the mineral were done in triplicate and reported as mean mineral content in mg/kg of dry matter.

Data Analysis

The data collected were stored in a database created in MS Excel, a variety of subjects were analyzed by combining quantitative and qualitative social scientific methods. One-way ANOVA model was used to evaluate the association of proximate composition and mineral contents with the fish species using SAS software (SAS version 9.0).

Results and Discussion

Physico-chemical param of Tekeze reservoir and lake Hashenge

The values of physico-chemical properties of water are presented in Table 1. Most of the values of water quality param during the study period were in the optimum condition for fish production except for the low dissolved oxygen value observed in the month of January in Tekeze reservoir. The mean transparency, pH, and temperature were 189 ± 32.5 cm, 8.03 ± 0.2, 26.05 ± 1.2°C and 62.00 ± 11.8 cm, 7.71 ± 0.2, 19.77 ± 0.6°C in Tekeze reservoir and Lake Hashenge respectively. The conductivity of the two water bodies showed the mean value of 462 ± 26.4 uS/cm for Tekeze reservoir and 537.75 ± 9.5 uS/cm for Lake Hashenge. TDS showed a mean value of 1.53 ± 0.2 g/L and 8.99 ± 0.3 g/L for Tekeze and Lake Hashenge respectively. The mean Dissolved Oxygen was 4.25 ± 2.2 in Tekeze reservoir and it varied between 1.03 mg/L (January) and 5.86 mg/L (March). In Lake Hashenge, the dissolved oxygen ranged from 4.97 in February to 5.88 mg/L in December with a mean value of 5.33 ± 0.4 mg/L.

The low level of DO (1.03 mg/L) in Tekeze reservoir may be due to the turnover of the lake. During that time there was fish mortality due to dissolved oxygen depletion (personal observation, 2015). The mean range of values of physico-chemical factors of the reservoir and the lake are within limit for fish tolerance, survival and production and indicated good quality of water in the study areas according to APHA (1998) [27]. The desirable level of DO, temperature and pH for optimum growth of fish are >5 mg/L, 26-30°C and 6.5-8 respectively [28]. This study also shows that the water param were in the optimum range except for DO in Tekeze reservoir in January month which were very low and the mean temperature of Lake Hashenge seems low for tilapia growth. This may lead to the less abundance of Nile Tilapia in the lake.

Diet composition of Nile tilapia (*O. niloticus*)

The diet of *O. niloticus* in Tekeze reservoir is composed of phytoplankton, detritus, macrophytes zooplankton and silt. The brown color and rough texture of the stomach contents indicate that the fish fed more on benthic plant material and mud at the water sediment interface than on suspended particles, which was in line with the report of Fryer and Iles, (1972). Since the productivity of the reservoir is low because of high light attenuation, *O. niloticus* has to rely on any plant material available in the reservoir, which is why detritus constitutes the bulk of its diet. The most abundance food items identified from the stomach of *O. niloticus* from Tekeze reservoir were *Pediastrum* (68.85%), *Microsystis* (60.45%) and *Peridinium* (59.70%), whereas the diet type of *O. niloticus* collected from Lake Hashenge were *Daphnia* (63.12%), *Copepods* (56.90%) and *Nuaplii* (52.11%) (Table 2). The analysis showed that the diet composition of *O. niloticus* from Tekeze reservoir were mostly phytoplankton and in case of Lake Hashenge zooplankton were the most abundance food items. The types of food items found in the stomachs of *O. niloticus* collected from Tekeze reservoir were difference from the stomach content of fish collected from Lake Hashenge in type and abundance. In addition to zooplankton and phytoplankton, detritus and aquatic macrophytes were also considerable importance in the diet of *O. niloticus* due to some nutritional benefits. Several authors have provided similar interpretations about the importance of detritus and macrophyte in different parts of Africa [2,29]. In the present study, proportion of phytoplankton was higher from the stomach of *O. niloticus* collected from Tekeze reservoir. The stomach content proportion of the fish collect from Lake Hashenge was higher in zooplankton than in phytoplankton. The composition differences and relative contribution of food items may partly explained by difference in habitat occupied of the fish.

Proximate composition of Nile tilapia

The proximate composition of the muscle of *O. niloticus* was estimated and presented in Table 3. Data on moisture, crude protein, crude fat, ash and carbohydrate content were expressed as percentage composition. The proximate composition of the fillet of *O.niloticus* collected from the two water bodies showed significant difference (P<0.05). This variation may be many possible factors such as size, sex, maturity of samples and sampling locations that can affect the differences in proximate composition of fish [30].

Sex has no significant (P>0.05) effect in the proximate composition (moisture, ash, crude fat, crude protein and carbohydrate) of the fish species collected from the two water bodies. Moisture content among the fish species was observed between 77.55 and 79.83%. The results showed that there was significant difference (P<0.05) in the moisture content of the fish species collected from the two water bodies. The moisture content of male fishes was higher than the female fishes within the species even though they were not statistically significant (P>0.05). This result was in line with the results of Edirisinghe, et al [30]. Results obtained from the moisture analysis of the fish species collected from the two water bodies showed that the fish samples, *O. niloticus* from Tekeze reservoir, which was locally harvested in large quantities had the highest percentage of moisture content (79.83 ± 0.34 for male and 79.11 ± 0.14% for female) than *O. niloticus* from Lake Hashenge had the lowest moisture content (77.55 ± 0.22% for female and 77.69 ± 0.39% for male). This shows that, *O.niloticus* from Hashenge have concentrated nutrients than *O. niloticus* from Tekeze Reservoir which agreed with the report of Egbal et al. [31] between *C. lazera* and *O. niloticus*. Zmijewski et al [32] found a reverse correlation between the fat and water content to be common among fish species, and it was in line with the present result in some extent. Job et al. [1] reported that the moisture content of *O. niloticus* was 80.90% which is almost similar with the current report (77.55%-79.83%). According to

Physico-chemical parameters	Water body									
	Tekeze Reservoir					Lake Hashenge				
	Months					Months				
	Dec	Jan	Feb	Mar	Mean ± SD	Dec	Jan	Feb	Mar	Mean ± SD
DO (mg/L)	5.02	1.03	5.1	5.86	4.25 ± 2.2	5.88	5.46	4.97	5.02	5.33 ± 0.4
pH	7.77	8.19	8.05	8.09	8.03 ± 0.2	7.92	7.56	7.8	7.54	7.71 ± 0.2
Temperature (°C)	25.78	24.5	26.8	27.13	26.05 ± 1.2	18.9	19.82	20.05	20.32	19.77 ± 0.6
Conductivity (uS/cm)	362	356	349	381	362 ± 26.4	547	535	544	525	537.75 ± 9.5
TDS (g/L)	1.37	1.79	1.52	1.43	1.53 ± 0.2	9.11	8.11	9.34	8.78	8.99 ± 0.3
Transparency (cm)	207	145	185	219	189 ± 32.5	76	55	50	67	62 ± 11.8

Table 1: Monthly Physico- chemical parameters of Tekeze reservoir and Lake Hashenge water.

Water body					
Tekeze reservoir			Lake Hashenge		
Food items	Frequency occurrence		Food items	Frequency occurrence	
	Number	percentage		Number	percentage
Pediastrum spp.	41	68.85	*Pediastrum* spp.	15	10.88
Peridinium spp.	23	59.7	*Spirogyra* spp.	3	1.24
selenastrum spp.	35	40.12	*Staurastrum* spp.	6	5.16
Melosira spp.	27	39.45	*Anabaena* spp.	14	12.23
Staurastrum spp.	20	41.56	*Microcystis* spp.	21	32.13
Eudorina spp.	11	34.38	*Peridinium* spp.	23	30.56
Microcystis spp.	32	60.45	*Daphnia* spp.	54	63.12
Euglena spp.	7	41.18	*Diaphanosoma* spp.	39	44.67
Scenedesmus spp.	13	31.71	*Copepods* spp.	51	56.9
Calanoid spp.	7	20	*Nauplii* spp.	47	52.11
Copepods spp.	5	12.42	*Keratella* spp.	23	31.95
Keratella spp.	8	16.54	*Navicula* spp.	24	34.7
Moina spp.	9	28.57	*Nitzschia* spp.	20	33.21
Copepod spp.	12	27.78	*Aulacoseira* spp.	18	27.77
Naupplii spp.	4	8.56	Macrophyte	42	45.56
Fish eggs	8	5.38	Attached algae	38	40.22
Fish scale	10	18.75	Insects	28	36.09
Dertitus	22	31.67	Fish scale	17	22.06
Insects	20	6.45	Fish eggs	8	18.41
Macrophyte	3	8.61	Debris	30	40.23

Table 2: Frequency of occurrence of different food items consumed by *O. niloticus* in Tekeze reservoir and Lake Hashenge.

Proximate	Nile Tilapia collected from Hashenge		Nile Tilapia collected from Tekeze	
Composition	Male	Female	Male	Female
Moisture	77.69 ± 0.39^{b}	77.55 ± 0.22^{b}	79.83 ± 0.34^{a}	79.11 ± 0.14^{a}
Ash	0.81 ± 0.08^{b}	0.97 ± 0.11^{ab}	1.05 ± 0.09^{a}	1.16 ± 0.07^{a}
Crude fat	2.45 ± 0.18^{a}	2.35 ± 0.09^{a}	1.27 ± 0.15^{b}	1.41 ± 0.13^{b}
Crude protein	16.13 ± 0.29^{a}	16.32 ± 0.30^{a}	15.32 ± 0.28^{b}	15.77 ± 0.13^{ab}
Carbohydrate	1.61 ± 0.42^{a}	1.22 ± 0.14^{a}	1.46 ± 0.21^{a}	1.36 ± 0.17^{a}

Data is expressed as mean ± SD of three separated determinations.
$^{a-b}$Value in the same columns with different superscript letters within a same strain are significantly different (p<0.05)

Table 3: Proximate composition of fish species (% wet weight).

Mineral contents	Nile tilapia from Hashenge		Nile tilapia from Tekeze Resrevoir	
	Female	Male	Female	Male
Ca	628.65 ± 5.78^{b}	629.05 ± 2.36^{b}	673.38 ± 0.86^{a}	673.29 ± 1.91^{a}
Mg	756.39 ± 2.80^{b}	753.17 ± 3.77^{b}	877.16 ± 2.59^{a}	875.25 ± 2.03^{a}
Na	1536.57 ± 2.90^{b}	1532.04 ± 2.99^{b}	2071.82 ± 4.69^{a}	2064.15 ± 3.15^{a}
K	14043.65 ± 4.39^{b}	14021.34 ± 8.00^{c}	18616.37 ± 5.47^{a}	18610.06 ± 6.89^{a}
P	396.89 ± 1.30^{b}	393.62 ± 7.62^{b}	486.38 ± 9.54^{a}	487.91 ± 6.86^{a}
Zn	21.25 ± 2.31^{c}	22.17 ± 0.35^{c}	34.07 ± 1.06^{a}	27.29 ± 1.02^{b}
Cu	2.87 ± 0.15^{a}	2.98 ± 0.09^{a}	1.19 ± 0.15^{b}	1.18 ± 0.07^{b}
Fe	45.78 ± 2.10^{ab}	49.09 ± 0.33^{a}	32.63 ± 2.98^{c}	41.06 ± 0.09^{b}
Mn	0.65 ± 0.03^{a}	0.62 ± 0.03^{a}	0.42 ± 0.05^{b}	0.46 ± 0.04^{b}

Data is expressed as mean ± SD of three separated determinations
$^{a-c}$Value in the same columns with different superscript letters within a same strain are significantly different (p<0.05)

Table 4: Mineral contents of fish species given as mg/kg dry weight.

FAO [33] moisture and lipid contents in fish fillets are inversely related. The percentage range of the moisture content of fish muscle was within the acceptable level (60%-80%) in all the samples which could be due to the stable water levels in the environmental location where the fish were collected [34]. In this study, the moisture content of male fish was higher than the female fish, and this may be due to the higher level of organic materials in females [35]. In connection with this work different researchers have reported that moisture content of male fish was higher than the female fish [36,37].

The content of crude protein of the fish species collected from the two water bodies ranged between 15.32 and 16.32%, which was in the range of permissible limit (15-28%) for fish and fisheries products, and the protein content of female *O. niloticus* from Hashenge was higher (16.32 ± 0.30%) and male *O.niloticus* from Tekeze reservoir showed significantly lower (p<0.05) protein content (15.32 ± 0.28%) [38]. Alemu et al. [23] reported that the protein content of male and female *O. niloticus* collected from Zeway was 14.5 and 14.6% respectively which was lower than the result of present study. Higher crude fat and protein content in *O. niloticus* collected from Lake Hashenge may associate with the presence of abundance zooplankton food items of the fish in the lake then in the reservoir. El-Serafy et al. [20] reported that feeding conditions has association with proximate composition content. Among the male and female *O. niloticus* collected from Tekeze reservoir, there was significantly higher protein (P<0.05) in male as shown in (Table 1). In connection with this De Silva et al. [39] reported that the protein content of *O. niloticus* collected from Kattakaduwa reservoir was significantly higher (P<0.05) in male than female. In contrast this was not true for the fish collected from Lake Hashenge. The values of crude protein were higher from the fish species collected from Lake Hashenge. This may be due to the diet composition of the fish as shown from the stomach of the fish collected from Lake Hashenge was mostly it was zooplankton, in case of Tekeze reservoir it as phytoplankton. This result was in line with Zenebe [40].

The crude fat content values showed significant difference (p<0.05) within the species with *male O. niloticus* from Hashenge had the highest value (2.45%) and male *O.niloticus* from Tekeze had the lowest (1.27%). More similar reports are available from the studies of various researchers.

The crude fat content of *O. niloticus* was reported in the range of 0.7 to 8.5% Visentainer et al. [41] and the value of this investigation was within this range. The crude fat content of *O. niloticus* collected from Lake Hashenge was significantly higher (P<0.05) than the value found from Tekeze reservoir within the species. This may be due to the water temperature difference between the two water bodies and the type of diet of the fish. In this connection, Favalora et al. [42] and Flos et al. [43] reported that, the quality of fish is affected by param such as feed type, level of dietary intake and growth. A number of factors influence the concentration of lipids in tilapia such as water temperature, stage of life, environmental salinity, food type and species Fabiola & Martha [44] and diet of the fish [40].

Based on the fat content *O. niloticus* from both water bodies was distinguished as lean fish as fat contents of these fishes were lower than 5% by weight [45]. The low concentrations of fat in the muscles of the fresh water species could be due to poor storage mechanism and the use of fat reserves during spawning activities [46].

The ash content ranged between 0.81% and 1.16% in the sampled fishes. This indicates that, the species is a good source of minerals such as Calcium, Potassium, Zinc, Iron and Magnesium since ash is a measure of the mineral content of food item and the inorganic residue that remains after the organic matter has been burnt off. The highest ash content was recorded from *O. niloticus* collected from Tekeze reservoir (1.16% in male) and lowest value from female *O. niloticus* from Lake Hashenge (0.81%). Similar values of ash have also been reported by Alemu et al. [23] for *O. niloticus* Lake Ziway. Results of Job et al. [1] are in disagreement with the present results in the ash content of *O. niloticus* which was lower (0.57%).

The carbohydrate content ranged between 1.22% for female *O.niloticus* and 1.61% for male *O. niloticus* from Tekeze Reservoir. The results observed for carbohydrate showed no significant difference ($p > 0.05$) within fish species collected from the two water bodies (Table 3).

The biochemical composition of tilapia varies considerably depending on growing conditions (temperature, dissolved oxygen, pH, salinity, turbidity, altitude, light or luminosity, among others factors) and in terms of certain characteristics of the species (age, environment and season) [44].

Minerals analysis

Concentrations of mineral contents of *O. niloticus* collected from the two water bodies are presented in Table 4. A total of 9 macro and micro elements (Ca, Mg, Na, K, P, Zn, Cu, Fe and Mn) were considered for the investigation and the contents observed within the fish species were statistically different ($P<0.05$).

The pattern of elemental concentration in the muscle of each of the fish species was in the order of K>Na>Ca>Mg>P>Fe>Zn>Cu>Mn. The concentration of K was highest from the elements analyzed from fish species and Mn was found in lowest concentration.

The Mn concentration levels in the three fish species did not exceed the WHO limit of 2.50 mg/kg for fish and fish products in present study (0.12-0.65 mg/kg) [46].

The lowest content of Cu (1.18 ± 0.07 mg/kg) was investigated from male *O. niloticus* from Tekeze reservoir and highest (2.98 ± 0.09 mg/kg) in male *O. niloticus* from Lake Hashenge. In the present study the concentrations of Cu in the muscle of *O. niloticus* was in the range of the concentration found from the muscle of *O. niloticus* collected from Lake Awassa and Ziway (1.68-4.95 mg/kg of dry weight) [47]. The Cu concentration levels recorded in muscles of the sampled fish species (1.18-2z.98 mg/kg) were below the WHO recommended limit of 3.0 mg/kg in fish and fish products) [48].

The level of Iron (Fe) was highest in male *O. niloticus* from Lake Hashenge (49.09 ± 0.33 mg/kg) and lowest in female *O. niloticus* from Tekeze (32.63 ± 2.98 mg/kg). The range was from 32.63 to 49.09 mg/kg of dry weight which, was in the range of the permissible limit (10-56 mg/kg) for fish and fisheries product [49].

The results obtained from this study showed that the Zinc content of the fish species was between 21.25 ± 2.31 and 34.07 ± 1.06 mg/kg which was in the range of tolerable value (10-75 mg/kg) of fish [50]. Zn content was significantly different ($P<0.05$) with in the species and sex. Abraha et al. [51] reported that the concentrations of Fe, Zn and Mn in the muscle of *O. niloticus* collected from Lake Hashenge were 64.87, 24.95 and 1.01 mg/kg of dry weight respectively which was higher than the present study.

The results obtained from this study revealed that the phosphorous (P) and magnesium (Mg) contents of fish species were between 393.62 and 487.91 mg/kg; 753.17 and 877.16 mg/kg respectively. The highest average concentration of P was observed in male *O. niloticus* from Lake Hashenge. Stanek and Janicki [52] reported that the concentration of calcium in the muscle of male and female roach was not significantly different. This study is also agreed with the present work.

The levels of potassium (K) and sodium (Na) in all samples ranged from 11184.09 to 18616.37 mg/kg and 1532.04 to 2092.22 mg/kg, respectively. Highest concentration of K was observed in female *O. niloticus* from Tekeze reservoir. The concentration of K in male and female *O. niloticus* from Lake Hashenge showed significant difference ($P<0.05$) which was higher in female fish.

Variations in the concentration of minerals in fish muscles could be due to their concentration in the water bodies, the physiological state of the fish and or the ability of the fish to absorb the elements from the diets and the water bodies [53,54].

This agrees with the report of Farkas et al. [55] that the concentrations of element in fish body could be related primarily to their feeding habits [56-58].

Conclusion

From the present study it can be concluded that, there is variation in abundance of food items of *O. niloticus* collected from the two water bodies. The difference in the abundance of food items *O. niloticus* between the two water bodies may cause in variation in moisture content, crude protein, crude fat, crude ash and carbohydrate content. Water qualities have an effect on the biochemical composition content of the fish. Water temperature of Lake Hashenge was lower than that of Tekeze reservoir. Female fish contained slightly higher protein and fat as compared to male. Generally *O. niloticus* in Tekeze reservoir and Lake Hashenge was found to be omnivorous fish mainly feeding on Zooplankton, phytoplankton, detritus, insects and macrophytes. This study shows that the superiority of *O.niloticus* from Hashenge in crude protein and crude fat content than *O. niloticus* from Tekeze reservoir. *O. niloticus* in Tekeze reservoir and Lake Hashenge, is all rich sources of protein, moisture, lipid, ash and minerals.

The study also providing update information in fish fillets composition and mineral contents to food composition database and consumers can have sufficient knowledge in the biochemical contents of *O. niloticus* fish species.

Acknowledgments

The authors of this paper are thankful to Tigray Agricultural Research Institute (TARI) for full support of the research and Ambo University for free tuition fee. We gratefully acknowledge Abergelle Agricultural Research Center for logistic support.

References

1. Job BE, Antai EE, Inyang-Etoh AP, Otogo GA, Ezekiel HS (2015) Proximate Composition and Mineral Contents of Cultured and Wild Tilapia (Oreochromis niloticus) (Pisces: Cichlidae) (Linnaeus, 1758). Pak J Nutr 14: 195-200.
2. Shipton T, Tweddle D, Watts M (2008) Introduction of the Nile Tilapia (Oreochromis niloticus) into the Eastern Cape. Enviro-Fish Africa (Pty) Ltd, Ocean Terrace Park, East London. Pp: 22.
3. Njir M, Okeyo-Owuor JB, Muchiri M, Cowx IG (2004) Shifts in the food of Nile tilapia, Oreochromis niloticus (L.) in Lake Victoria, Kenya. Afr J Ecol 42: 163-170.
4. Jauncey K (2000) Nutritional requirements. In: Beveridge, MCM and McAndrew BJ (eds.) Tilapias: Biology and Exploitation, Kluwer Academic Publishers, United Kingdom pp: 327-375.
5. Beveridge MCM, Baird DJ (2000) Diet, feeding and digestive physiology. In: Beveridge, MCM and McAndrew BJ (eds.) Tilapias: Biology and Exploitation, Kluwer Academic Publishers, Great Britain 25: 59-87.
6. Demeke A (1998) Age and growth determination of tilapia, Oreochromis niloticus L. (Pisces: Cichilidae) in some lakes of Ethiopia. Unpubl. Ph.D. Thesis, School of Graduate Studies, Addis Ababa University, Addis Ababa. Pp: 115.

7. Yirgaw T, Demeke A, Seyoum M (2000) The food and feeding habit of Oreochromis niloticus L. (Pisces: Cichlidae) in Lake Chamo, Ethiopia. SINET Ethiop J Sci 23: 1-12.

8. Todurancea C, Fernando CH, Paggi JC (1988) Food and feeding ecology of Oreochromis niloticus (Linnaeaus, 1758) juveniles in Lake Awassa, Ethiopia. Hydrobiologia 79: 267-289.

9. Alemayehu N, Prabu PC (2008) Abundance, food habits and breeding season of exotic Tilapia zillii and native Oreochromis niloticus L. fish species in Lake Ziway Ethiopia. Maejo Int J Sci Tech 2: 345-360.

10. Adeniyi SA, Orikwe CL, Ehiagbonare JE, Joshia SJ (2012) Nutritional Composition of three different fishes (Clarias gariepinus, Malapterurus electricus and Tilapia guineenisis). Pak J Nutr 11:891.

11. Zenebe T, Ahlgren G, Boberg M (1998) Fatty acid content of some freshwater fish of commercial importance from tropical lakes in Ethiopian Rift Valley. J Fish Biol 53: 987-1005.

12. Job BE, Ekanem A (2010) Nutritional status of two periwinkles species from a tropical. J Environ Pollution and Health 8: 41-44.

13. Tobin DK, Mntysaari A, Martin EA, Houlihan SAM, Dobly DF, et al.(2006) Fat or lean? The quantitative genetic basis for selection strategies of muscle and body composition traits in breeding schemes of rainbow trout (Oncorhynchus mykiss). Aquaculture 261: 510-521.

14. Dumas A, France J, Bureau D (2010) Modeling of growth and body composition in fish nutrition: where have we been and where are we going? Aquac Res 41: 161-181.

15. Breck JE (2014) Body composition in fishes: body size matters. Aquaculture 433: 40-49.

16. Azam K, Ali MY, Asaduzzaman M, Basher MZ, Hossain MM (2004) Biochemical Assessment of Selected Fresh Fish. J Biol Sci 4: 9-10.

17. Huss HH (1995) Quality and Quality Changes in Fresh Fish. FAO. Rome pp: 348.

18. Biró J, Hancz C, Szabó A, Molnár T (2010) Effect of sex on the fillet quality of Nile tilapia fed varying lipid sources. Ital J Anim Sci 8: 225-227

19. Abdullahi SA (2000) Evaluation of the nutrition composition of some fresh water fish families in Northern Nigeria. J Agric Environ 1: 141-151.

20. Visentaine SS, Ibrahim SH, Mahmoud SA (2005) Biochemical and histopathological studies on the muscles of the Nile tilapia (Oreochromis niloticus) in Egypt. Egypt J Aquac & Fisheries Biol 9: 81-96

21. Paul U, Vivian A (2011) The Biochemical Composition of Three Exotic Fish Delicacies: Scomber scombrus, (Linnaeus, 1758), Trachurus trachurus (Linnaeus, 1758) and Sardina pilchard (Walbaum, 1792) Frozen and Imported into Nigeria. Pak J Nutr 10: 1158-1162.

22. Udo PJ (2012) The Proximate composition and mineral contents of two commercially important West African cichlids: Heterotis niloticus and Oreochromis niloticus (Pisces: Cichlidae). Pak J Nutr 11: 1087-1091.

23. Alemu L, Melese AY, Gulelat DH (2013) Effect of endogenous factors on proximate composition of Nile Tilapia (Oreochromis niloticus L.) fillet from Lake Zeway. Amer J Res Com 1: 405-410.

24. Ayeloja AA, George FOA, Dauda TO, Jimoh WA, Popoola MA (2013) Nutritional Comparison of Captured Clarias gariepinus and Oreochromis niloticus. Int Res J Nat Sci 1: 9-13

25. Hyslop EJ (1980) Stomach contents analysis: A review of methods and their application. J Fish Biol 17: 411-429.

26. Bowen SH (1983) Quantitative description of the diet. In: Nielsen LA , Johnson DL (eds.) Fisheries Techniques. Bethesda, Maryland pp: 325-336.

27. Boyd CE (1979) Water quality in warm water fish ponds. Craft master printer's Inc. Auburn, Alabama, USA. Pp: 359.

28. Stickney R (2009) Aquaculture: an introductory text, 2nd ed. Cambridge university press, Cambridge. Pp :304

29. Kamal M, Kurt A, Michael LB (2010) Tilapia Profile and Economic Importance. South Dakota Cooperative Extension Service USDA Doc.

30. Edirisinghe DMA, Cumaranatunga PRT, Ra Reservoir Pola K, Kirindearachchige PT (2013) Analysis of proximate composition and consumer preference of three reef fish Species. Sri Lanka J Aquat Sci 18: 27-36

31. Egbal OA, Mohammed EA, Regiah AK, Hana MT, Asgad AM (2010) Investigating the quality changes of raw and hot smoked Oreochromis niloticus and Clarias lazera. 9: 481.

32. Zmijewski T, Kujawa R, Jankowska B, Kwiatkowska A, Mamcarz A (2006) Slaughter yield, proximate and fatty acid composition and sensory properties of rapfen (Aspius aspius L.) with tissue of bream (Abramis brama L.) and pike (Esox lucius L.). J Food Comp Anal 19: 176-181

33. Food and Agricultural Organization (FAO) (1999) State of World Fisheries and Aquaculture. FAO. Rome. Pp:150.

34. Adewumi AA, Adewole HA, Olaleye VF (2014) Proximate and Elemental Composition of the Fillets of Some Fish Species in Osinmo Reservoir, Nigeria. Agri Biol J N Amer 5: 109-117

35. Amer HA, Sedik MF, Khalafalla FA, Awad HA (1991) Results of chemical analysis of prawn muscle as influenced by sex variations. Die Nahrung 35: 133-138.

36. Bhavan PS, Radhakrishanan S, Seenivasan C, Shanthi R, Poongodi R (2010) Proximate Composition and Profiles of Amino Acids and Fatty Acids in the Muscle of Adult Males and Females of Commercially Viable Prawn Species Macrobrachium rosenbergii Collected from Natural Culture Environments. Int J Biol 2: 395-401.

37. Cornelia AB (2012) Investigation of the chemical composition and nutritional value of smoothhound shark (Mustelus mustelus) meat. University of Stellenbosch, South Africa.

38. United State Department of Agriculture (USDA) (2010) Agricultural Research Service, National Nutrition Data base for standard reference. Release, 23 Nutrition Laboratory.

39. De Silva MPKSK, Senaarachchi WARK, Liyanage NPP (2015) Evaluation of sensory and proximate properties of reservoir grown Nile Tilapia (Oreochromis niloticus) and cage cultured genetically improved farmed tilapia (gift). Int J Fish Aqua Studies 2: 10-13.

40. Zenebe T (2010) Diet composition impacts the fatty acid contents of Nile Tilapia, Oreochromis niloticus L, in Ethiopian highland lakes. Verh Internat Verein Limnol 30: 1363-1368.

41. Visentainer JV, Souza NE, Makoto M, Hayashi C, Franco MRB (2005) Influence of diets enriched with flaxseed oil on the alinolenic, eicosapentaenoic and docosahexaenoic fatty acid in Nile Tilapia (Oreochromis niloticus). F Chem 90: 557-560.

42. Favalora E, Lopiano L, Mazzola A (2002) Rearing of sharpsnout seabream (Diplodus puntazzo) in Mediterranean fish farm: monoculture versus polyculture. Aquat Res 33: 137-140.

43. Flos R, Reig L, Oca J, Ginovart M (2002) Influence of marketing and different land-based systems on gilthead sea bream (Sparus aurata) quality. Aquact Int 10: 189-206.

44. Hernández F, Elena M (2012) Nutritional Richness and Importance of the Consumption of Tilapia in the Papaloapan Region (Riqueza nutricional eimportancia del consumo de la mojarra tilapia en la región del Papaloapan). Redvet Rev electrón vet 13: 6-12.

45. Bennion M, Scheule B (2003) Introductory foods (12th ed.) Prentice Hall, New York.

46. Food and Agricultural Organization/World Health Organization (FAO/WHO) (1984) List of maximum level sb recommended for contaminants by the joint FAO/WHO Codex, Alimentarius Commission 3: 1-8.

47. Kebede A, Wondimu T (2004) Distribution of Trace Elements in Muscle and Organs of Tilapia Oreochromis niloticus, From Lakes Awassa and Ziway, Ethiopia. Bull Chem Soc Ethiop 18: 119-130.

48. World Health Organization (WHO) (2008) Guidelines for drinking Water Quality: Recommendations 3rd Ed. World Health Organization, Geneva Pp: 516.

49. Food and Agricultural Organization (FAO) (2010) Nutritional Elements of Food and Fish. FAO, Rome.

50. World Health Organization (WHO) (1985) Guidelines for Drinking Water Quality. Recommendation WHO: Geneva 1: 130.

51. Gebrekidan A, Berhe M, Weldegebriel Y (2012) Bioaccumulation of Heavy Metals in Fishes of Hashenge Lake, Tigray, Northern Highlands of Ethiopia. Amer J Chem 2: 326-334.

52. Stanek M, Janicki B (2011) Impact of Season and Sex on Calcium and Phosphorus Content in the Meat of Roach (Rutilus rutilus L.) from the Brda River (Poland, Bydgoszcz). Folia biologica (Krakow) 59: 189-194.

53. Alli M, Salam A, Igbal F (2001) Effect of environmental variables on body composition parameters of Channa punctata. J Res Sci 12: 200-206.

54. Ako PA, Salihu SO (2004) Studies on some major and trace metals in smoked and oven dried fish. J Appl Sci Environ Mgt 8: 5-9

55. Farkas A, Salánki J, Specziár A (2003) Age and size-specific patterns of heavy metals in the organs of freshwater fish Abramis brama L. populating a low-contaminated site. Water Res 37: 959-964.

56. APHA (American Public Health Association) (1998) Standard methods for the examination of water and waste water. 20th edition, American Public Health Association Inc, New York. Pp: 1193.

57. Association of Official Analytical Chemists (AOAC) (2000) Official Methods of Analysis (17thedn), pp: 153-162.

58. Osibona AO, Kusemiju K, Akande GR (2009) Fatty acid composition and amino acid profile of two Freshwater species, African catfish (Clarias gariepinus) and Tilapia (Tilapia zillii). AJFAND 9: 1-6.