Feeding habits and relative condition factor of Nile tilapia *Oreochromis niloticus* (Linnaeus, 1758) (Pisces: Cichlidae) in Damte Reservoir, Southern Ethiopia

Ermias Shirko[1], Elias Dadebo[2], Teshome Belay[3,*]

[1]Department of Biology, College of Natural and Computational Sciences, Wolaita Sodo University, Wolaita, Ethiopia
[2]Department of Aquatic Sciences, Fisheries and Aquaculture, College of Natural and Computational Sciences, Hawassa University, Hawassa,, Ethiopia
[3]Department of Animal Sciences, College of Agriculture and Natural Resource, Dilla University, Dilla, Ethiopia

ABSTRACT

The aim of the present study was to assess the feeding habits and relative condition factor of the Nile tilapia (*Oreochromis niloticus* (Linnaeus, 1758) in Damte Reservoir. A total of 584 *O. niloticus* samples were collected from two locations of the Reservoir based on their ecological differences. To diversify the sampling size, *O. niloticus* samples were additionally randomly selected from the fishermen's landings during four months of the dry season (February to May) and four months of the wet season (June to September). The collected data were summarized using descriptive statistics and analyzed with Microsoft Excel 2010 and SPSS v27 software. The diet compositions were expressed based on frequency of occurrences and volumetric contributions. From the total fish samples, 371 (63.53%) contained food in their stomachs, while 213 (36.47%) stomachs were empty. Detritus, macrophytes, and phytoplankton were the most frequently occurred food categories with relatively high volumetric contributions in the stomachs of fish. Notable changes were observed in the contributions of detritus, macrophytes, and phytoplankton, where their volumetric contributions increased with fish size. The major food categories remained consistent between seasons, though their volumetric contributions varied. The mean combined relative condition factor (*Kn*) value was 1.14 ± 0.014 for mixed sexes of *O. niloticus*. From the results of the present study, *O. niloticus* is an omnivore feeding on a wide range of food categories in Damte Reservoir. Female *O. niloticus* had higher mean Kn values than males, but the difference was not statistically significant (p > 0.05). Based on this finding, it is recommended to conduct further detailed studies to keep the overall conditioning of *O. niloticus* from the Reservoir.

Keywords: Condition factor; Damte Reservoir; Feeding habits; *Oreochromis niloticus*
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INTRODUCTION

The Nile tilapia (*Oreochromis niloticus*) (Linnaeus, 1758) is one of the most commercially important fish species in tropical and subtropical countries (El-Sayed and Fitzsimmons, 2023). In Ethiopian inland water bodies, *O. niloticus* is considered the most preferable fish species, which accounts for 49% of total capture production (Gashaw Tesfaye and Wolff, 2014). In order to develop different management decisions aligned with its feeding behaviors for this preferred species, researchers have widely studied it from different lotic and lentic systems of the country. Some of the

* Corresponding author: teshimeansc@gmail.com

available literature primarily focused on the feeding habits of *O. niloticus* from Ethiopian inland waters such as Lake Hawassa (Getachew Tefera and Fernando, 1989; Teshome Belay *et al*., 2025), Chamo (Yirgaw Teferi *et al.*, 2000), Shalla (Solomon Wagawa *et al*., 2022), Ziway (Abebe Tesfaye *et al.,* 2020), Koka Reservoir (Filipos Engdaw *et al.,* 2013), Lake Tana (Zenebe Tadesse, 2011; Filipos Engdaw, 2023), Lake Langano (Zenebe Tadesse, 1999; Genanaw Tesfaye *et al.,* 2021; Mathewos Temesgen *et al*., 2022), Gilgel Gibe Reservoir (Mulugeta Wakejira, 2013), Lake Boyo (Tamrat Handago *et al*., 2024), and the Rib reservoir (Agumassie Tesfahun and Sale Alebachew, 2023). The findings of all the above-mentioned researchers from various water bodies indicated that *O. niloticus* is categorized as a generalist species, which ingests both plant-based and animal-based food items. Apart from the food and feeding habit, studies have widely conducted on the condition factor of the species from various inland water bodies (Agumassie Tesfahun, 2018). In Damte Reservoir, *O. niloticus* is one of the preferred species for consumption, and capture practice is widely undertaken. However, biological aspects such as feeding habits and condition factors of the species are not formally conducted, and there is a gap of information for management decisions.

In Damte Reservoir and its surroundings, several anthropogenic activities, such as agricultural practices, are common. Therefore, to manage the *O. niloticus* resource properly, a study on feeding biology and condition factor is needed. Hence, this area-specific study was conducted to understand the biology of the fish stock for future management and sustainable utilization. The objectives of the present study were to assess the feeding biology, such as diet composition, ontogenetic dietary shifts, seasonal variations of feeding behavior, and the relative condition factor of *O. niloticus* in Damte Reservoir, Ethiopia. Consideration of the biological features of the species will help inform management decisions and provide baseline information for future investigation.

MATERIALS AND METHODS

Description of the study area

The Damte Reservoir is located in the Damot Gale District, Wolaita Zone, and Southern Ethiopia. Geographically, Damte Reservoir is located at 7°1′0″ N to 7°7′0″ N latitude and 37°53′30″ E to 37°57′30″ E longitude, with an elevation of 2,050 meters above sea level (Figure 1). It is also located 346 km to the south of the capital city of Ethiopia, Addis Ababa. The water for the reservoir drains from the surroundings of Shone town and nearby districts. According to Damot Gale District Agricultural Office information, Damte Reservoir was initially constructed in 1997 E.C/2005 G.C., and finished in 2001 E.C/2009 G.C., for the purpose of irrigation and fishing activities. Currently, the reservoir also serves an additional socio-economic purpose to local communities. Since 2002 E.C/2010 G.C., two commercially important fish species, namely the *O. niloticus* and the African catfish (*Clarias gariepinus* (Bruchell, 1822), were stocked by Damot Gale District Agricultural Office. The dry season extends from December to May and the wet season includes June to November (Figure 2). In the mid of May, the rainfall gradually increased and reached its peak in August (203.1 millimeter (mm). The next peak rainy months were July and September. In November, the pattern of the rainfall slightly decreased and showed the upcoming of the dry season. The highest temperature was observed in February (28 °C) and, the lowest in August (12.3 °C) (Figure 2).

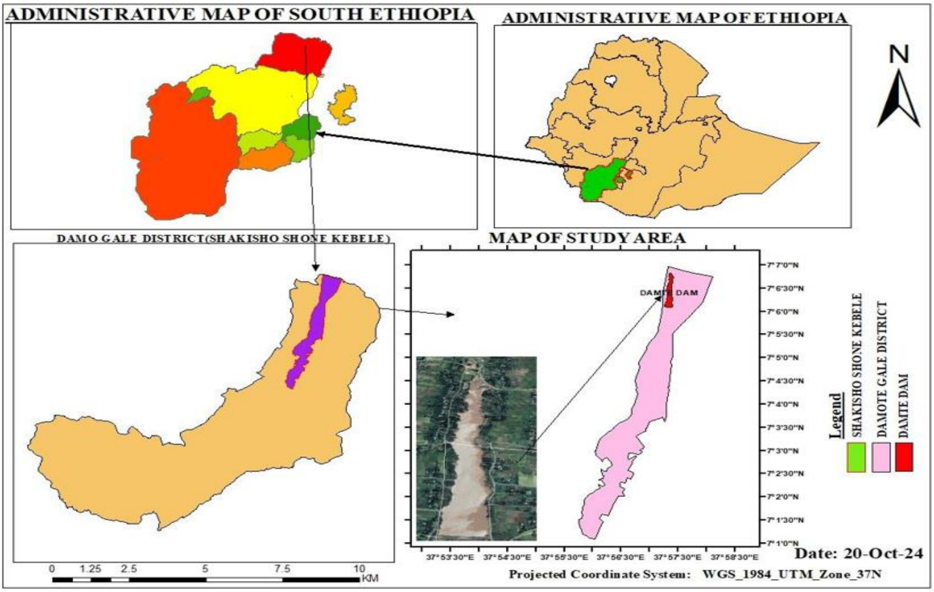

Figure 1. Geographic location of Damte Reservoir (Source: Authors' sketch using ArcGIS software).

Sampling

Initially, two sampling sites were targeted and selected based on their ecological differences. For the first site, the upper site is near Lalo Garbe Village, and the lower is near the reservoir wall (Figure 1). To diversify and avoid personnel sampling bias, additional samples were randomly taken from the commercial fishers' landings, which was captured using gillnets. The sampling was conducted for eight months, including four months of the dry season (February to May) and four months of the wet season (June to September) based on meteorological data. The collected samples were transported to Hawassa University Fishery Laboratory with the aid of iceboxes. Morphometric measurements such as total length (TL) and total weight (TW) were taken to the nearest 0.1 cm and 0.1 g, respectively. After morphometric measurement, dissection with the aid of a surgical blade was conducted at the fishery laboratories of Hawassa University. Immediately after dissection, their stomachs were extracted and preserved in 5% formalin solution. Food items were identified using a compound microscope (Leica DME, magnification 100X) and a dissecting microscope (Leica MS5, magnification 40X).

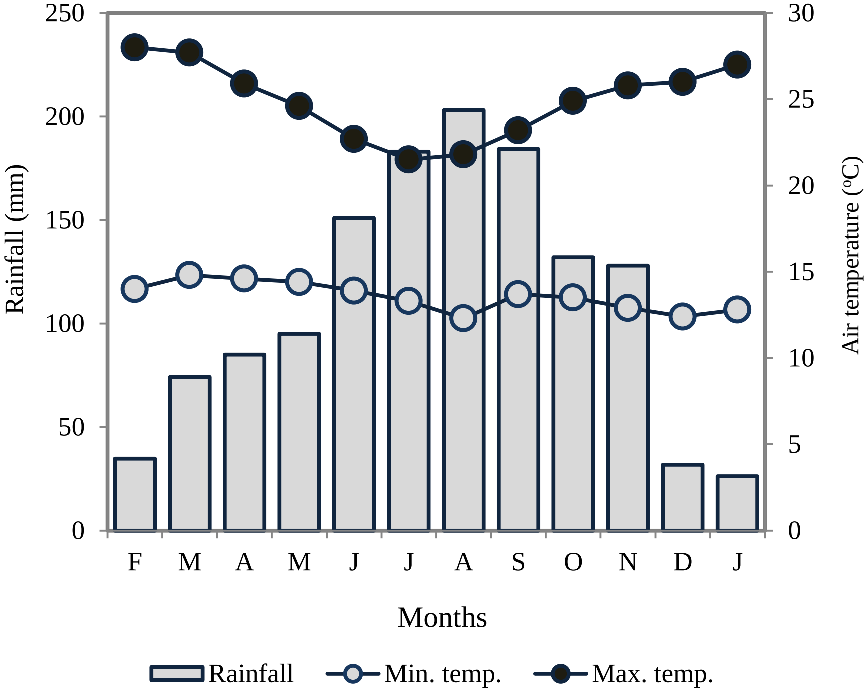

Figure 2. Average rainfall and temperature patterns of Damte Reservoir surrounding during 2023 (Source: Ethiopian Metrology Institute, Hawassa Branch).

Feeding habit

Diet composition analysis

The stomach contents were emptied into a Petri dish to identify the food items. The relative importance of each food item was determined using frequency of occurrence (Hyslop, 1980) and volumetric analysis method (Bowen, 1996).

Frequency of occurrence

In the frequency of occurrence, the number of stomach samples containing one or more of a given food item was expressed as a percentage of all non-empty stomachs examined (Hyslop, 1980).

Volumetric analysis

The volume of food items was measured by the displacement method in a partially filled graduated cylinder. Different sizes of graduated cylinders were taken for volume measurement based on the size of the stomach samples. The graduated cylinders were filled with tap water, and the volume of water was recorded. Larger food items were separated into their taxa with the assistance of a dissecting microscope (LEICA MS) by adding to the known graduated cylinder, where the displaced water volume was considered the volume of a specific food item (Elias Dadebo *et al.*, 2014). However, some food items, like phytoplankton, require a unique treatment. After measuring the total volume of stomach samples, the samples were continuously shaken to homogenize and transferred to Petri dish. Three drops of sub-sample were set on a slide. The percent contribution for each food item was identified using a compound microscope (LEICA DME) with a magnification power of 100X. For similarly identified taxa, their averages were considered. Finally, the volumetric contributions of each food item per total volume of the non-empty stomach sample were expressed as percentages (Bowen, 1996).

Ontogenetic dietary shifts

The ontogenetic dietary shifts of *O. niloticus* were studied based on the volumetric contribution of each food item within each length group. For this purpose, fish were classified into five size classes depending on their total length: 10-14.9 cm, 15-19.9 cm, 20-24.9 cm, 25-29.9 cm and 30-34.9 cm. The relative importance of each food item in each size class was estimated by taking the mean percentage volume of each category of food item to the total volume in that size class.

Relative Condition Factor (Kn)

The well-being of *O. niloticus* was determined using the Relative Condition Factor (Kn) from the data of morphometric measurements (Jones *et al.*, 1999). The male and female sexes of *O. niloticus* were identified based on the standard guideline of Holden and Rait (1974). After identifying the sex of specimens, their Kn value was calculated. Mathematically, it was calculated as:

$$Kn = \frac{W}{aL^b} \times 100$$

Where W is total body weight (g), L is total length (cm), and a and b are constants derived from the length-weight relationship of the raw data ($W = aL^b$).

Statistical analysis and interpretation

Data were organized in Microsoft Excel and analyzed using SPSS version 27. The data were presented using text and different descriptive statistics such as tables and graphs. To compare relative condition factor, ANOVA was used at $p < 0.05$ significance level.

RESULTS AND DISCUSSION

Diet composition

A total of 584 *O. niloticus* samples ranging from 10 cm to 34.9 cm in total length were collected for the present study. Of these, 213 stomachs (36.47%) were empty. The remaining 371 (63.52%) stomach samples were non-empty consisted of five different major food categories, including macrophytes, phytoplankton, detritus, insects, and zooplankton at different proportions (Table 1). Five different taxa of phytoplankton were identified, including diatoms, green algae, blue-green algae, euglenoids, and dinoflagellates. The results of the present study were in line with the findings from various East African inland water bodies of the same population, which have been reported as a generalist feeder. Some of the available literature includes the findings of Yirgaw Teferi *et al*. (2000) from Lake Chamo, Filipos Engdaw *et al.* (2013) from Koka Reservoir, Mathewos Temesgen *et al*. (2022) from Lake Langano, Njiru *et al.* (2004) from Lake Victoria, Agumassie Tesfahun and Sale Alebachew (2023) from Rib Reservoir, Filipos Engdaw (2023) from Lake Tana, Tamirat Handago *et al.* (2024) from Lake Boyo, and Teshome Belay *et al.* (2025) from Lake Hawassa.

Based on the frequency of occurrence method, detritus, macrophytes, and phytoplankton were the three most frequently ingested food categories occurring in 94.61%, 88.41%, and 85.18%, respectively. Among phytoplankton, diatoms (34.47%), blue-green algae (32.35%), and green algae (32.1%) were the dominant taxa. The occurrences of insects and zooplanktons were low. The present findings are in agreement with the findings of Tamirat Handago *et al.* (2024) from Lake Boyo and Agumassie Tesfahun and Sale Alebachew (2023) from the Rib Reservoir, who reported that detritus was the most preferred food category, compared to other identified major food items.

However, different from the present finding, insects were the dominant food item of *O. niloticus* in Lake Victoria (Njiru *et al*., 2004). On other inland water bodies, phytoplankton was dominant food item, such as Lake Chamo (Yirgaw Teferi *et al.*, 2000), Lake Hawassa (Teshome Belay *et al.*, 2025), and Lake Langano (Mathewos Temesgen *et al*., 2022). The occurrences of other food categories such as zooplankton and insects were relatively low during the present study (Table 1). The present low occurrence of zooplankton in the diet of *O. niloticus* was different from other findings such as from Lake Ziway (Alemayehu Negasa and Prabhu, 2008), Lake Hayq (Workiye Worie and Abebe Getahun, 2015), and Lake Langano (Mathewos Temesgen *et al*., 2022).

Based on volumetric contribution analysis, detritus, phytoplankton, and macrophytes were the three most important food categories, accounting for 34.53%, 31.36%, and 29.59%, respectively. The contributions of the remaining food items were low (Table 1).

Table 1. Diet compositions of *O. niloticus* from Damte Reservoir (n= 371).

	Frequency of occurrence		Volumetric analysis	
Food categories	**Frequency**	**Percent**	**Volume (ml)**	**Percent**
Detritus	351	94.61	165.92	34.53
Macrophytes	328	88.41	142.17	29.59
Phytoplankton	316	85.18	149.73	31.17
Diatoms	139	37.47	35.80	7.45
Green algae	119	32.1	35.73	7.44
Blue green algae	120	32.35	33.67	7.01
Euglenoids	83	22.37	25.51	5.31
Dinoflagelletes	59	15.90	19.04	3.96
Zooplankton	43	11.59	8.49	1.77
Cladocerans	12	3.23	2.41	0.50
Copepods	18	4.85	2.97	0.62
Rotifers	20	5.39	3.11	0.65
Insects	68	18.33	11.98	2.49
Chironomidae larvae	30	8.09	4.36	0.91
Ephemeroptera	13	3.50	2.20	0.46
Tricoptera	19	5.12	3.66	0.76
Anisoptera	15	4.07	1.77	0.37

Similar detritus dominance was identified from Rib Reservoir (Agumassie Tesfahun and Sale Alebachew, 2023). Different results were reported from other inland water bodies of Ethiopia. Some of the identified reports include phytoplankton as the dominant food category (Abebe Tesfaye *et al*., 2020; Flipos Engdaw, 2023; Teshome Belay *et al.*, 2025). The variations in the contributions of different food items across different inland water bodies could be due to the size of fish considered, the availability of food items, the physicochemical characteristics of water bodies, and the morphometric characteristics of water bodies (Agumassie Tesfahun and Mathewos Temesgen, 2018; Zenebe Tadesse, 2011).

Ontogenetic dietary shifts

A notable ontogenetic dietary shift was observed. The contributions of detritus, macrophytes, and phytoplankton increased with fish size (Figure 3). The contributions of zooplankton and insects decreased as the fish size increased (Figure 3). Similar observations were reported from different inland water bodies of Ethiopia (Flipos Engdaw *et al.*, 2013; Workiye Worie and Abebe Getahun, 2015; Mathewos Temesgen *et al.*, 2022; Flipos Engdaw, 2023; Teshome Belay *et al*., 2025). This might be related to the physiological requirements because juvenile fish need high protein intake to support high growth rates and metabolism (Benavides *et al.*, 1994). In line with the present study, inability of small sized fish to accommodate large volumes of macrophytes, and detritus can be another reason for juveniles to feed on larval insects and zooplankton (Zenebe Tadesse, 2011; Flipos Engdaw *et al.*, 2013). In contrast to the present finding, Agumassie Tesfahun and Sale Alebachew (2023) reported that zooplankton were abundant food items in the size class between 30- 34 cm total length. This difference might be due to the abundance and distributions of food items and physico-chemical characteristics of the considered water bodies (Agumassie Tesfahun and Mathewos Temesgen, 2018).

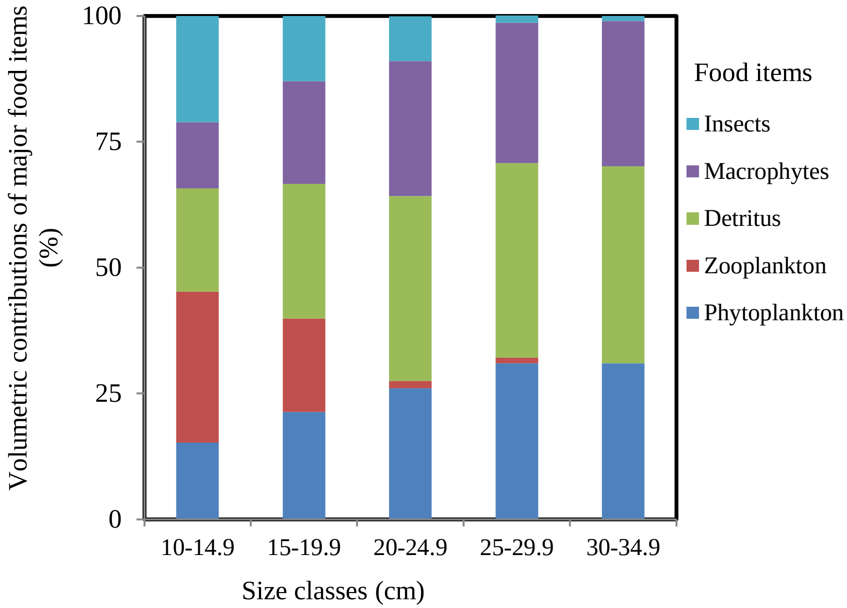

Figure 3. Ontogenetic dietary shift of *O. niloticus* from Damte Reservoir

Seasonal variation in diet compositions

The types of food categories ingested did not vary notably between seasons, though their proportional contributions showed some variation (Table 2). Except for the phytoplankton and detritus, which were higher in dry months, the volumetric contribution of macrophytes, zooplankton, and insects was higher in the wet months than in dry months (Table 2). Furthermore, except for zooplankton, which was higher in wet months than in dry months, the frequency of occurrence of detritus, macrophytes, insects, and phytoplankton was higher in dry months than in wet months (Table 2). Similar differences in diet composition were reported from different inland water bodies on the same species. Some of the available information, including from Lake Ziway (Alemayehu Negasa and Prabhu, 2008), Koka Reservoir (Filipos Engdaw *et al.*, 2013), Lake Hayq (Workiye Worie and Abebe Getahun, 2015), and the Omo River (Mulugeta Wakjira, 2016), indicates there was a dietary variation between dry and rainy months. The slight difference in the role of individual food items between sampling months may be aligned with the distributions, availability, water physicochemical characteristics, and the quality of the food items that they ingest (Zenebe Tadesse, 2011).

Table 2. Diet compositions of *O. niloticus* in rainy (n = 172) and dry (n = 199) month from Damte Reservoir

Food categories	**Frequency of occurrence**		**Volumetric contribution**	
	Dry season	**Rainy season**	**Dry season**	**Rainy season**
Detritus	97.49	91.28	34.98	34.07
Macrophytes	94.97	80.81	28.44	30.82
Phytoplankton	90.95	78.49	33.10	29.53
Diatoms	49.75	24.42	9.56	5.20
Green algae	38.19	25.00	7.36	7.52
Blue green algae	35.18	29.07	7.56	6.41
Euglenoids	19.6	25.58	4.26	6.43
Dinoflagelletes	16.58	15.12	4.11	3.81
Zooplankton	10.05	13.37	1.16	2.69
Cladocerans	3.02	3.49	0.35	0.66
Copepods	5.03	4.65	0.58	0.65
Rotifers	3.52	7.56	0.29	1.02
Insects	18.59	18.60	2.33	2.90
Chironomidae larvae	9.55	6.40	1.06	0.74
Ephemeroptera	1.01	6.40	0.12	0.81
Tricoptera	5.03	5.23	0.71	0.82
Anisoptera	4.02	4.07	0.31	0.43

Relative condition factor (*Kn*)

The combined Kn > 1 (a mean value of 1.14 ± 0.014), which means *O. niloticus* from Damte Reservoir is indicated to be in good condition. However, based on sex-based comparisons, the Kn of males *O. niloticus* ranged from 0.40 to 2.19 with a mean of 0.933 ± 0.013 and from 0.75 to 2.77 with a mean value of 1.39 ± 0.016 for females' populations. Males are in poor condition on average (Kn < 1). This individual difference might be the variations of individual size differences, gonad size, and spawning season differences (Masud and Singh, 2022). The total mean comparisons of Kn indicated a significant variation ($p < 0.05$) between male and female *O. niloticus*. However, the trend of Kn-value sex by month interaction followed a similar pattern (Figure 4) and didn't show a significant difference when considering their sex by month interaction of Kn-value ($p > 0.05$). The mean Kn of the present study was low compared to Lake Naivasha (Kn = 2.46) (Otieno *et al*., 2014). The Kn of *O. niloticus* from Damte Reservoir was comparable to other studies (Waithaka *et al*., 2020; Mohamed and Salman, 2021; Teshome Belay *et al*., 2025). The individual variations of Kn might be related to the size of fish considered; the physicochemical characteristics of the water body; the impact of breeding patterns; the food items they ingest (Keyombe *et al*., 2017); and feeding intensity (Ighwela *et al*., 2011).

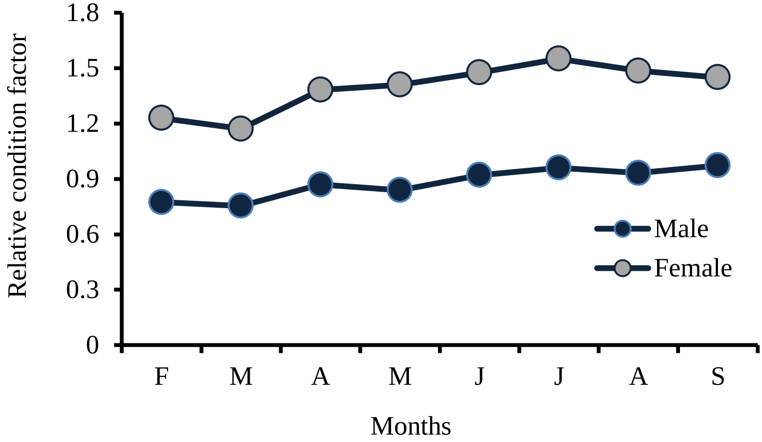

Figure 4. Relative condition factor (Kn) at different months of the year of *O. niloticus* from Damte Reservoir

CONCLUSIONS AND RECOMMENDATIONS

During the present study, detritus, macrophytes, phytoplankton, zooplankton, and insects were identified from the stomach contents of *O. niloticus*. Smaller sized *O. niloticus* primarily fed on insects and zooplankton, while adults' primary sources were detritus, phytoplankton, and macrophytes. *O. niloticus* was categorized as omnivore juveniles and shift to herbivorous feeding habit as adults in Damte Reservoir. The mean Kn value (1.14) was lower compared to other water bodies, such as Lake Hawassa and Lake Chamo. This suggests the need for conservation measures and further research to identify factors affecting fish condition in Damte Reservoir. Since the sampling months for the present study were only eight months, year round seasonal study is recommended.

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Conflict of interest

The authors declare that they have no competing interests.

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