LIMNOLOGICAL CHARACTERISTICS AND FISHERY RESOURCES OF BABATI AND BURUNGE LAKES IN TANZANIA

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Received *August 29, 2023;* ***Revised*** *October 02, 2023;* ***Accepted*** *October 03, 2023*

ABSTRACT

A study was conducted in Babati and Burunge lakes in Tanzania to assess the limnological characteristics and fishery resources from August 2022 to March 2023. Sampling was conducted from ten different stations in each lake using standard method ISO 5667-4:1987. 200 fishes representing ten different species were sampled at fishermen landing sites and measured. The results showed no significant difference (p>0.05) in limnological characteristics within seasons and between lakes. Limnological characteristics were within WHO agreed values except biological oxygen demand (10.7 ± 6.43 mg/l), Chloride (31.33 ± 0.88 mg/l), pH (9.8 ± 0.06) and turbidity (51.3 ± 0.88 cm) which were all higher than the accepted values. Chlorophyll-a contents were lower than recommended standard for both lakes in both seasons. Ten fish species were found, six found exclusively in Lake Babati and four in Lake Burunge. Oreochromis niloticus, Oreochromis urolepis and Oreochromis variabilis were restricted to dry season in Lake Babati, while the rest were found in dry and wet seasons in both lakes. Majority of fish species sampled had larger size in the dry than in the wet season. Most fish species sizes were within the reported size ranges for that particular fish species. Clarias gariepinus recorded maximum size (872.3 ± 15.38 g and 54.2 ± 1.96 cm) in Lake Babati, while Tilapia melanopleura recorded maximum size (443.3 ± 6.17 g and 25.7 ± 0.33 cm) in Lake Burunge. The study concluded that both lakes water met the requirements for fish production and requires effective management against pollution.

Keywords: Lakes, Limnological characteristics, Fish species diversity, Chlorophyll-a

INTRODUCTION

Most Tanzanian Lakes are highly productive (Wikipedia, 2022), biologically rich, support biodiversity and provide ecological services (Yanda and Madulu, 2005), and contribute to the national economies (Odongkara *et al*., 2009). Fishery resources growth and survival require favorable environment (Moyo and Rapatsa, 2021), accomplished by effectively maintaining essential water quality parameters within acceptable limits to enhance their proliferation.

Dissolved oxygen (DO_2) is essential for fish metabolism and respiration (Verberk *et al.,* 2021; Abd El-Hack *et al*., 2022). Fish living in well-oxygenated water tend to have better growth rates compared to those in oxygen-depleted environments (Rubalcaba *et al*., 2020). Fish growth needs DO_2 concentrations of 5 to 6 ppm (Wang *et al*., 2023). On the other hand, dissolved carbon dioxide (CO_2) influences acidity and hardness. Fish stay away from CO_2 concentrations above 5 to 10 mg/L (Boyd, 2008). Temperature affects fish metabolism and growth, the ideal temperature range for fish growth is between 13 to 21°C (Alfonso *et al*., 2021). Warmer waters accelerate metabolic rates, leading to faster growth in some fish species (Kounna *et al*., 2021). However, extreme temperatures stress fish and impact their growth negatively (Abd El-Hack *et al*., 2022).

Acidity and pH levels influence nutrient availability (Gäb *et al*., 2020), toxicity, and metabolic processes in fish (Rubalcaba *et al*., 2020). Extreme pH levels affect fish health and growth (Gäb *et al*., 2020). According to Mustapha and Atolagbe (2018), pH of water more than pH 9.0 for prolonged time, diminish fish growth and reproduction. Fish have a narrow tolerance range of pH and die at pH of 4 and above 11 (Moyo and Rapatsa, 2021). Turbidity and water clarity, caused by suspended particles affect fish feeding behaviors and visual predator-prey interactions (Bunnell *et al*., 2020; Newport *et al*., 2021). Clearer waters allow fish to locate prey more easily and potentially contribute to better growth (Bunnell *et al*., 2020: Watson *et al*., 2022). Chloride level plays an important role in fish growth by influencing osmoregulation (Zidan *et al*., 2022), metabolic rate (Mustapha and Atolagbe, 2018), nutrient availability (Bunnell *et al*., 2020), feeding patterns (Abd El-Hack *et al*., 2022), stress levels (Avila-Perez *et al*., 2023), disease susceptibility and reproductive success (Moyo and Rapatsa, 2021).

Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) are important water quality parameters that provide insights into the level of organic pollution in aquatic environments (Abd El-Hack *et al*., 2022). BOD and COD don't directly influence fish growth (Rubalcaba *et al*., 2020), their impacts on water quality indirectly affect fish populations and aquatic ecosystems in various ways serving as indicators of organic pollution and water quality. According to Amin *et al*. (2022), elevated BOD and COD levels can lead to oxygen depletion, toxic conditions, nutrient imbalances and changes in the aquatic food web, all of which impact negatively on fish growth.

Nutrient concentrations (nitrogen and phosphorus) influence primary productivity of aquatic ecosystems (Howarth *et al*., 2021). Higher nutrient availability leads to increased food availability, contributing to their growth and size (Mmanda *et al*., 2020; Amin *et al*., 2022). Nitrate concentration, above 100 mg/L is toxic, stressful and harms fish; affecting its ability to transport oxygen and result in reduced growth rates (Isaza *et al*., 2021), lower immune system function, and increased susceptibility to diseases (Amin *et al*., 2022). Phosphorus below 25 µg/L limits primary production in lakes, and alters fish community structure (Cheruvelil *et al*., 2022). Chlorophyll-a (Chl-a), determines water quality, biomass and yield, and in turn Chl-a concentrations determines fish production, growth (Cai *et al*., 2022), and the trophic status of lakes (Vanderley *et al*., 2022).

Tanzania is home to different kinds of freshwater fish species, *Oreochromis niloticus* Linnaeus 1758, *Oreochromis urolepis* Norman, 1922, *Tilapia melanopleura* Duméril, 1861, *Oreochromis esculentus* M. Graham 1928, *Clarias gariepinus* Burchell 1822, *Oreochromis variabilis* Boulenger 1906, *Haplochromini* Poll 1986, *Palaemonetes paludosus* Gibbes 1850, *Oreochromis mossambicus* Peters 1852 and *Rastrineobola argentea* Pellegrin 1904. Fish size varies depending on the environment, diet, genetics makeup and farming practices. Fish growth in terms of length and weight is influenced by water quality parameters in variety of ways (Abd El-Hack *et al*., 2022). The relationship of limnological characteristics and instantaneous fish growth in Babati and Burunge lakes is necessary for fisheries management, conservation efforts and maintaining healthy aquatic ecosystems. Proper management of these parameters is essential for maintaining healthy fish populations in natural ecosystems and aquaculture settings.

The aim of this study was to investigate the limnological characteristics and assess the fishery resources of Babati and Burunge lakes in Tanzania. Specifically, analyzed the physical and chemical properties of the water and assessed the fishery resources, with a focus on evaluating the suitability of the lakes' water quality for fish growth.

MATERIALS AND METHODS

Study Area: The study focused on the physicochemical parameter of water and fish resources of two inland freshwater lakes in Manyara region, Lake Babati (18 km^2), 4° 13'- 4° 22' S and Lake Burunge (64 km^2), 35° 45' - 35° 75' E (Figure 1).

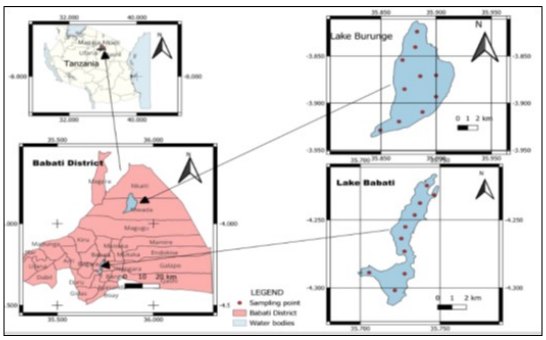

Figure 1: Map of Babati and Burunge Lakes, Tanzania showing the sampled stations (QGIS, 2022)

The lakes located in the East African Rift valley surrounded by picturesque landscapes. Lake Babati is fed by several small rivers and streams, and it serves as an important water source for both human activities and local wildlife. The lake is known for its rich biodiversity, and supports a variety of fish species, including tilapia and catfish. Lake Burunge is a home to several fish species, including tilapia and catfish with its surface area varying depending on the water levels. The lake lies between Lake Manyara National Park and the Tarangire National Park. Both lakes are important for local fishing and commonly targeted for aquaculture in the region.

Water and Fish Sampling: First, the coordinates were recorded using GPS for all sampled points in each Lake. Water samples for nutrients (nitrate and phosphate) analysis were collected from the field between August 2022 to March 2023 using 300 ml Niskin bottles, frozen and preserved in a deep freezer at -20°C. To analyze Chl-a, water samples collected in 1.5-liter plastic bottles cleansed by rinsing with sample water prior to filling. From each lake landing stations, a random selection of 200 fish representing ten different species was made between August 2022 to March 2023. Fish data were supplemented by interviewing the fishermen on type of fishery resources available.

Field Determination of Physicochemical Parameters: Water samples were taken from every sampling location at a depth of 50 cm. Readings of pH, temperature, dissolved oxygen (DO_2), transparency (water clarity), conductivity and salinity were made using hand held Sigma Hanna Checker 1 pH meter, Multi probe meter, Dissolved oxygen analyzer, turbidity meter, Hatch conductivity meter model 44600, and hand held refractometer 300011 respectively.

Laboratory Determination of Physicochemical Parameters and Biomass: The measurement of dissolved carbon dioxide (DCO_2) was conducted through titration, involving the addition of 20 ml of 0.02N NaOH to 100 ml of the sample. The CO_2 is released and absorbed in a solution containing excess NaOH. Titration with standard NaOH leads to the determination of CO_2 present in the sample (Crossno *et al*., 1996). Free CO_2 in water = R x N x 1000 x Eq. Wt. of CO_2 ÷ volume of water sample taken (ml), where R = volume of NaOH titrated and N = Normality of NaOH (0.05).

Phosphates (NO_3^-) and nitrates (PO_4^{3-}) were determined by colorimetric and spectrophotometric assay as described by Wang *et al*. (2017). 1.5 litre samples of water were passed through 0.45 µm Whatman filter papers using vacuum pumps. Phosphates (NO_3^-) and nitrates (PO_4^{3-}) were measured at wavelengths of 885 nm and 630 nm respectively. Subsequently, the filters were immersed in 10 ml of 90% acetone and placed in refrigeration (at 4°C) overnight to facilitate pigment extraction. Chl-a, pigments were extracted in 10 ml of 97% ethanol. Following this, the chlorophyll extract was subjected to centrifugation at 4000 rpm for 10 minutes to remove particles. Next, the clear liquid above the sediment was carefully poured into sanitized test tubes and analyzed for Chl-a concentration using an ultraviolet spectrophotometer model

1601 - Shumadzu Cooperation, Tokyo, Japan. Absorbance r was recorded as described by Parsons *et al.* (1989).

Fish Identification and Measurement: Identification of fish species sampled was carried out by using the method described by Zhang *et al.* (2022). Different types of fish species sampled were counted and measured along with physicochemical parameters. Fish total length (TL) and breadth were measured using a measuring ruler to ± 0.1 cm, and the body weights were measured using a digital weighing scale to ± 0.01 g. The frequency and abundance of fish species were determined according to Innal (2020).

Statistical Analysis: To assess differences in limnological characteristics between Babati and Burunge lakes, t-tests were conducted for each parameter to determine if statistically significant differences exist. To compare fishery resources between the two lakes, analysis of variance (ANOVA) tests were conducted for fish size in terms of weight and length.

RESULTS AND DISCUSSION

The results of the physical and chemical characteristics as well as the biomass measured in two lakes, indicated numerical differences, that were not statistically significantly different ($p>0.05$) in two lakes (Table 1). These numerical differences may be attributed to various natural and anthropogenic factors such as lake morphology, local geology, climate, land use, and human activities in the surrounding areas. Both lakes exhibited a general pattern of temperature decrease from July to March, which is expected due to seasonal variations (Alfonso *et al.*, 2021). Lake Burunge consistently had higher temperatures compared to Lake Babati; this may be influenced by lake size, depth and local climate (Kounna *et al.*, 2021). In Lake Babati, pH levels showed a relatively stable values, whereas that of Lake Burunge remained relatively constant, but at a higher and more alkaline level. The differences in pH levels between the two lakes may have been influenced by geological characteristics, water sources and the presence of alkaline substances (Yanda and Madulu, 2005). Turbidity in Lake Burunge consistently has much lower levels; this observation was associated with differences from varying sediment loads and human activities around the lakes (Newport *et al.,* 2021).

Both lakes demonstrated relatively stable conductivity values with slight variations reflecting the concentration of dissolved ions in the water. The differences between the lakes' conductivity may be influenced by mineral content, water sources, and human impacts (Abd El-Hack *et al*., 2022). Both lakes maintained similar patterns of chloride over the months. Lake Babati had slightly lower chloride compared to Lake Burunge. Chloride levels are influenced by evaporation, inflow of fresh water, and geological characteristics of the lake basin (Alfonso *et al.*, 2021). Both lakes showed slight variations in DO_2 levels, with Lake Burunge consistently having higher DO_2 levels. Higher DO_2 levels in Lake Burunge may have been due to the better mixing and aeration, and lower organic matter decomposition (Verberk *et al.,* 2021).

Both lakes exhibited variations in dissolved DCO_2 levels over the months, with relatively higher values in Lake Babati. According to Ali *et al*. (2022) these differences in DCO_2 may be due to variations in biological activity, sediment decomposition, and gas exchange at the water surface. A decreasing trend in Chl-a levels from July to March. This trend was expected since according to Vanderley *et al*. (2022), Chl-a levels often decrease during the colder months due to reduced sunlight and decreased biological activity.

The results in Table 2 indicated variations in NO_3^-, and PO_4^{3-} concentrations in both lakes; highlight the potential influence of observed nutrient loading arising from vegetable cultivation runoff, and human settlements in particular cow dung. Elevated nutrient concentrations observed especially NO_3^-, and PO_4^3, contributed to eutrophication causing excessive plant growth leading to oxygen depletion at night and potential harm to aquatic life.

Table 1: Monthly variations in the physicochemical properties and biomass of Lakes Babati and Burunge, Tanzania

Water property	Lakes	Months						Mean ± SEM
		Jan	Feb	Mar	Aug	Sep	Nov	
Temperature (^{O}C)	Babati	19.00	19.20	18.40	20.10	20.30	20.80	19.63 ± 0.37
	Burunge	20.20	20.80	20.00	22.20	22.90	21.10	21.10 ± 0.46
pH	Babati	7.30	7.90	8.00	7.50	7.10	7.30	7.52 ± 0.15
	Burunge	9.70	9.90	9.80	9.20	9.20	9.20	9.50 ± 0.14
Turbidity (cm)	Babati	52.00	49.00	44.00	51.00	50.00	53.00	49.83 ± 1.30
	Burunge	2.70	2.20	2.50	3.60	3.90	3.60	3.08 ± 0.29
DO_2 (mg/L)	Babati	37.30	37.90	37.40	37.30	37.70	37.20	37.47 ± 0.11
	Burunge	51.00	57.30	59.30	50.90	50.70	50.80	53.33 ± 1.59
DCO_2 (mg/L)	Babati	65.00	67.00	63.00	71.00	70.00	69.00	67.50 ± 1.26
	Burunge	66.00	67.50	67.00	65.20	65.80	69.30	66.80 ± 0.60
BOD (mg/L)	Babati	23.50	3.40	5.10	3.20	6.10	8.20	8.25 ± 3.14
	Burunge	2.60	4.10	3.30	4.40	5.20	7.10	4.45 ± 0.64
COD (mg/L)	Babati	21.40	17.50	19.50	9.30	6.10	8.00	13.63 ± 2.69
	Burunge	17.60	18.00	17.80	7.50	11.20	10.30	13.73 ± 1.89
Alkalinity (mg/L)	Babati	88.00	87.00	98.00	78.00	73.00	69.00	82.17 ± 4.41
	Burunge	79.00	81.00	91.00	71.00	80.00	77.00	79.83 ± 2.66
Total hardness (mg/L)	Babati	101.00	107.00	97.00	84.00	79.00	76.00	90.67 ± 5.19
	Burunge	104.00	99.00	111.00	77.00	73.00	72.00	89.33 ± 7.06
Chloride (mg/L)	Babati	18.00	19.00	18.00	22.00	22.00	21.00	20.00 ± 0.77
	Burunge	29.00	27.00	28.00	31.00	30.00	33.00	29.67 ± 0.88
NO_3^- (mg/L)	Babati	0.43	0.51	0.39	0.676	0.690	0.57	0.54 ± 0.05
	Burunge	0.52	0.31	0.39	0.89	0.71	0.71	0.59 ± 0.09
PO_4^{3-} (mg/L)	Babati	0.01	0.01	0.01	0.01	0.02	0.01	0.01 ± 0.00
	Burunge	0.07	0.09	0.08	0.04	0.03	0.03	0.06 ± 0.01
***Chl-a* (μg/l)**	Babati	0.14	0.14	0.14	1.24	1.22	1.20	0.68 ± 0.24
	Burunge	0.11	0.11	0.12	1.14	1.13	1.15	0.63 ± 0.23

Table 2: Seasonal variations in the physicochemical properties and biomass in lakes Babati and Burunge, Tanzania

Water property	Lakes	Wet season	Dry season	WHO, 2022
		Mean ± SEM	Mean ± SEM	
Temperature (^{O}C)	Babati	18.9 ± 0.24	20.4 ± 0.21	24 – 30
	Burunge	20.3 ± 0.24	22.1 ± 0.52	
pH	Babati	7.3 ± 0.22	7.3 ± 0.11	7.5 - 8.5
	Burunge	9.8 ± 0.06	9.2 ± 0.00	
Turbidity (cm)	Babati	48.3 ± 2.33	51.3 ± 0.88	20 -30
	Burunge	2.5 ± 0.14	3.7 ± 0.10	
DO_2 (mg/L)	Babati	3.43 ± 0.07	4.467 ± 0.24	4 – 5
	Burunge	4.50 ± 0.00	5.200 ± 0.06	
DCO_2 (mg/L)	Babati	65 ± 1.15	70.000 ± 0.58	< 5
	Burunge	66.8 ± 0.44	66.767 ± 1.28	
BOD (mg/L)	Babati	10.7 ± 6.43	5.8 ± 1.45	< 10
	Burunge	3.3 ± 0.43	5.6 ± 0.80	
COD (mg/L)	Babati	19.5 ± 1.12	7.8 ± 0.93	< 50
	Burunge	17.8 ± 0.11	9.7 ± 1.11	
Alkalinity (mg/L)	Babati	91 ± 3.51	73.3 ± 2.60	50 – 300
	Burunge	83.7 ± 3.71	76 ± 2.64	
Total hardness (mg/L)	Babati	101.67 ± 2.91	79.7 ± 2.33	30 -180
	Burunge	104.67 ± 3.48	74 ± 1.53	
Chloride (mg/L)	Babati	18.33 ± 0.33	21.67 ± 0.33	10 – 25
	Burunge	28.00 ± 0.58	31.33 ± 0.88	
NO_3^- (mg/L)	Babati	0.443 ± 0.03	0.646 ± 0.04	0.1 - 4.5
	Burunge	0.408 ± 0.06	0.772 ± 0.06	

PO_4^{3-} (mg/L)	Babati	0.009 ± 0.00	0.012 ± 0.00	< 20
	Burunge	0.081 ± 0.01	0.033 ± 0.01	
***Chl-a* (µg/L)**	Babati	0.141 ± 0.003	1.216 ± 0.011	< 2
	Burunge	0.112 ± 0.002	1.140 ± 0.005	

The higher nutrient concentrations in Lake Burunge compared to Lake Babati may be due to differences in catchment characteristics, and land use. Seasonal changes in nutrient concentrations are influenced by temperature, precipitation and biological activity (Cheruvelil *et al*., 2022).

Lake Babati consistently had higher Chl-a levels compared to Lake Burunge throughout the study period indicating differences in nutrient loading, ecosystem structure, and or other environmental factors between the two lakes. With regards to nutrient availability and lake productivity, the trophic status of both lakes suggests mesotrophic (moderate nutrients levels) (Amin *et al*., 2022). Different fish species have varying tolerances to nutrient levels and Chl-a concentration and their growth could have been influenced by the availability of food and the health of the aquatic ecosystem. Chl-a levels observed indicated a productive ecosystem with a moderate to high biomass of phytoplankton, which can provide a sufficient food source for many fish species. For tilapia, moderate levels of Chl-a support their growth. Catfish typically consume other fish and aquatic organisms rather than directly feeding on phytoplankton at the transition from being planktivores (larvae) to juveniles. Therefore, the Chl-a concentration may not be as critical for catfish growth as it is for herbivorous species like tilapia. However, maintaining a balanced aquatic ecosystem with suitable prey organisms for catfish is important for their growth.

Data in Table 3 highlighted the variations in weight and length across for both wet and dry seasons for each fish species in Lake Babati and Lake Burunge and their association with growth patterns, responses to environmental factors such physicochemical characteristics, food availability and habitat conditions. Fish species identified in Lake Babati were *O. niloticus, O. urolepis, O. variabilis, C. gariepinus, Haplochromini* sp. and *P. paludosus*.

The data suggested that the fish species' characteristics vary between wet and dry seasons, as indicated by the differences in mean weight and length values. For example, the *O. niloticus* had a higher mean weight and length (510.70 ± 19.70 g, 27.40 ± 0.29 cm) during the dry season compared to the wet season mean weight and length (129.70 ± 3.48 g, 9.83 ± 1.05 cm). The common size range provides an idea of the typical sizes these fish species can attain, both in terms of weight and length. As for Lake Burunge, Fish species in exhibit variations in their characteristics between wet and dry seasons, as seen in the differences in mean weight and length values. The lake harbours *T. melanopleura, O. esculentus* and *O. mossambicus* with generally higher mean weights and lengths during the dry season compared to the wet season. In contrast, *R. argentea* mean weight and length values are relatively stable between wet and dry seasons. The findings of this study were in agreement with the studies of Shamsuddin *et al*. (2022) and Watson *et al.* (2022) who reported seasonal differentiation in fish growth patterns.

This information explains the seasonal dynamics of these species' growth patterns and adaptations within their ecosystem. Seasonal changes might impact on fish growth rates and feeding behaviors, suggesting that some fish species may have specific growth patterns. *O. niloticus* and *O. urolepis*. *T. melanopleura, O. mossambicus, Sardines* spp*., T. melanopleura* and *O. grahmi* exhibit relatively isometric growth. Some species might experience faster growth during certain months, these growth patterns aid in fisheries management and conservation efforts. Deviations from expected growth patterns indicate changes in the ecosystem, including shifts in food availability, habitat quality, or the presence of stressors (Abd El-Hack *et al*., 2022). Comparatively, Lake Babati recorded the highest average fish weight due to the fact that there is a closed fishing

Table 3: Seasonality in fisheries resources (weight and length sizes) of lakes Babati and Burunge, Tanzania

Fish species	Wet season		Dry season		Expected size	
	Weight (g) Mean ± SEM	Length (cm) Mean ± SEM	Weight (g) Mean ± SEM	Length (cm) Mean ± SEM	Weight (g)	Length (cm)
Lake Babati						
Oreochromis niloticus	129.7 ± 3.48	9.83 ± 1.05	510.7 ± 19.7	27.4 ± 0.29	200 – 600	20 - 30
Oreochromis urolepis	134.7 ± 1.20	10.3 ± 0.12	255.9 ± 10.34	25.7 ± 0.57	150 – 300	15 – 30
Oreochromis variabilis	110 ± 12.90	11.9 ± 1.35	275.7 ± 9.58	26.5 ± 0.47	120 – 230	15 – 35
Clarias gariepinus	NFC	NFC	872.3 ± 15.38	54.2 ± 1.96	< 1200	30 – 50
Haplochromini sp.	NFC	NFC	29.6 ± 0.31	8.3 ± 0.21	5 - 20	5 – 20
Palaemonetes paludosus	NFC	NFC	24.5 ± 0.29	6.9 ± 0.09	5 - 50	2.5 - 5.0
Lake Burunge						
Tilapia melanopleura	149.7 ± 25.72	12.1 ± 3.23	443.3 ± 6.17	25.7 ± 0.33	300 - 450	15 - 25
Oreochromis esculentus	124 ± 1.53	11.4 ± 0.09	369.7 ± 2.40	23 ± 0.26	150 - 400	15 - 25
Oreochromis mossambicus	193.7 ± 11.68	20.3 ± 0.87	380.3 ± 0.33	24 ± 0.00	100 - 300	15 - 25
Rastrineobola argentea	17.3 ± 0.88	6.2 ± 0.54	19.6 ± 0.30	7.3 ± 0.18	1 – 5	5 – 8

NFC = No fish captured

period from May to June every year that allows reproduction and growth contrary to Lake Burunge where fishing is conducted throughout the year. There was a direct proportional relationship between weight gain and length, suggesting positive isometric growth and the suitability of both lakes for fish growth.

Surveying the limnological characteristics of Lake Babati is needful for the preservation of its unique aquatic biodiversity. The lake is home to various fish species and other aquatic organisms that are adapted to its dynamic water quality, temperature and nutrient conditions (Hongoa, 2014). The fishery resources contribute significantly to the livelihoods of local communities. Fishing is often a primary source of income and protein for many residents in the area (Hongoa, 2014). Proper management of these resources based on an understanding of the limnological characteristics ensures sustainable fishing practices. Limnological characteristics such as water temperature, nutrient levels and oxygen content impact the on health of the lake's ecosystem.

Monitoring these factors helps identify water pollution, eutrophication and habitat degradation, allowing for timely interventions to maintain a balanced ecosystem. Clear water, diverse fish populations and well-maintained ecosystems attract visitors interested in fishing, boating and ecotourism, thus benefiting the local economy (Uddin *et al*., 2021). Lake Burunge serves as a water source for domestic and agricultural purposes. Monitoring nutrient levels and pollution ensure a safe and clean water supply for both human and environmental needs. Similar to Lake Babati, fisheries in Lake Burunge provide an important source of income and nutrition for local communities (Tang'are and Mwanyoka, 2023). Sustainable management based on limnological data helps prevent overfishing and supports long-term food security. Well-managed fisheries and a healthy lake ecosystem contribute to economic growth through both local employment opportunities and tourism development (Jamu *et al*., 2011). The attraction of anglers, birdwatchers, and other nature enthusiasts boosts the local economy. Limnological factors impact the ecological balance of the lake. Proper monitoring and management ensure that invasive species don't disrupt the native ecosystem and that biodiversity remains intact.

Conclusion: Limnological characteristics and fishery resources in Lake Babati and Lake Burunge are interconnected and vital to the social, economic, and ecological well-being of the surrounding communities and the region as a whole. These factors enable informed decision-making for sustainable development and conservation efforts. The mean of each parameter indicated that, the physicochemical parameters of the two lakes were suitable for fisheries purpose. The study revealed that fish growth and well-being cannot be attributed to a single parameter. Nevertheless, maintaining optimal levels of these parameters is necessary to ensure a substantial fish harvest. Further research is required to investigate the fish ecology in Lake Burunge during periods of drought.

ACKNOWLEDGEMENTS

The authors expressed their sincere appreciation to respondents, technicians and different officials who by their capacity generously shared their time, making our data collection process and analysis meaningful and comprehensive for this study. Furthermore, the authors thanked the Management of the University of Dodoma for financing the study, provision of encouragement, and their belief in the importance of research and education.

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