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Comparative Study of Water Quality and Fish Community Structure in Gangasandra and Melekote Tanks, Tumkur District.

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Abstract: *Water reservoirs in semi-arid regions like Karnataka, India, are vital for biodiversity conservation, irrigation, and potable water supply. This study investigates the seasonal variations in physicochemical parameters, heavy metal contamination, and fish population dynamics in two perennial reservoirs-Gangasandra and Melekote tanks, over a two-year period (May 2022 to April 2024). Water quality parameters including temperature, pH, dissolved oxygen (DO), electrical conductivity (EC), turbidity, total dissolved solids (TDS), total hardness, alkalinity, and nutrients were monitored monthly using standardized protocols (APHA, 2017). Heavy metals (Fe, Cd, Mn, and others) were quantified via atomic absorption spectroscopy. Fish populations were sampled seasonally using multi-mesh gill nets, with Oreochromis mossambicus as a focal species for abundance estimation. Results showed typical monsoonal fluctuations: temperature ranged from 20°C in winter to 25°C pre-monsoon; pH remained near-neutral with minor seasonal shifts; EC, turbidity, and TDS peaked post-monsoon due to runoff inputs. Melekote tank exhibited higher mineral and organic loading, reflected in elevated total hardness (288–358 mg/L) and biological oxygen demand (BOD) values, likely influenced by adjacent sewage treatment. Heavy metal concentrations were within acceptable limits but highlighted potential bioaccumulation risks. Fish community structure varied seasonally, correlating with changing water quality. These findings underscore the influence of hydrological cycles and anthropogenic pressures on reservoir ecosystem health. The comparative analysis provides crucial baseline data for sustainable management and conservation of semi-arid reservoir ecosystems in Karnataka.*
Keywords: *Perennial reservoirs, fish population dynamics, semi-arid ecosystems, Gangasandra tank, Melekote tank, aquatic biodiversity, and water resource management.*

INTRODUCTION

Water reservoirs play a critical role in supporting regional biodiversity, agricultural irrigation, and providing potable water for human consumption, especially in semi-arid regions such as Karnataka, India (Boyd, 2000; Reddy et al., 2024). Perennial tanks, such as the Gangasandra and Melekote reservoirs, are integral components of local hydrology and ecology, supporting aquaculture and sustaining rural livelihoods (Sharma et al., 2019). However, these reservoirs face increasing pressures from anthropogenic activities, including urban runoff, sewage inflows, and agricultural leaching, which threaten their water quality and aquatic biodiversity (Meena et al., 2020; Rao et al., 2021). Understanding the seasonal dynamics of physicochemical parameters and fish population structure in such systems is essential for effective water resource management and conservation strategies (Talwar & Jhingran, 1991; Jayaram, 2010).Seasonal variation in water quality parameters like temperature, pH, dissolved oxygen (DO), and nutrient loads directly influence biological processes and fish community dynamics (Wetzel, 2001; Hutchinson, 1957). Monsoonal rainfall in semi-arid zones induces fluctuations in parameters such as turbidity, electrical conductivity, and total dissolved solids (TDS), which in turn affect fish habitat suitability and productivity (Anitha et al., 2020; Shivakumar et al., 2020). The presence of heavy metals such as Fe, Cd, and Mn further complicates aquatic health due to their toxicity and bioaccumulation potential (Alloway, 2013; Sarkar et al., 2016). Hence, simultaneous monitoring of physico-chemical parameters and fish population metrics provides a comprehensive assessment of reservoir ecosystem health (APHA, 2017; WHO, 2017).

MATERIALS AND METHODS

Study Area

The study was conducted in two perennial water reservoirs located in Tumkur District, Karnataka, India. The Gangasandra tank, approximately 8 km from Tumkur city, spans a water spread area of 83.2 hectares. The Melekote tank, situated 1.59 km from Tumkur, covers 47.2 hectares and is adjacent to a sewage treatment facility. Both reservoirs are extensively used for aquaculture, irrigation, and drinking water, making them ecologically and

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economically significant for local communities.

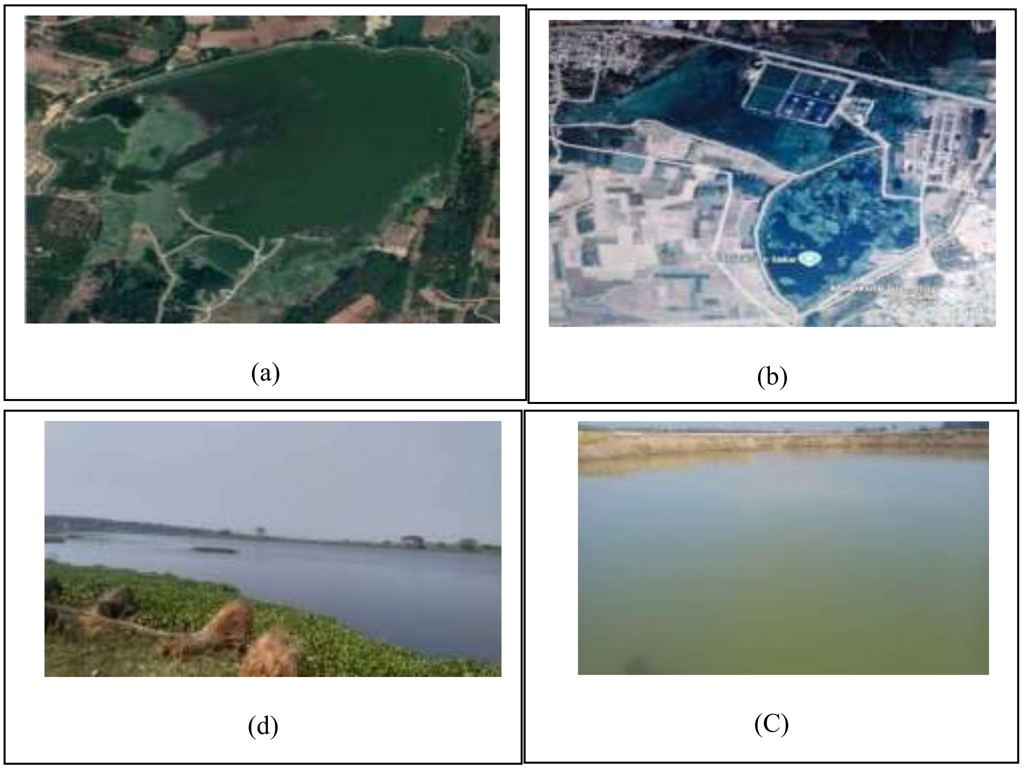


Figure 1. Geographical location of tanks (satellite view) and sampling sites: a). Gangasandra tank b). Melekote tank c). Sampling site at Gangasandra tank d). Sampling site at Melekote tank

Sample Collection

Samples were collected monthly from May 2022 to April 2024, between 7:00 and 11:00 AM to minimize diurnal variations. HDPE bottles were used to prevent chemical contamination. Each sample was labelled with collection date, time, and location, and transported under controlled conditions, following standard procedures (APHA, 2017; WHO, 2011).

Physico-Chemical Parameters

Water quality parameters were assessed following standardized procedures outlined by the American Public Health Association (APHA, 2005; 2017) and Hach Manual (2010). Surface and bottom water temperatures were recorded using a precision thermometer (±0.1°C) and averaged (APHA, 2017). The pH was measured electrochemically using a pH meter, indicating hydrogen ion concentration on a scale from 0 to 14, with neutrality at pH 7 (APHA, 2017). Electrical conductivity (EC) was determined on-site using a portable conductivity meter, expressed in µS/cm. Turbidity was analyzed using a nephelometer and reported in Nephelometric Turbidity Units (NTU) (APHA, 2017). Total alkalinity, reflecting the buffering capacity of water, was measured via titration to determine carbonate and bicarbonate content. Total dissolved solids (TDS) were quantified using a TDS meter, with values expressed in mg/L.

Total hardness, indicating the concentration of calcium and magnesium ions, was determined by EDTA titration using Eriochrome Black-T as an indicator (APHA, 2017). Chloride concentration was estimated by Mohr's method employing silver nitrate titration and potassium chromate indicator. Fluoride was measured using the SPADNS colorimetric method at 570 nm with a UV-Visible spectrophotometer (APHA, 2017). Sulphate levels were determined using the turbidimetric method involving barium chloride, measured at 420 nm. Nitrate was estimated via the phenol sulphonic acid method with absorbance measured at 410 nm (APHA, 2017). Calcium concentrations were determined by titration with EDTA using murexide as an indicator under alkaline conditions. Dissolved oxygen (DO) was analyzed using Winkler's iodometric method with in-field fixation and titration (APHA, 2005). Carbon dioxide content was estimated by titration using phenolphthalein and standard NaOH solution. Biological Oxygen Demand (BOD) was assessed by incubating aerated samples at 20°C for five days and calculating the decrease in DO (APHA, 2017).

Heavy metals including Fe, Cd, Mn, Cu, As, Pb, Ni, Cr, and Zn were quantified using an Atomic Absorption Spectrophotometer (Perkin Elmer Analyst AA100) and confirmed with a UV-Visible Spectrophotometer in accordance with APHA (2017) and Hach Manual (2010).

Fish Sampling and Identification

Fish were collected seasonally using drag nets, cast nets, and gill nets, with the help of local fishermen. A multi-mesh gill net (180 m length; 6 mesh sizes: 20–90 mm) was deployed at dusk and retrieved at dawn. Photographs were taken immediately to aid identification and avoid errors due to preservation-induced discoloration. Identification relied on morphological characters such as coloration, fin structure, and body pattern using standard ichthyological references (Talwar & Jhingran, 1991; Jayaram, 2010).

Population Abundance

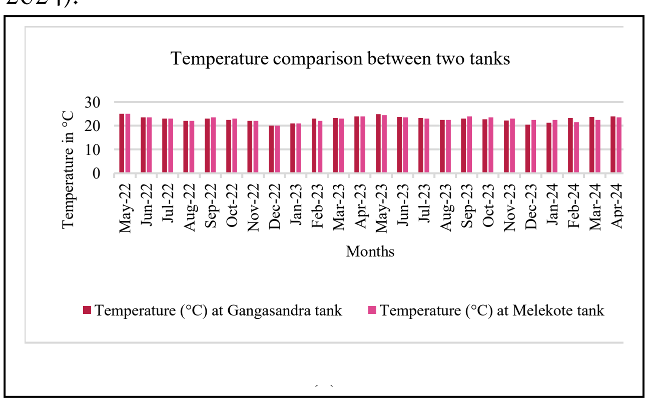
Population estimates of *Oreochromis mossambicus* were obtained via seasonal sampling. Morphological identification followed standard taxonomic keys (Talwar & Jhingran, 1991; Jayaram, 2010). Nets used included drag nets, cast nets, and gill nets, and data were corroborated using on-site photographs.

Relative Abundance

Relative abundance (RA) was calculated using the formula: RA (%) = (Number of individuals of a species × 100) / Total number of individuals of all species.

RESULT AND DISCUSSION

Seasonal variations in physico-chemical parameters of Gangasandra and Melekote tanks in Tumkur reflect typical monsoonal and semi-arid hydrological cycles. Water temperature in both reservoirs ranged from 20°C in winter to 25°C during pre-monsoon, with a significant dip during the monsoon months due to rainfall-induced cooling (Kumar *et al.*, 2021; Reddy *et al.*, 2024). These seasonal shifts are ecologically significant as they affect metabolic rates, dissolved oxygen solubility, and primary productivity (Sharma *et al.*, 2019). pH remained near-neutral in both tanks, with minor seasonal fluctuations: monsoon rains lowered pH slightly due to runoff, while summer values rose due to photosynthetic CO_2 uptake and evaporation (Mishra *et al.*, 2019; Kumar *et al.*, 2020). Electrical conductivity (EC) displayed higher values during monsoon and post-monsoon due to increased ionic load from runoff, particularly in Melekote tank, where values peaked at 1698 µS/cm (Rao *et al.*, 2021; APHA, 2005). Turbidity patterns showed monsoon-related peaks caused by sediment inflow, followed by summer declines due to sediment settling (Anitha *et al.*, 2020; Sharma *et al.*, 2019). Alkalinity and TDS levels also mirrored seasonal hydrological changes. In Gangasandra, alkalinity peaked post-monsoon due to organic decomposition, while TDS rose in October (465 mg/L) following runoff events (Ravindra *et al.*, 2020; BIS, 2012). Melekote recorded higher alkalinity and TDS, indicating stronger buffering and mineral content, with post-monsoon peaks reflecting leaching and erosion (Boyd, 2000; Reddy *et al.*, 2024).



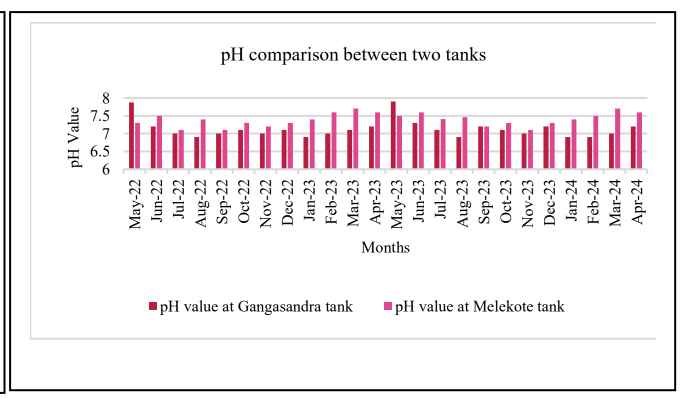


Figure 2. a). Temperature comparison of Gangasandra and Melekote tanks, b). pH comparison of Gangasandra and Melekote tanks

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Figure 3. Comparison physiochemical properties of Gangasandra and Melekote tanks, a). Electrical conductance b). Turbidity, c). Alkalinity, d). TDS, e). Total hardness, f). Chloride, g). BOD, h). Calcium.

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Figure 4. Comparison physiochemical properties of Gangasandra and Melekote tanks, a). Magnesium, b). Fluoride, c). Nitrate, d). Sulphate, e). Dissolved oxygen, f). Carbon dioxide, g). Iron, h). Copper.

Total hardness and BOD further highlighted seasonal ecological dynamics. In Gangasandra, total hardness ranged from 110 to 190 mg/L, peaking during monsoon due to mineral inflow, while Melekote values were higher (288–358.2 mg/L), influenced by catchment geology and erosion (WHO, 2017; Mohammed *et al.*, 2020). BOD levels peaked during monsoon at both sites due to an influx of organic matter; however, Melekote showed higher pre-monsoon BOD (up to 12.8 mg/L), likely from stagnation and decomposition (Meena *et al.*, 2020; Murugesan *et al.*, 2020). Calcium concentrations also peaked post-monsoon due to leaching and evaporation effects, supporting aquatic life through maintenance of hardness and physiological balance (Kannan *et al.*, 2020; Kumari *et al.*, 2018). These findings collectively emphasize the role of seasonal hydrological processes in shaping water quality and ecological dynamics in semi-arid reservoirs, aligning with trends observed in similar Indian water bodies (Shivakumar *et al.*, 2020; Divya *et al.*, 2024).

Sulfate concentrations in Gangasandra tank ranged between 14.8 and 20.82 mg/L, showing seasonal dynamics with elevated values during winter (January 2023) due to reduced levels during the early monsoon (June 2022) as a result of dilution by rainfall (Yilmaz, 2011; Tiwari *et al.*, 2020). The limited spatial variation in sulphate suggests relatively uniform water quality across the tank, attributed to its compact size and minimal inflow sources (Singh *et al.*, 2017). In contrast, Melekote tank exhibited higher sulphate levels (25.8–39.5 mg/L), with peaks in post-monsoon and winter seasons, possibly due to increased leaching from surrounding soils and evapotranspiration effects (Kumar *et al.*, 2020; Srinivas *et al.*, 2021). Dissolved oxygen (DO) levels in both tanks showed typical seasonal fluctuations driven by temperature and biological activity. Gangasandra showed higher DO during the post-monsoon due to aeration and lower temperatures, and lower values during summer when oxygen solubility decreases (Wetzel, 2001; Hutchinson, 1957; Boyd, 2000). Melekote exhibited a similar trend with DO ranging from 5.5 to 6.9 mg/L (Rana *et al.*, 2003; Singh *et al.*, 2017), and all values stayed within ecologically acceptable ranges (APHA, 2005; Shetty *et al.*, 2020). Carbon dioxide (CO_2) levels also reflected seasonal variability, with Gangasandra recording 34–42 mg/L, peaking in warmer months due to enhanced respiration and organic matter decomposition (Boyd, 2015; Tundisi *et al.*, 2014; Kling *et al.*, 2019). Melekote showed elevated CO_2 concentrations during pre- and post-monsoon periods, likely due to stratification and decay processes, while monsoon rains facilitated CO_2 dilution through enhanced mixing and photosynthesis (Chaturvedi *et al.*, 2018; Kumar *et al.*, 2020; Vijayan *et al.*, 2016). These CO_2 dynamics are significant indicators of water quality and eutrophication trends (Yadav *et al.*, 2021).

Trace metal analysis revealed key spatial and seasonal differences between the tanks. In Gangasandra, iron levels ranged from 0.10 to 0.28 mg/L, with monsoon peaks attributed to surface runoff, remaining below BIS (2012) and WHO (2017) safety thresholds (Kumar *et al.*, 2018). Conversely, Melekote exhibited higher Fe levels (0.65–1.10 mg/L), occasionally exceeding permissible limits during runoff seasons (Jyothibabu *et al.*, 2010; Laxman *et al.*, 2018). Cadmium concentrations in Gangasandra varied from 0.001 to 0.005 mg/L, nearing WHO (2017) limits during late monsoon and pre-summer, likely due to evaporation and catchment runoff (Singh *et al.*, 2018; Rai *et al.*, 2020). Melekote reported slightly higher Cd values (up to 0.009 mg/L), suggesting agricultural runoff as a source (Alloway, 2013; Jarup, 2003), raising concerns for chronic toxicity and bioaccumulation in aquatic biota (Wang *et al.*, 2004; Sarkar *et al.*, 2016). Seasonal manganese (Mn) peaks in Melekote, particularly during the monsoon, were driven by runoff but stayed within safe ecological limits (Sajwan *et al.*, 2015; Sharma *et al.*, 2020). Copper in Gangasandra showed winter highs (0.071–0.075 mg/L) and early monsoon lows (0.001–0.002 mg/L), sometimes exceeding WHO (2017) limits (Sundaray *et al.*, 2011; Chakraborty *et al.*, 2016). Lead (Pb) concentrations peaked in Gangasandra during monsoon due to runoff and surpassed the BIS (2012) limit of 0.01 mg/L at times (Singh *et al.*, 2021; Jain *et al.*, 2019), while Melekote maintained Pb within permissible levels but showed seasonal spikes (Bhatnagar & Gupta, 2008; Yuan *et al.*, 2013). Nickel (Ni) levels in Melekote were low (0.001–0.003 mg/L), with minor seasonal variations linked to runoff and mineral leaching (APHA, 2005; Patil & Chonde, 2015). Zinc (Zn) concentrations, ranging from 0.001 to 0.0038 mg/L, showed higher values during the monsoon and lower in summer, driven by rainfall-induced transport and evaporation (Singh *et al.*, 2020; Kumar & Sharma, 2019), and remained within safe limits (Gupta *et al.*, 2021; Ravichandran *et al.*, 2018).

Table 1. Fish diversity at Gangasandra tank

Scientific Name	Family	IUCN Status

Oreochromis mossambicus	Cichlidae	Least concern
Oreochromis niloticus	Cichlidae	Least concern
Cyprinus carpio	Cyprinidae	Least concern
Catla catla	Cyprinidae	Least concern
Clarius gariepinus	Clariidae	Least concern
Clarius batrachus	Clariidae	Least concern
Channa punctata	Channidae	Least concern
Channa striata	Channidae	Least concern
Parambassis ranga	Ambassidae	Least concern
Lepidocephalichthys thermalis	Cobitidae	Least concern

Seasonal fish population assessments of *Oreochromis mossambicus* in Gangasandra and Melekote tanks were carried out monthly from May 2022 to April 2024 using standardized sampling methods including drag, cast, and multi-mesh gill nets, supplemented by on-site photographic identification to reduce taxonomic errors (Talwar *et al*., 1991; Jayaram, 2010; Negi *et al*., 2013). Identification relied on morphological keys such as scale pattern and fin structure (Jayaram, 2010). Fish diversity indices and relative abundance were calculated using established ecological metrics (Southwood, 1996; Negi *et al*., 2013). Results showed O. *mossambicus* maintained a consistently low relative abundance across Gangasandra tank sites, ranging from 0.61% to 1.99%, with higher occurrences during post-monsoon and winter months attributed to favourable physicochemical conditions including stable water temperature and dissolved oxygen (Garg *et al*., 2009; Padmakumar *et al*., 2017; Shivashankar *et al*., 2019). Seasonal declines during monsoon months were linked to increased turbidity and hydrological disturbances, limiting the species' dominance (Bhakta & Bandyopadhyay, 2007; Sugunan, 1995; Kumar *et al*., 2017). Ecological adaptability of dominant species such as *Oreochromis niloticus* and *Cyprinus carpio* was evident, while air-breathing catfish *Clarias gariepinus* thrived sporadically under hypoxic summer conditions (Deshmukh *et al*., 2011; Pillay, 1993). Improved second-year counts of species like *Catla catla* indicated positive ecological shifts possibly due to stocking and better habitat management (Deshmukh *et al*., 2011). Overall, O. *mossambicus* played a persistent but secondary role in the Gangasandra fish community, reflecting its ecological plasticity in response to seasonal environmental fluctuations (Sugunan, 1995; Jhingran, 1991).

Table 2. Relative abundance of *O. mossambicus* in Gangasandra tank

Month	**Relative abundance of *O. mossambicus* in % (Site 01)**	**Relative abundance of *O. mossambicus* in % (Site 02)**	**Relative abundance of *O. mossambicus* in % (Site 03)**	**Relative abundance of *O. mossambicus* in % (Site 04)**
May 2022	1.05	0.80	0.97	0.83
June 2022	1.20	1.12	0.61	1.16
July 2022	1.36	0.80	0.73	1.16
August 2022	0.75	0.96	0.97	0.66
September 2022	0.90	0.96	0.85	0.66
October 2022	0.75	1.12	1.21	1.33
November 2022	0.90	1.28	1.21	1.83
December 2022	1.51	1.44	0.85	1.50
January 2023	1.20	1.44	1.21	1.50

February 2023	1.51	0.96	1.09	1.00
March 2023	1.36	1.28	1.21	1.50
April 2023	0.90	1.12	1.09	1.66
May 2023	1.20	0.80	1.09	1.16
June 2023	1.36	0.96	0.85	1.33
July 2023	1.36	0.96	0.85	1.33
August 2023	0.90	0.80	0.97	0.83
September 2023	0.90	1.12	0.97	0.83
October 2023	0.90	1.28	1.09	1.16
November 2023	1.05	1.28	1.21	1.99
December 2023	1.51	1.28	0.73	1.50
January 2024	1.36	0.80	1.09	1.50
February 2024	1.51	1.12	0.97	0.83
March 2024	1.51	1.44	1.09	1.50
April 2024	1.05	1.12	1.21	1.66

Table.Fish diversity at Melekote tank

Scientific Name	**Family**	**IUCN Status**
Oreochromis mossambicus	Cichlidae	Least concern
Oreochromis niloticus	Cichlidae	Least concern
Clarius gariepinus	Clariidae	Least concern
Clarius batrachus	Clariidae	Least concern

In Melekote tank, *O. mossambicus* showed similar low but stable relative abundance (0.47%–2.59%), with consistent peaks in post-monsoon and winter months linked to enhanced food availability and optimal water quality parameters such as dissolved oxygen and lower turbidity (Canonico *et al*., 2005; Kumar *et al*., 2017; Suresh & Lin, 1992). Despite its adaptability, the species' limited dominance was attributed to interspecific competition, habitat degradation, and variable physicochemical conditions (Canonico *et al*., 2005; Padmavathi & Ramesh, 2016). The co-occurrence with *O. niloticus* suggested niche partitioning amidst potential resource competition (El-Sayed, 2006). The moderate abundance of invasive *Clarias gariepinus* raised ecological concerns due to its predatory nature (Musinguzi *et al*., 2019). Seasonal abundance patterns indicated that monsoon-related hydrological changes and increased water flow caused temporary declines in *O. mossambicus* populations, whereas stable conditions during post-monsoon and winter supported reproductive success and survival (Boyd, 1998; Sharma & Dey, 2020). These findings underscore the species' ecological resilience and adaptive capacity in semi-managed tropical reservoirs but highlight the influence of both natural and anthropogenic factors in shaping its population dynamics (Canonico *et al*., 2005; FAO, 2020).

Table 4. Relative abundance of *O. mossambicus* in Melekote tank

Month	Relative abundance of O. *mossambicus* in % (Site 01)	Relative abundance of O. *mossambicus* in % (Site 02)	Relative abundance of O. *mossambicus* in % (Site 03)	Relative abundance of O. *mossambicus* in % (Site 04)
May 2022	1.25	1.25	2.59	1.47
June 2022	1.04	1.04	1.18	1.18
July 2022	1.25	1.25	0.47	0.59
August 2022	1.25	1.25	1.18	1.76
September 2022	1.88	1.88	1.65	0.88
October 2022	2.08	2.08	2.35	1.47
November 2022	1.67	1.67	1.88	2.06
December 2022	1.46	1.46	2.59	2.06
January 2023	1.25	1.25	0.71	0.59
February 2023	0.83	0.83	1.65	1.47
March 2023	1.46	1.46	0.94	2.35
April 2023	1.88	1.88	1.65	1.76
May 2023	1.25	1.25	2.59	1.47
June 2023	1.46	1.56	2.35	1.47
July 2023	1.25	1.04	1.18	1.76
August 2023	1.04	1.04	0.47	0.88
September 2023	1.04	1.04	1.41	1.47
October 2023	2.08	1.56	1.88	1.18
November 2023	2.08	2.34	2.59	1.76
December 2023	1.67	1.30	1.41	2.06
January 2024	1.25	1.82	2.35	1.76
February 2024	1.25	1.56	0.94	1.18
March 2024	1.04	1.56	1.18	1.47
April 2024	1.46	1.30	0.94	2.06

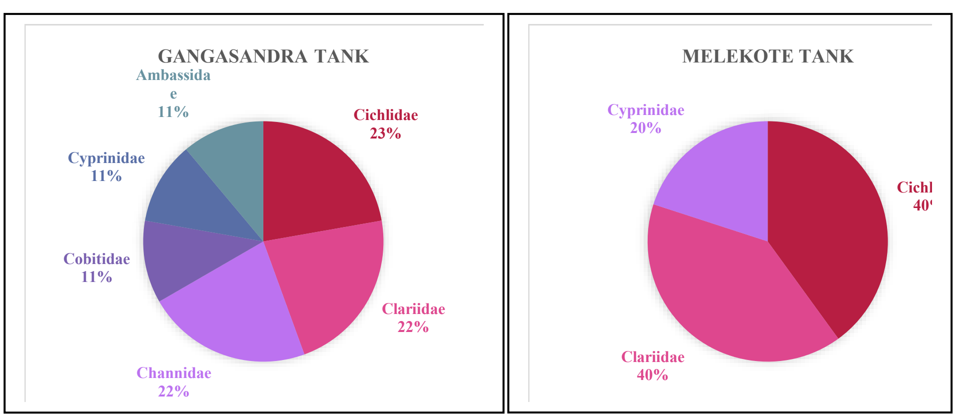

Figure 5. Comparison of Fish abundance% at (a) Gangasandra and (b)Melekote tank.

CONCLUSION

Seasonal variations in the physico-chemical parameters of Gangasandra and Melekote tanks in Tumkur are strongly influenced by the region's monsoonal and semi-arid hydrological cycles, which govern water temperature, pH, conductivity, turbidity, alkalinity, and nutrient dynamics. Both reservoirs exhibited typical temperature fluctuations from 20°C in winter to 25°C pre-monsoon, with monsoonal cooling significantly affecting metabolic and ecological processes (Kumar *et al*., 2021; Reddy *et al*., 2024; Sharma *et al*., 2019). pH variations mirrored rainfall and evaporation patterns, maintaining near-neutral conditions essential for aquatic life (Mishra *et al*., 2019; Kumar *et al*., 2020). Electrical conductivity and turbidity reflected runoff and sediment influx during the monsoon, with Melekote tank showing generally higher ionic and mineral content indicative of stronger buffering capacity and catchment influences (Rao *et al*., 2021; Boyd, 2000).

Nutrient and organic matter indicators such as alkalinity, TDS, hardness, and BOD displayed seasonal peaks linked to runoff, decomposition, and biological activity, emphasizing the reservoirs' dynamic biogeochemical cycling. Melekote consistently showed elevated hardness and BOD, likely due to local geology and anthropogenic inputs (WHO, 2017; Meena *et al*., 2020). Dissolved oxygen and carbon dioxide fluctuations corresponded with temperature and biological respiration, sustaining aquatic ecosystems within acceptable ecological thresholds (Wetzel, 2001; Boyd, 2015). Trace metals including Fe, Cd, Cu, Pb, Mn, Ni, and Zn varied seasonally and spatially, with Melekote generally exhibiting higher concentrations and occasional exceedance of safety limits, raising concerns for bioaccumulation and aquatic health (Jyothibabu *et al*., 2010; Alloway, 2013; Sarkar *et al*., 2016).

Fish population assessments demonstrated that *Oreochromis mossambicus* maintained a stable but low relative abundance in both tanks, with post-monsoon and winter peaks corresponding to favourable physicochemical conditions and lower hydrological disturbances (Garg *et al*., 2009; Shivashankar *et al*., 2019). The species' limited dominance reflects interspecific competition, habitat variability, and adaptive ecological plasticity (Canonico *et al*., 2005; Sugunan, 1995). The presence and fluctuating abundances of invasive and native species such as *Clarias gariepinus, Oreochromis niloticus*, and *Cyprinus carpio* further highlight the complex trophic interactions and ecological shifts influenced by both natural seasonal cycles and anthropogenic pressures (Deshmukh *et al*., 2011; Musinguzi *et al*., 2019; FAO, 2020). Overall, these findings underscore the importance of continuous monitoring to understand and manage water quality and fish populations in semi-arid tropical reservoirs, supporting sustainable fisheries and ecological health.

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