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Assessment of Physico-Chemical Parameters and Zooplankton Diversity in Anandpur Dam, Junagadh, Gujarat, India

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Abstract

The physico-chemical profile of the freshwater reservoir (dam) in Anandpur, Saurashtra, Gujarat, where limnological research was carried out from June 2021 to May 2023, is described in this report. Temperature, transparency, pH, electrical conductivity, dissolved oxygen, biological oxygen demand, acidity, alkalinity, total hardness, calcium hardness, magnesium hardness, chlorides, salinity, and other variables were examined in the surface water of the dam. These components' seasonal fluctuations were examined, and their interrelationships are addressed. Water had an alkaline pH. Summertime saw a rise in EC, whereas the post-monsoon season saw a reduction. Alkalinity and total hardness tended to drop in the winter and summer and to rise during and after the monsoon. The amount of dissolved oxygen was highest in the winter and lowest in the summer. Temperature and EC indicated an inverse connection with dissolved oxygen. Total 36 species of zooplankton were also recorded. The highest arthropodan and rotifer zooplankton species were recorded.

Keywords: Limnology, Zooplankton, Physico-chemical Parameters, Freshwater, Dam.

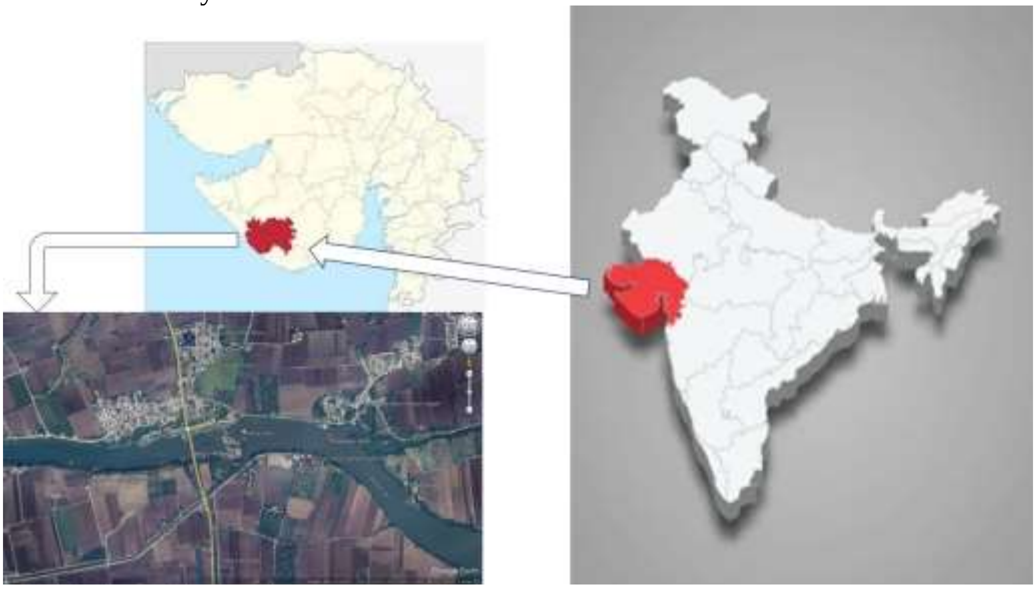
Introduction

The quantities of plankton and the ultimate production of aquaculture products are significantly influenced by the physical, chemical, and biological properties of the water. For many omnivorous and carnivorous fish, zooplankton is an essential food source. It also provides the required quantity of protein for the fish's quick larval development (Kalpana et. al., 2017). Four types of zooplankton are often found in freshwater ponds, lakes, and dams: Cladospores and crustacean zooplankton belonging to Copepoda, Ostracoda, and Cladocera (Kalpana et. al., 2017).

By moving energy from lower trophic levels to higher trophic levels, zooplankton play an intermediary role in the food chain and greatly contribute to the secondary production of aquatic ecosystems. Significant biodiversity loss or depletion is occurring in the aquatic ecosystem as a result of several health stressors, such as sewage, home, industrial, and agricultural effluents transporting organic waste containing extremely hazardous compounds. These consequences are expected to be stronger (Sala et al., 2000). The population dynamics of zooplankton are influenced by a number of factors, including light intensity, food availability, dissolved oxygen level, and predators. Low pH and increased salinity can also lessen the variety and density of zooplankton. (Horne and Goldman, 1994). The growth of zooplankton is regulated by abiotic chemicals, which include water, carbon dioxide, oxygen, calcium, nitrogen, and phosphorus salts, amino acids, and humic acids, among other vital inorganic and organic elements. Season, depth, weather, and water qualities all affect plankton development and abundance, which in turn affects the variety of creatures in the ecosystem (Rao et al., 1990), (Boyd and Tucker, 1998).
The physical, chemical, and biological properties of water have a significant impact on the productivity of zooplankton and the overall output of aquaculture products (Rahman and Hussain, 2008) (Poongodi et al., 2009) (Radhakrishnan et al., 2009) (Shanthi et al., 2010) and (Manickam et al., 2012). The current study examined the physico-chemical characteristics of the freshwater at Anandpur Dam in the Junagadh District of Gujarat, India, as well as its zooplankton species diversity and population density.

Material & Methods

Over the course of two years, from June 2021 to July 2023, water and plankton samples were taken from the Anandpur Dam in the Junagadh District of Gujarat, India (Fig. 1), which is located at latitude 21°24'2.51"N and longitude 70°31'12.75"E. The only sources of water for this lake are the Ozat river and rainfall. The Ozat river rises close to Visavadar Taluka and empties into the Arabian Sea. Its catchment area is 3185 sq. km. and its length is 125 km. The Ozat river is a 5975-meter-long earthen spillway in the river gorge that is 387.26 metres long and made of rubble masonry. It has 25 radial gates that allow it to pass the design flood in 14890 cubic seconds. A spillway's maximum height is 16.94 metres, whereas an earthen dam's maximum height is 12.25 metres. 42 settlements have 9960 hectares of potential for irrigation. (Source: https://indiawris.gov.in/wiki/doku.php?id=ozat_-_ii_medium_irrigation_project_ji01177) (Source: https://guj-nwrws.gujarat.gov.in/showpage.aspx?contentid=1668&lang=english) In order to analyse the data, seasons were considered: summer (March, April, and May), monsoon (June, July, and August), post-monsoon (September, October, and November), and winter (December, January, and February). The data were collected monthly.



(Figure 1: Map of Anandpur Dam)
Source: Google Earth- map is not to scale

Analysis of Physico-chemical Properties of Dam Water

The sterile polyethylene bottles used to collect the surface water samples were stored in an ice box before being sent to the lab for physico-chemical parameter analysis. Every month from the first week of June 2021 to July 2023, early mornings between 5:00 AM and 8:00 AM were used to gather the water and plankton samples. Estimates of the following were made: total solids (TS), total dissolved solids (TDS), total suspended solids (TSS), pH, electric conductivity (EC), salinity, chlorinity, acidity, alkalinity, dissolved oxygen (DO), biological oxygen demand (BOD), total hadness, Ca++ hardness, and Mg++ hardness. (APHA, 1998) (Baird et. al., 2017).

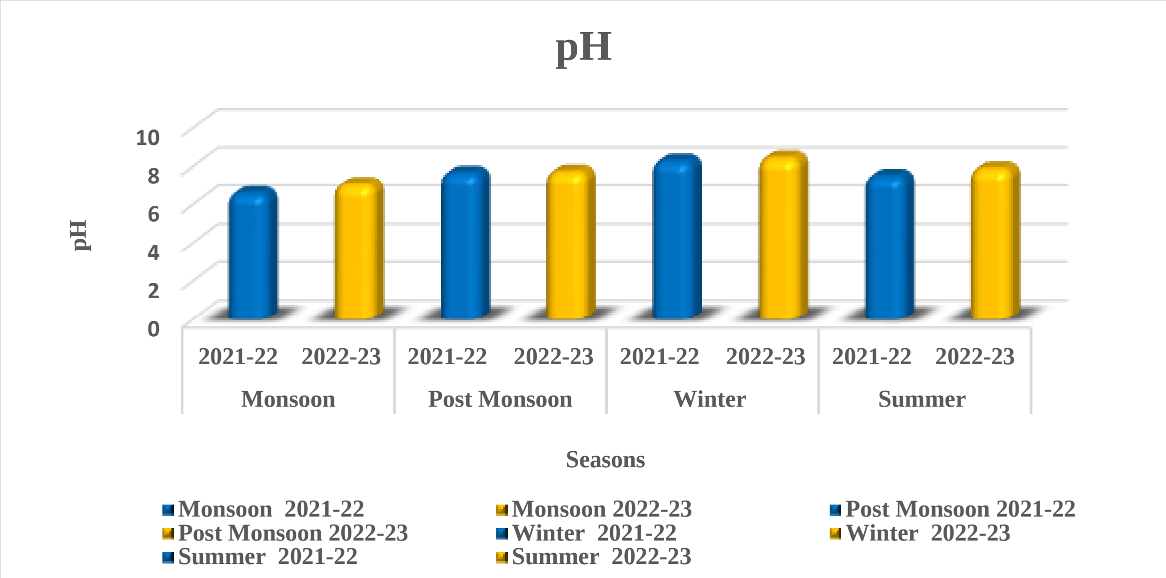
Qualitative and quantitative analysis of zooplankton

Water samples were collected horizontally at a depth of 50 to 100 cm using Henson's standard plankton net (150 µm mesh) in a zigzag pattern for qualitative investigation of zooplankton. Regarding the zooplankton quantitative analysis Using a 10-liter plastic container, 200 litres of water were filtered through a plankton net composed of bolting silk (No. 10, mesh size: 150 µm). The plankton biomasses were immediately transferred to 100 ml plastic specimen bottles that were filled with 10 ml of formalin, an aqueous solution of formaldehyde, at a concentration of 4%. Using a tiny needle and brush, various zooplankton groups—Rotifer, Cladocera, Copepoda, and Ostracoda—were separated and segregated under a binocular stereo zoom dissection microscope. When zooplankton was identified, referring the standard manuals, text books and monographs (Sahu et. al., 2013) (Edmondson, 1959) (Source: https://www.marinespecies.org/) (Sharma and Michael, 1987) (Battish, 1992) (Reddy, 1994) (Murugan et al., 1998) (Altaff, 2004) and (Santhanam et al., 1989, utilising a light microscope and a compound microscope. Using a wide-mouthed pipette, 1 ml of the material was obtained and put into the Sedgwick Rafter's counting cell. They were counted after giving them some time to settle. For every group, at least five counts of this kind were made. The plankton's species and developmental stage were taken into account. The mean values were determined. (Dhanasekaran, 2017).

Result & Discussion

Table 1: Classification of Zooplankton

Kingdom	Phylum	Class	Order	Family	Genus	Species
Chromista	Ciliophora	Prostomatea	Prorodontida	Colepidae	*Coleps*	*hirtus*
		Litostomatea	Haptorida	Tracheliidae	*Dileptus*	------
			Pleurostomatida	Litonotidae	*Loxophyllum*	------
		Oligohymenophorea	Sessilida	Epistylididae	*Epistylis*	------
			Peniculida	Parameciidae	*Paramecium*	*aurelia*
					Paramecium	*caudatum*
		Spirotrichea	Euplotida	Euplotidae	*Euplotes*	*patella*
		Heterotrichea	Heterotrichida	Stentoridae	*Stentor*	*roeselii*
					Stentor	*sp.*
Protozoa	Euglenozoa	Euglenoidea	Euglenida	Euglenaceae	*Euglena*	*acus*
					Euglena	*virdis*
					Euglena	*gracilis*
				Phacaceae	*Phacus*	*caudata*
Animalia	Rotifera	Eurotatoria	Ploima	Asplanchnidae	*Asplanchna*	------
				Brachionidae	*Brachionus*	*angularis*
					Brachionus	*calyciflorus*
					Brachionus	*diversicornis*
					Brachionus	*quadridentatus*
					Brachionus	*rubens*
					Keratella	*quadrata*
				Lecanidae	*Lecane*	*bulla*
				Synchaetidae	*Polyarthra*	*vulgaris*
				Philodinidae	*Rotaria*	*neptunia*
				Trichocercidae	*Trichocerca*	*rattus*
		Monogononta	Flosculariaceae	Filinidae	*Filinia*	*longiseta*
	Arthropoda	Malacostraca	Mysida	Mysidae	*Hemicypris*	*anomala*
			Decapoda	Alpheidae	*Nauplii*	------
		Copepoda	Cyclopoida	Cyclopidae	*Cyclops*	------
			Calanoida	Diaptomidae	*Heliodiaptomus*	*viddus*
		Branchiopoda	Anomopoda	Daphniidae	*Ceriodaphnia*	------
					Ceriodaphnia	*pulchella*
					Daphnia	*carinata*
					Daphnia	*obtusa*
					Daphnia	*pulex*
	Annelida	Polychaeta	Incertae sedis	Aeolosomatidae	*Aelosoma*	------
	Platyhelminthes	Catenulida		Stenostomidae	*Stenostomum*	*unicolor*



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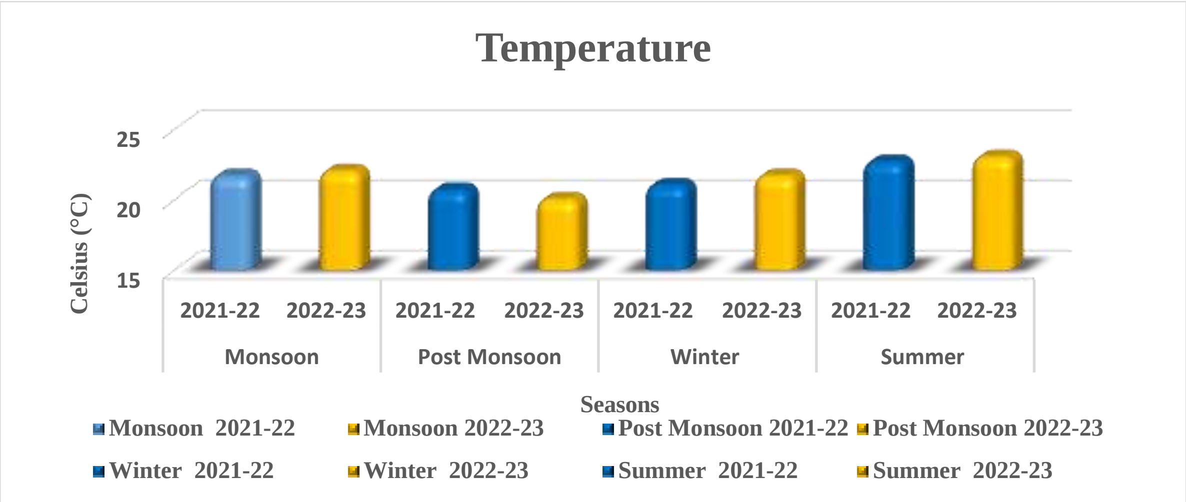

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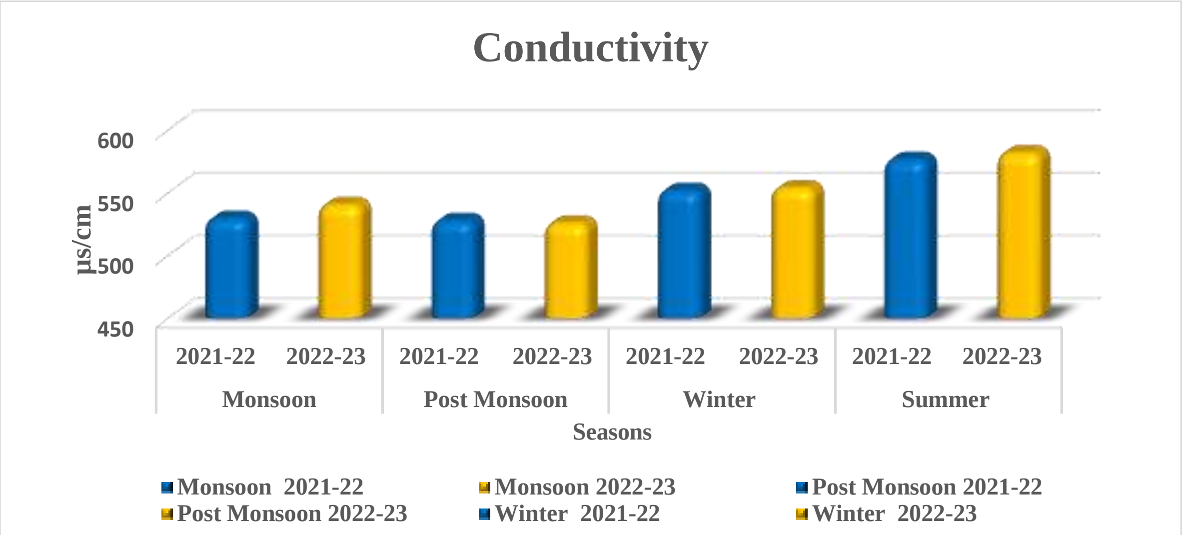

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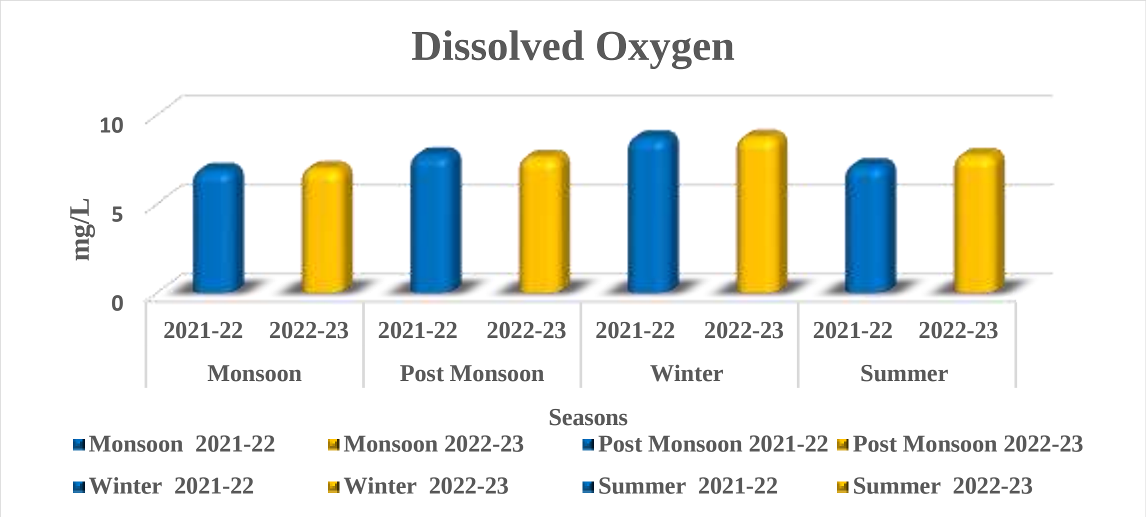

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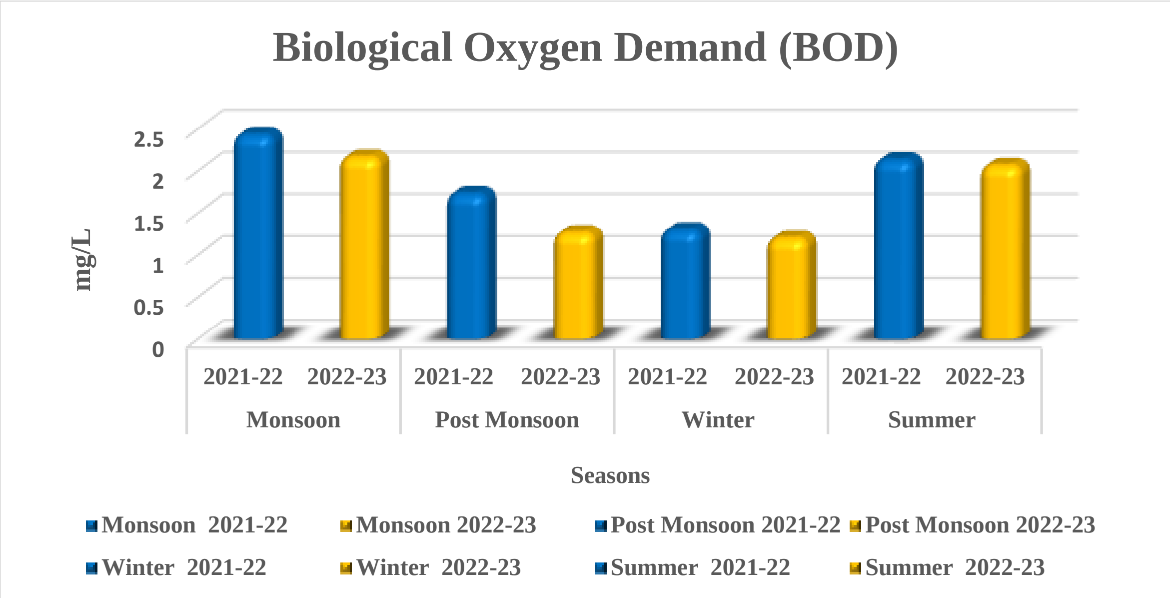

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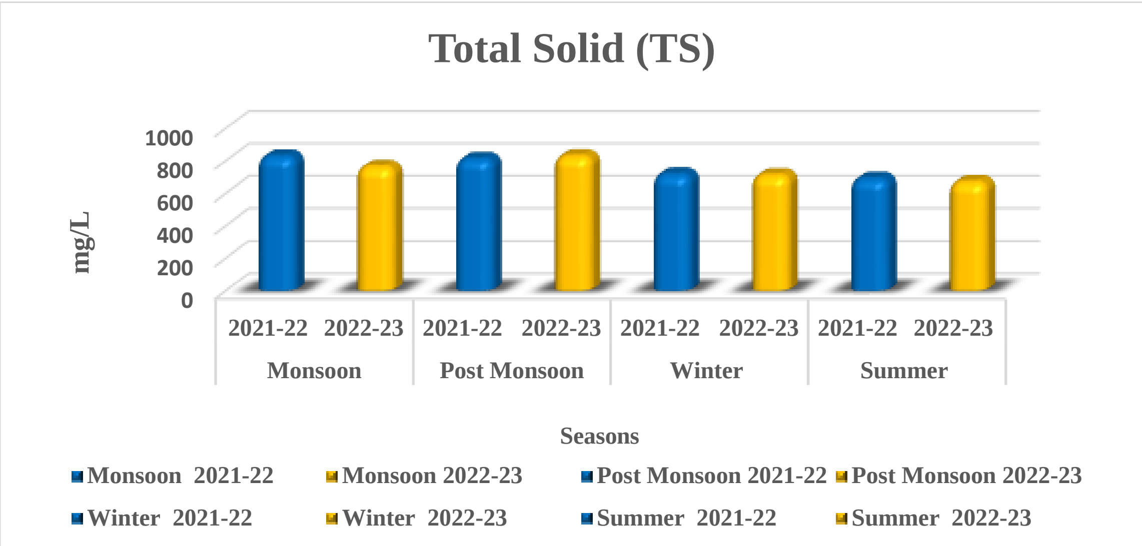

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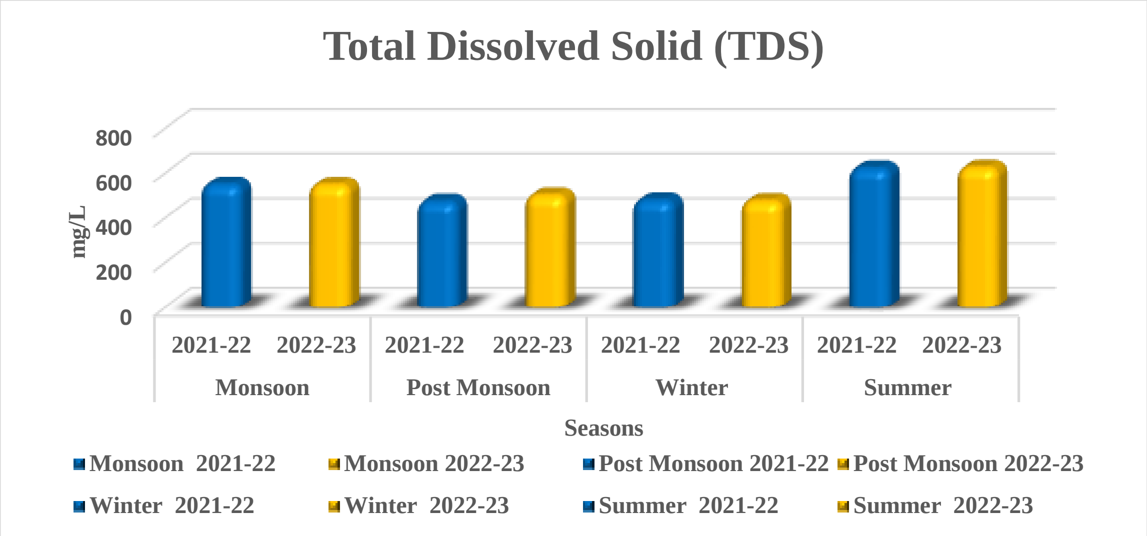

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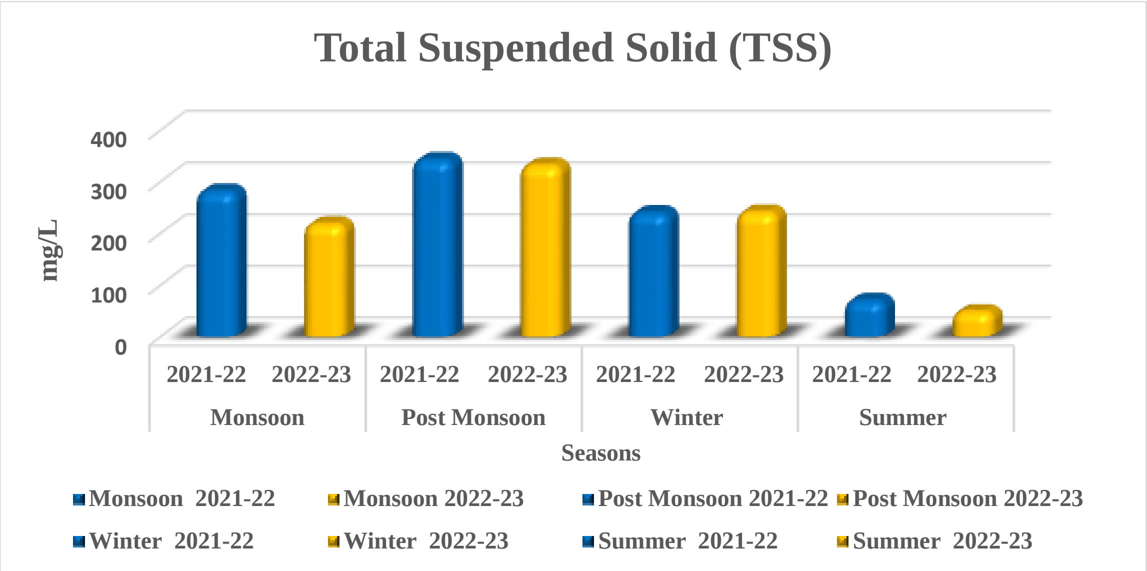

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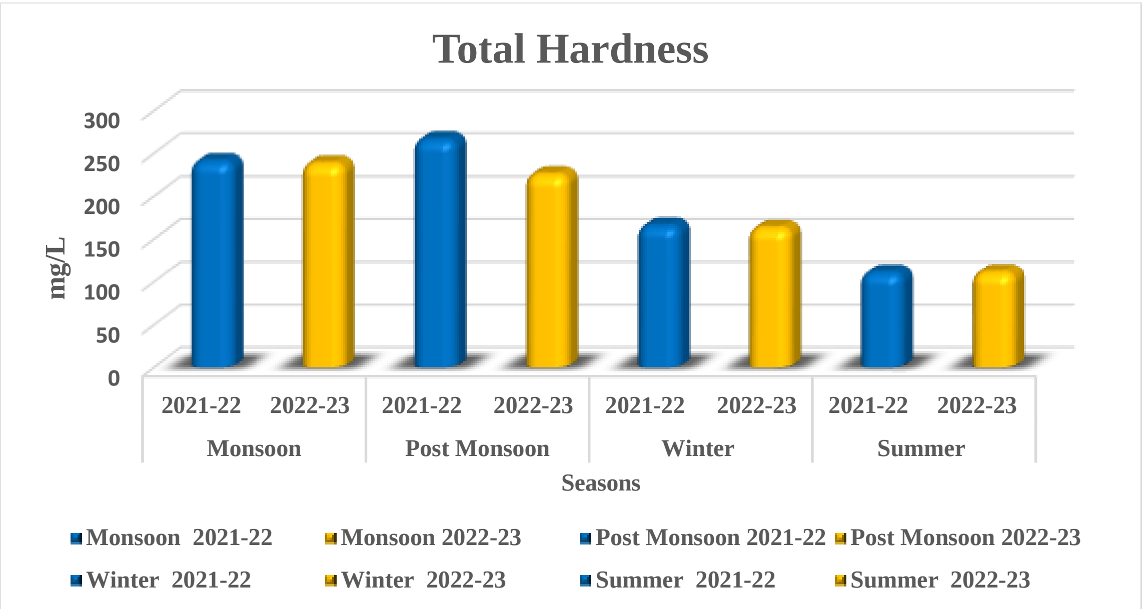

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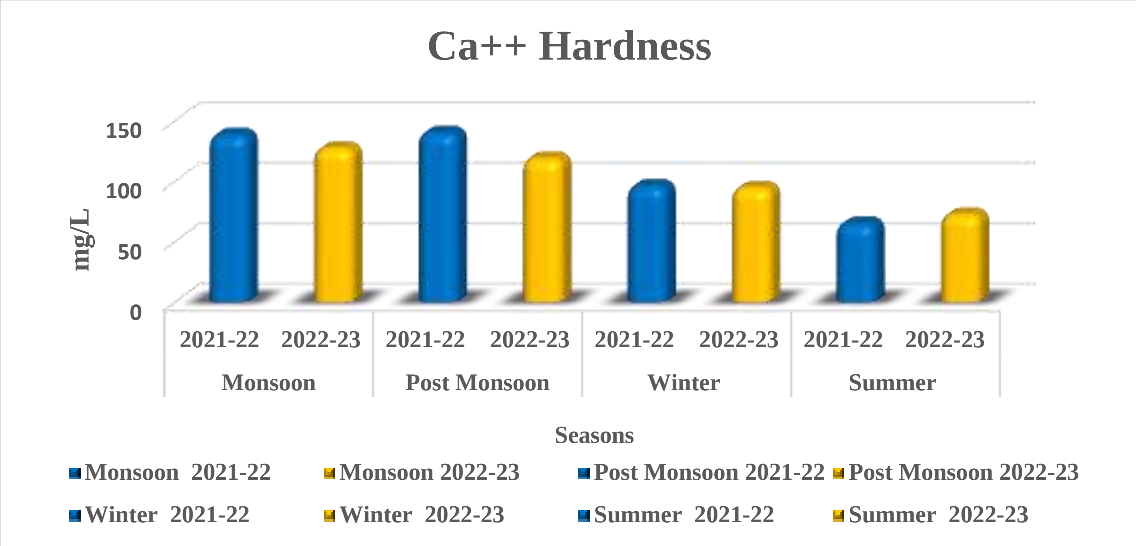

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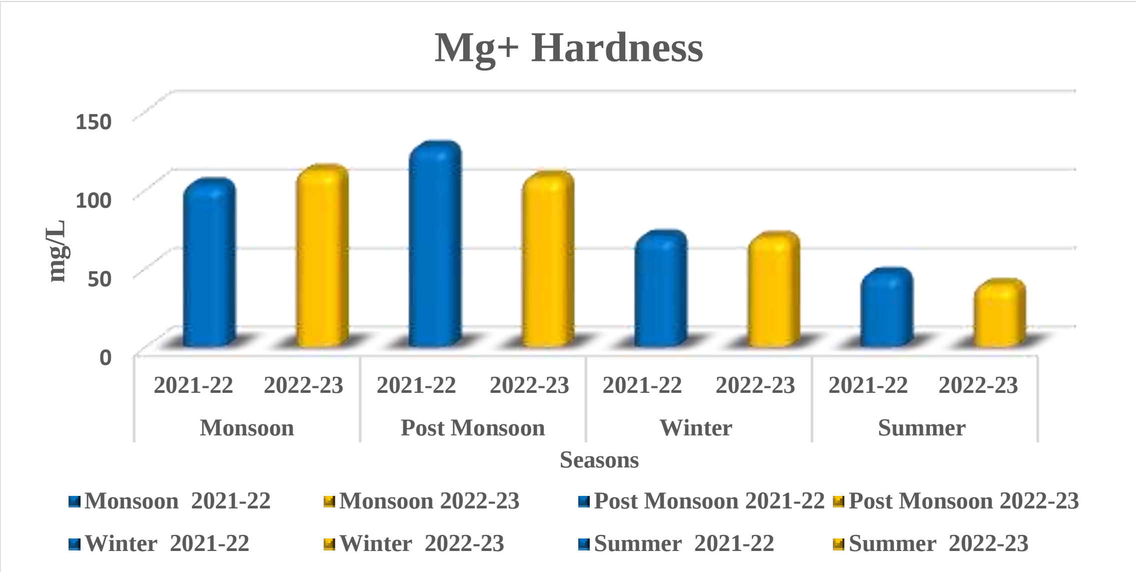

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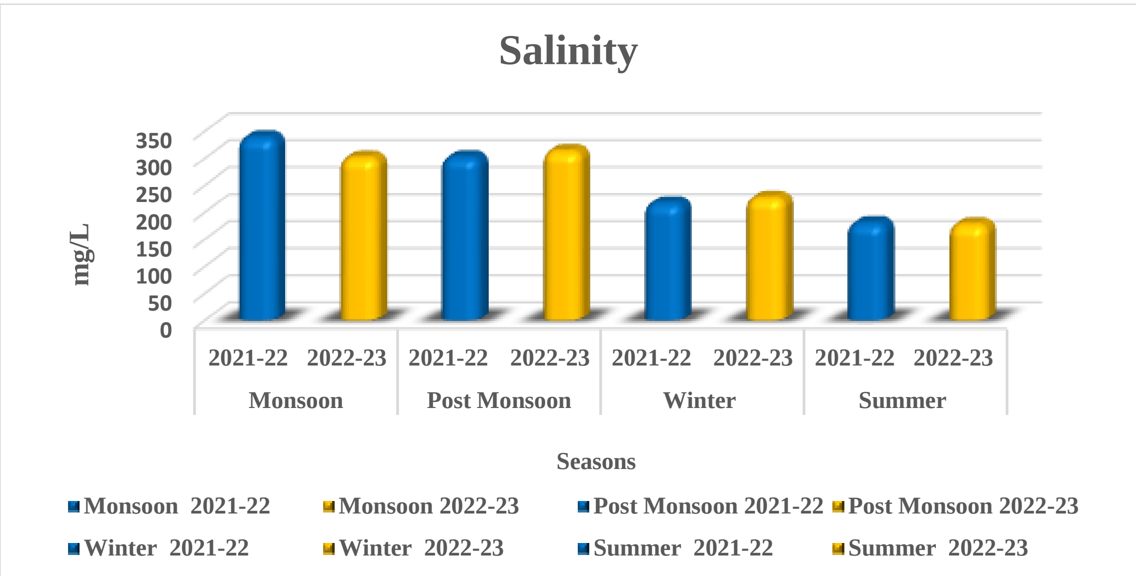

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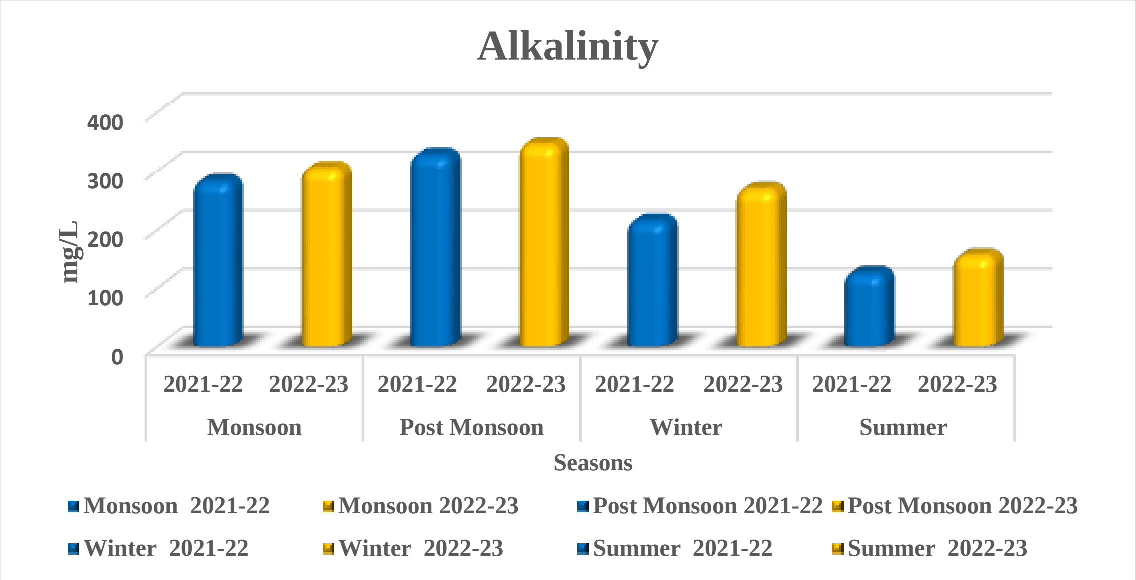

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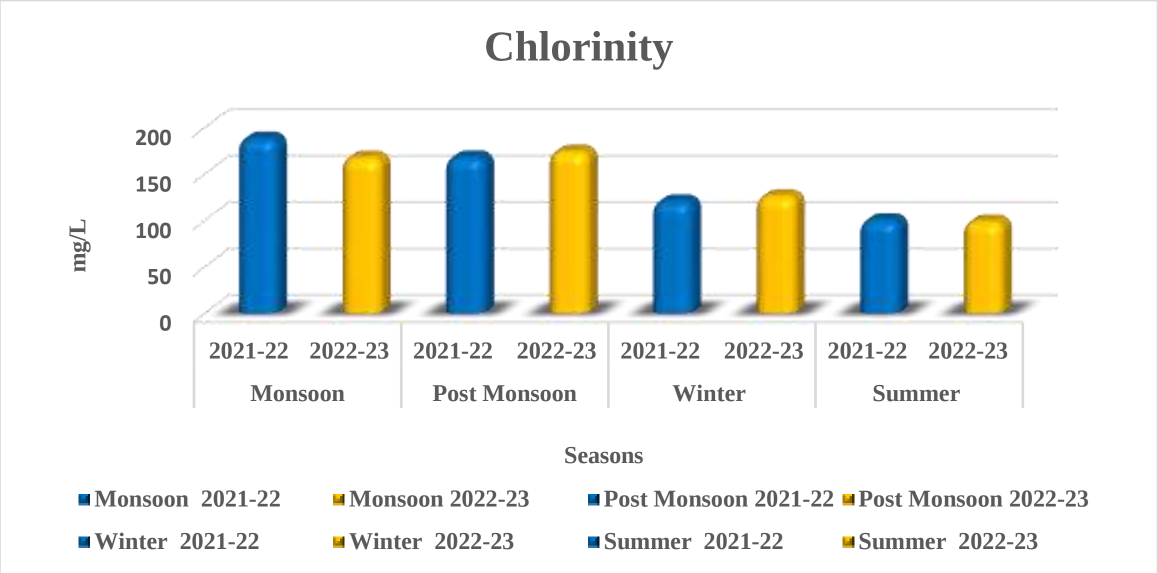

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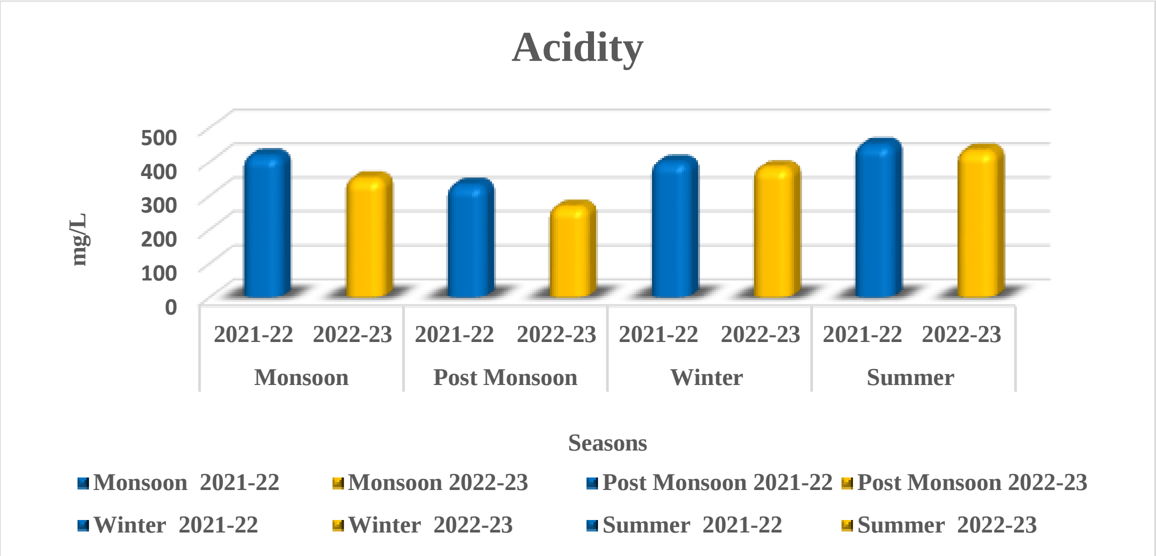

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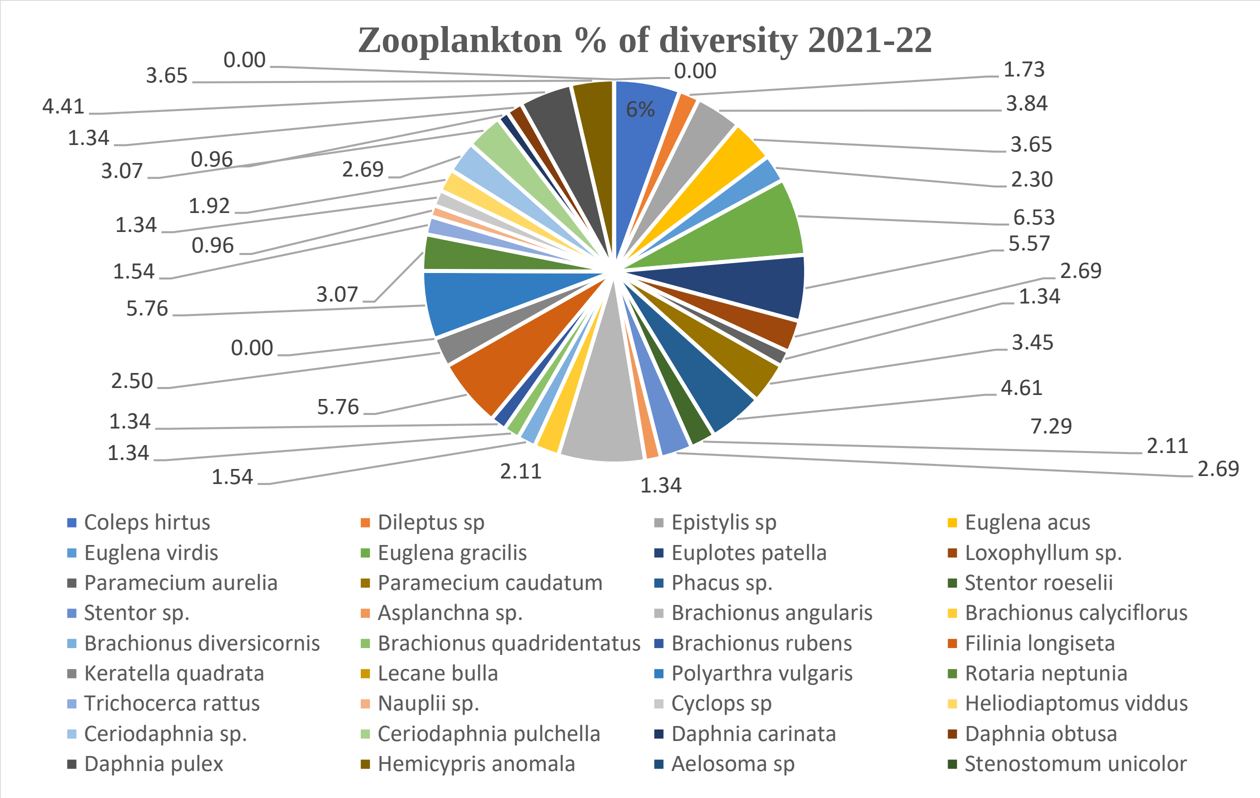

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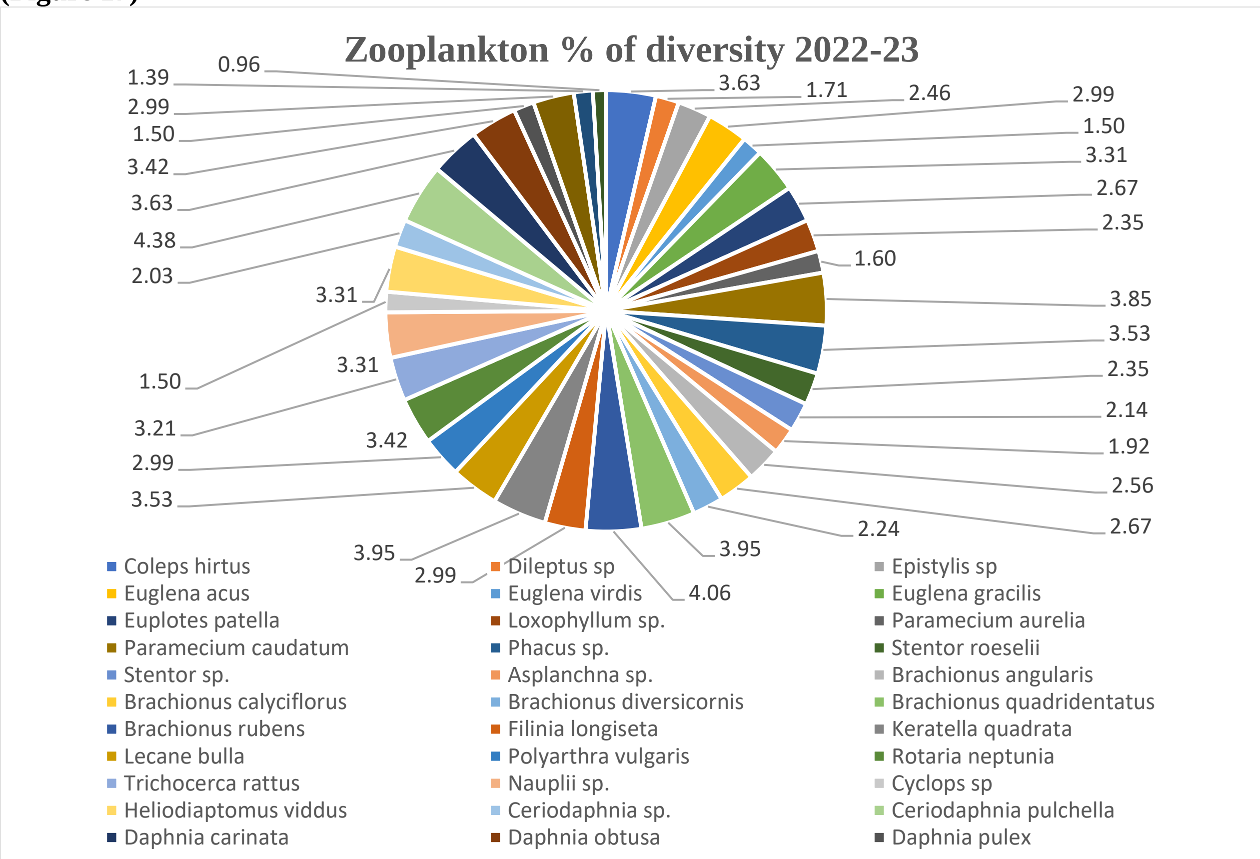

(Figure: 18)

In the present study, during two year analysis of physico- chemical properties, in the year of 2021-22 shows that, Biological Oxygen Demand (BOD), Total Solids (TS), Salinity and Chlorinity during monsoon, Total Suspended Solids(TSS), Calcium Hardness and Magnesium Hardness during post monsoon and Salinity during Summer were found highest while pH during monsoon, Total Dissolved Solids (TDS) during winter and Dissolved Oxygen (DO), Total Hardness, Calcium hardness, alkalinity and chlorinity during summer were found lowest (Figure 2- 16). In the year of 2022-23 alkalinity during post monsoon, pH and DO during winter and Electric Conductivity (EC) and TDS were found highest while EC, BOD and Chlorinity during post monsoon and TS, TSS, Magnesium Hardness and Salinity found lowest(Figure 2- 16). The distribution patterns and species composition of plankton are greatly influenced by the physical-chemical parameters and the amount of nutrients present in the water. (Khuhawar and Matoi, 1995) (Horne and Goldman, 1994) (Manickam et. al., 2015b) (Manickam et., al., 2015a). Water temperature has a significant impact on every metabolic, physiological, and living activity, including eating, reproduction, mobility, and dispersal of organisms. Chemical and biological processes happen quickly when the temperature rises. The temperature of the water regulates the biological oxygen demand kinetics to some degree (Khuhawar and Matoi, 1995). Because carbonates and bicarbonates are present, natural water tends to be alkaline in nature. The pH is determined by the concentration of carbonates and free carbon dioxide (aqueous CO_2). A rise in pH is supported by the increased production of phytoplankton due to the higher photosynthetic activity (Das and Srivastava, 1956). Anthropogenic activities such as washing clothes in detergents and mixing sewage are also blamed for the elevated pH. In this study, improved primary and secondary productivity is explained by the higher pH values observed in the summer and before the monsoon. In a freshwater ecosystem, salinity controls organism dispersal, metabolism, and survival. Depending on how other elements like temperature, oxygen, and ionic substances interact with it, it can have a variety of ecological and physiological impacts.

The abundance of nutrients and the level of pollution in a body of water are two biological variables that determine the species makeup and dominance of zooplankton. The number of zooplankton in both lakes was found to be comparable to other freshwater bodies. (Kalpana et. al., 2017). In present study, total 36 species of zooplankton were identified and recorded. During 2021-22 total 33 species were recorded, among them *Branchionus angularis* (7.29%) > *Euglena gracilis* (6.53%) > *Filinia longiseta* (5.76%) shows highest % diversity of zooplankton species and Nauplius sp., Daphnia carinata (0.96%) < *Daphnia obtuse*, *Cylops sp.*, *Branchionus rubens*, *B. quadridanta*, *Asplanchna sp.*, and *Paramecium aurelia* (1.34%) shows lowest % diversity of zooplankton species (Figure 17). During 2022-23 total 36 species were recorded, among them Ceriodaphnia pulchella (4.38%) > *Branchionus rubens* (4.06%) > *B. quadridantarus* (3.95%) shows highest % diversity of zooplankton species and *Stenostonus* (0.96%) < *Aelosoma sp*. (1.39%) < *Daphnia pulex*, *Cyclops sp.* And *Euglena virdis* (1.50%) shows lowest % diversity of zooplankton species (Figure 18). During year of 2021-22 *Lacane bulla*, *Aelospma Sp.* and *Stenostomous unicolar* these three species were not found but next year 2022-23 these species were found (Figure 17 & 18). During the analysis we found that the Branchionidae family was highest with 2 genus and 6 species followed by Daphnidae family with 2 genus and 5 species. In India, 21 species of Brachionus have been reported (Kalpana et. al., 2017). Abundance of Brachionus spp., particularly, *B. angularis*, *B. calyciflorus*, *B. diversicornis*, *B. quadridentatus* and *B. rubens* have been reported as indicators of eutrophication (Kalpana et. al., 2017).

The genus Brachionus was discovered to have the maximum number of Rotifers in the current study. The presence of the majority of these pollution indicator species implies that the Anandpur dam may be experiencing a eutrophication process. (Kalpana et. al., 2017). As primary consumers and in terms of species count, rotifers and Arthropodan zooplankton are at the top of the aquatic food chain. The bulk of Cladoceran genera are littoral, dwelling amid weeds and some of them on the bottom mud of freshwater lakes, with just a small number of species being planktonic. (Kalpana et. al., 2017).

Conclusion

In the conclusion, our study has provided insightful information on the physico-chemical characteristics and zooplankton diversity of an Anandpur dam. The zooplankton diversity was found to be higher in 2022–2023 than in 2021–2022. The examination of water quality indicators, such as temperature, dissolved oxygen, pH, and other factors, has given a thorough picture of the environmental circumstances inside the dam. These factors are crucial in determining how the environment is shaped and how diverse the zooplankton species are. The analysis of zooplankton diversity has shown how closely environmental conditions affect the make-up of the zooplankton population. The trophic status and overall balance of the dam are reflected in the diversity, quantity, and presence of zooplankton species, which act as indicators of the ecological health of the structure. Through a knowledge of the dynamics of zooplankton diversity and physico-chemical parameters, we may create methods that effectively monitor and manage these ecosystems in a sustainable manner. This information is especially important in light of global issues like climate change and human activity that may have an influence on freshwater ecosystems.

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