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RESEARCH ARTICLE

DETERMINATION OF WATER QUALITY INDEX OF BIJAVARA LAKE, TUMKUR DISTRICT, KARNATAKA

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Abstract

Water is a crucial, abundant and most essential natural resource for the survival of all living organisms. Freshwater ecosystems provide essential resources for drinking, agriculture, manufacturing energy, and transportation. In recent years, due to continuous population growth, rapid industrialization, and the technologies associated with waste disposal, the rate of discharge of pollutants into the environment has significantly increased. Water quality used to measure the health of a water body, reflecting its capacity to support aquatic life, human activities, and other environmental functions and it is determined by the physico-chemical parameters of water. Physico-chemical parameters are essential indicators for evaluating water quality. These factors are essential for evaluating the health of water bodies, as they influence aquatic life and determine the water's suitability for human use. The present study was conducted in Bijavara lake to assess the water quality and the water samples were collected on monthly basis from February 2023 to January 2024. Surface water samples were collected in 2-liter polythene containers, and various physico-chemical parameters including pH, turbidity, total suspended solids, electrical conductivity, chloride, sulphate, magnesium, dissolved oxygen, and biochemical oxygen demand were determined. The Water Quality Index (WQI) was calculated using the Weighted Arithmetic Index Method. The results indicated that during all the seasons, Water Quality Index of water of Bijavara lake was showing good water quality. The water can be used for agriculture and domestic purposes but direct consumption of water is not recommended. Regular monitoring of the lake ensures the supply of safe and sustainable water for domestic use, agriculture, and industry, while also preserving environmental health.

Introduction:-

Water is a vital natural resource, crucial for the survival of mankind on our planet and is one of nature's most valuable gifts (Abebe,2013). It is crucial for sustaining life and there must be a reliable supply that is adequate, safe and accessible to everyone (WHO, 2004). Enhancing better availability of potable water can bring significant health advantages.

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Water naturally contains dissolved substances, suspended particles, and living organisms. Which are essential for maintaining good water quality, as they contribute to the vital biogeochemical cycles(Rajesh Prajapati and Ram Bilas,2018).

Aquatic ecosystems encompass a wide range of freshwater, brackish water and marine habitats, each distinguished by unique biodiversity, biological characteristics and ecological attributes. Within Freshwater ecosystems like ponds, lakes, tanks play a crucial role in the biosphere. All living organisms depend on water for survival and to carry out various metabolic processes (Parvathi *et al.,* 2017).

The analysis of physico-chemical parameters plays a crucial role in evaluating and assessing water quality reflecting the biological condition of the ecosystem. Investigating these water parameters is essential for conducting ecological research on aquatic systems enhancing our understanding of metabolic processes within these environments. Furthermore, physico-chemical parameters serve as a foundation for determining the appropriateness of water for its intended purposes and for enhancing its current condition (Lalitha H M, 2022).

Water quality is the physical, chemical, and biological parameters of water. It is a percentage of the status of water in comparison to requirements of at least one biotic animal kind as well as any human need or reason (Jadi *et al.,* 2022).

Water quality is influenced by a variety of natural and anthropogenic factors. Among the natural factors, geological, hydrological, and climatic conditions are the most significant, as they directly impact both on the quality and the quality of water resources. The water resources are mainly polluted by untreated industrial effluents, domestic sewage, and agricultural runoff containing fertilizers and pesticides. Significant number rural populations are often affected by the consumption of water with poor taste, high levels of chemicals, and harmful pathogens. Good health and well-being cannot be achieved without access to safe water (Chavhan *et al.,* 2022).

The Water Quality Index (WQI), which relies on several significant physico-chemical parameters, provides a significant measure of water quality. It is one of the most effective methods for relaying information about water quality. Hence, WQI is an essential element in the evaluation and managing the surface water resources. Fluctuations in the values of these parameters can greatly impact each other, thereby influencing the integrated status of the aquatic system and resulting in changes to its characteristics.

The interdependence of these parameters affects the overall ecological status of the lake (Ravikumar *et al.,* 2013; Vasista and Ganguly, 2020).

Surface water is considered to be more polluted than groundwater. However, the continuous disposal of industrial waste, municipal sewage and the dumping of solid residue can contaminate ground water sources, which can lead to adverse health effects.

The decline in surface water quality has emerged as a significant global issue due to increased pollution and the effects of climate change. This decline threatens the availability of water resources, especially for drinking purposes. Poor water quality is linked with the public health hazards, primarily through the transmission of waterborne diseases. Assessing water quality is essential for a better understanding of water resource conditions.

Monitoring and assessment of water quality is very much essential for successful management of water resources. Consequently, there is a rising demand for the monitoring of various water quality parameters of fresh water habitats.

Study area:

Bijavara Lake, located in Madhugiri Taluk, is one of the largest lakes in Tumkur District, Karnataka situated 3km north to Madhugiri town, known for Asia's second largest monolithic hill. It is situated at the geographic coordinates of 12.3531° N latitude and 76.8334° E longitude. It is a rain-fed, perennial water body and retains water throughout the year. The agricultural lands surrounding the lake continue to practice the traditional 'Kere-Bavi' irrigation system. The tank was mainly constructed for irrigation purposes. Now a days, the lake is utilized for various activities such as agriculture, fish culture, supply of potable water and, to some extent for domestic usage.

Materials and Methods:-

Surface water samples were collected from Bijavara Lake on a monthly basis between 7:00 AM and 9:00 AM for a period one-year, from February 2023 to January 2024, for the analysis of physico-chemical parameters. Physico-chemical parameters such as pH, turbidity, total suspended solids, electrical conductivity, chlorides, sulphates, magnesium, dissolved oxygen, and biological oxygen demand were analyzed in the laboratory following standard methods prescribed by APHA (2005) and Trivedi and Goel (1986).

In the present study, nine physico-chemical parameters were selected for the assessment of the Water Quality Index (WQI). The WQI was calculated based on the water quality standards recommended by the Bureau of Indian Standards (BIS, 1993) and the Indian Council of Medical Research (ICMR, 1975). The Weighted Arithmetic Index Method (Brown et al., 1970) was employed to determine the WQI of Bijavara Lake. Furthermore, the quality rating or sub-index (Qn) for each parameter was calculated using the following formula.

Quality Rating (Qn) = 100 [Vn – Vo] / [Sn – Vo]

Where:

Qn = Quality rating for the n^{th} water quality parameter.

Vn = Estimated value of the n^{th} parameter.

Sn = Standard permissible value of the n^{th} parameter.

Vo = Ideal value of n^{th} parameter in a pure water.

Ideal values in the most cases Vo = 0 (Except pH =7.0 and DO = 14.6 mg/l)

Unit weight is calculated by,

Unit weight (Wn)= K/Sn

Where:

Wn = Unit weight of the nth parameter.

Sn = Standard value of the nth parameter.

K = Constant for proportionality

The Water Quality Index (WQI) is calculated by the formula,

Water Quality Index (WQI) = $\sum$Wn Qn / $\sum$Wn

Where:

WQI = Water Quality Index
Wn = Unit weight of the n^{th} parameter.
Qn = Quality Rating of the n^{th} parameter.

Table 1:- Water Quality Index (WQI) and status of water quality.

Water Quality Index level	Water quality status
0 – 25	Excellent water quality
26 – 50	Good water quality
51 - 75	Poor water quality
76 - 100	Very poor water quality
>100	Unsuitable for drinking

Source: WHO, (2004); Chatterji and Raziuddin, (2002); Yogendra and Puttaiah, (2008).

Table 2:- Unit weights of selected parameters.

Sl.No.	Parameters	Standard values (Sn) (BIS/ICMR)	K=1/ (Σ1/Sn)	Unit Weight (Wi)
1.	PH	8.5	1.3067	0.153724
2.	Turbidity	5		0.261331
3.	Total suspended Solids (TSS)	500		0.002613
4.	Electrical Conductivity (EC)	300		0.004356
5.	Chloride	250		0.005227
6.	Sulphate	200		0.006533
7.	Magnesium	30		0.043555
8.	Dissolved oxygen	5		0.261331
9.	Biochemical Oxygen Demand	5		0.261331
				ΣWi =1

Results and Discussion:-

Table 3:- Calculation of Water Quality Index of Bijavara lake in Summer season.

SL.NO.	Parameter	Mean Conc. value (Vn)	Standard values (Sn)	Unite Weight Wi=K/Sn	Quality Rating (Qn)	Wi*Qn
1.	P^H	7.7	8.5	0.153724	46.66666667	7.173785
2.	Turbidity (NTU)	1.7	5	0.261331	34	8.885245
3.	Total suspended solids (mg/l)	28.6	500	0.002613	5.72	0.014948
4.	Electrical Conductivity (EC) (µs/cm)	148	300	0.004356	49.33	0.214872
5.	Chloride (mg/l)	21.2	250	0.005227	8.48	0.044322
6.	Sulphate (mg/l)	6.3	200	0.006533	3.15	0.02058
7.	Magnesium (mg/l)	6.62	30	0.043555	22.066	0.961116
8.	Dissolved Oxygen (mg/l)	6.8	5	0.261331	81.25	21.23312
9.	Biochemical Oxygen Demand (mg/l)	1.002	5	0.261331	20.04	5.237068

	ΣWi =1	ΣWi*Qn =43.78506

Table 4:- Water Quality Index of Bijavara lake in Rainy season.

Sl.NO.	Parameter	Mean Conc. Values (Vn)	Standard Values (Sn)	Unit Weight (Wi)	Quality Rating (Qn)	Wi *Qn
1.	P^H	7.4	8.5	0.153724	26.66	4.099306
2.	Turbidity (NTU)	1.2	5	0.261331	24	6.271938
3.	Total suspended solids (mg/l)	36	500	0.002613	7.2	0.018816
4.	Electrical Conductivity (EC) (µs/cm)	168	300	0.004356	56	0.243909
5.	Chlorides (mg/l)	22.1	250	0.005227	8.84	0.046203
6.	Sulphates (mg/l)	8.2	200	0.006533	4.1	0.026786
7.	Magnesium (mg/l)	5.34	30	0.043555	17.8	0.775281
8.	Dissolved Oxygen (mg/l)	6	5	0.261331	89.58	23.41088
9.	Biochemical OxygenDemand(mg/l)	2.9	5	0.261331	58	15.15718
				ΣWi =1	ΣWi*Qn = 50.05	

Table 5:- Water Quality Index of Bijavara lake in Winter season.

SL. NO.	Parameter	Mean Conc.value (Vn)	Standard Values (Sn)	Unit Weight (Wi)	Quality Rating (Qn)	Wi *Qn
1.	P^H	7.5	8.5	0.153724	33.4	5.13438
2.	Turbidity (NTU)	1.7	5	0.261331	34	8.885245
3.	Total suspended solids (mg/l)	19.2	500	0.002613	3.84	0.010035
4.	Electrical Conductivity (EC) (µs/cm)	175	300	0.004356	58.33	0.254072
5.	Chloride (mg/l)	19	250	0.005227	7.6	0.039722
6.	Sulphate (mg/l)	6.4	200	0.006533	3.2	0.020906
7.	Magnesium (mg/l)	4.62	30	0.043555	15.4	0.670749
8.	Dissolved Oxygen (mg/l)	5.8	5	0.261331	91.66	23.95532
9.	Biochemical Oxygen Demand(mg/l)	1.8	5	0.261331	36	9.407907
				ΣWi =1	ΣWi*Qn = 48.37833	

pH:

pH is a measure of the hydrogen ion concentration. It represents the concentration of hydrogen ions in a solution. Lower pH values indicate more acidic, while higher pH values reflect greater alkaline solutions.

In the present study, pH ranged between 7.4 to 7.7 indicating that the water is slightly alkaline in nature. Nayaka (2018) recorded pH ranging between 7.2 to 8.4 in Bijavara lake. Ongom *et al.,* (2017), Song *et al.,* (2020) and Muduli and Patnaik (2020) also reported pH range that indicate neutral to slightly alkaline conditions. These results were in accordance with the results of the present work.

Turbidity:
Turbidity is a parameter used to measure the clarity of liquids, especially water. It measures the concentration of suspended particles, including sediments, microorganisms, organic matter, and pollutants, which impact both on the appearance and hygienic quality of the water. High turbidity levels often point to contamination or pollution, while low turbidity signifies clearer water with fewer suspended particles, indicating better water quality. In present study turbidity ranges from 1.2-1.7 NTU. Turbidity of the lake water found increased during summer and winter and decreased in the monsoon. In Bijavara lake, Nayaka (2018) recorded the turbidity in the range between 1 to 4 NTU. Similar results were documented by Krishnaveni *et.al.,* (2024); Lalitha and Ramakrishna (2017). But, Kapaniet al., (2024) observed that turbidity levels tend to increase during the monsoon, which can be attributed to the deposition of sediment and the influx of pollutants carried by rainfall.

Total Suspended Solids: (TSS)
Total Suspended Solids (TSS) refer to inorganic and organic particles that remain suspended in water bodies. TSS is a key water quality parameter as it affects water clarity and light penetration. High levels of TSS can decrease the sunlight penetration, thus limiting photosynthesis in aquatic plants and algae, which in turn impacts oxygen production and food availability for aquatic organisms. TSS can carry pollutants such as pesticides and heavy metals, causing further degradation of water quality.

In the present study, TSS values ranged between 19.2 mg/l to 36.0mg/l and found to be increased during the rainy season and decreased during the winter.

Deepthi and Yamakanamardi (2014) reported the highest Total Suspended Solids values in April in Varuna and Madappa Lakes, and March and May in Giribettethe Lake. The lowest TSS values were observed in November in all the three lakes.

Electrical conductivity:(**EC)**
Electrical conductivity in water refers to its ability to conduct the electric current, primarily due to the presence of dissolved salts and minerals. Electrical conductivity is a significant parameter for assessing water quality, as it determines the suitability of water for various uses. High conductivity levels can indicate high levels of dissolved solids, which may impact on the taste, usability, and quality of water.

In the present work, the electrical conductivity was found between 148 to 175 µs/cm. This observation is in conformity with the observations of Kapani *et al.,* (2024) and Sinha *et al.,* (2013).

Chloride:
Chlorides are naturally present in water added through various sources, including the excretion of chloride by humans and animals, along with nitrogenous compounds (Basu *et al.,* 2010). However, the primary source of chloride in natural freshwater is often attributed to the discharge of domestic sewage (Trivedi and Goel,1986). Chloride concentration is commonly used as an indicator of sewage pollution. Chlorides are significant inorganic anions whose concentrations can vary in different natural water bodies.

In the present investigation, chloride concentration ranges from 19 mg/L to 22.1 mg/L and recorded high during monsoon and low in winter. Similar observations were made by Shiddamallayya and Pratima (2008), Simpi *et al.,* (2011), Thakur *et al.,* (2013) and Lalitha and Ramakrishna (2017).

Sulphate:
Sulphates in freshwater primarily originate from the weathering of sulphur-containing rocks and they can contribute to water hardness. High sulphate concentrations can disrupt aquatic ecosystems by affecting the growth of aquatic plants and animals. In the present study, Sulphate values ranged between 6.3 mg/l to 8.2 mg/l and found high during Rainy season and low during winter. Gayathri *et al.,* (2011) also observed high sulphate concentrations during monsoon and low concentrations during winter in Tungabhadra reservoir.

Magnesium:
Magnesium is one of the the main constituent of natural water and the second most significant metal present in it. It enters water through the various rocks, sewage and industrial waste. It plays a key role in contributing to water hardness. In the present study, Magnesium values ranged between 4.62 mg/l to 6.62 mg/l and found high during

summer season and low during winter.Rajesh Prajapati and Ram Bilas (2018)observed average values of the magnesium 43.24 mg/l in drinking water of Varanasi District.

Dissolved oxygen: (DO)

Dissolved oxygen is a vital abiotic component in aquatic ecosystems, essential for the survival of aquatic organisms and widely used as a key indicator of water quality. Dissolved oxygen (DO) levels are the key indicators of water quality, reflecting a water body's ability to support healthy and diverse aquatic life. The present study reported that the dissolved oxygen is ranged between 5.8 mg/l to 6.8mg/l. DO is higher in summer and comparatively low during winter, indicating the high photosynthetic activity. In Dalvoy lake, Kalasaiah and Balasubramanian (2010) recorded the dissolved oxygen, ranged between 1 and 8.6 mg/L in pre-monsoon and 1.0to 6.4 mg/L in post monsoon seasons. Similar observations were made by Farnaz and Rahmatullah (2021); Kapani *et al.,* (2024).

Biochemical Oxygen Demand:(BOD)

BOD levels indicate higher concentrations of organic matter, which can lead to oxygen depletion in aquatic environments, posing a threat to aquatic life. BOD is a critical tool in environmental monitoring and wastewater treatment, helping to assess water quality and the efficiency of treatment systems(Santhi *et al.,* 2023). In the present study, BOD was ranging between 1.002mg/l to 2.9 mg/l. In Bijavara lake, Nayaka (2018) recorded BOD ranging between 2mg/l to 4 mg/l. Similar observations were also made by Rajini (2020) and of the opinion that low BOD during summer and high in the monsoon indicating the increased eutrophication in monsoon.

Conclusion:-

In the present study, The Water Quality Index during summer, Rainy and winter season were ranging between 26 – 50 showing the water quality status as Good water quality as per WHO, (2004). Thus, the water is suitable for agricultural activities and after proper water treatment, it can be safely used for drinking purposes. Implementing Policies from the government, creating awareness among the villagers, practice of efficient water use in agriculture to reduce water wastage should be enforced to protect lakes.

Conflict of Interest:

The author has no conflict of interest.

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