An Assessment of Physicochemical Parameters of Water in Association with the Ichthyofauna Diversity of river Daya of Odisha, India

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ABSTRACT

The present study investigated the seasonal variation in water quality of the Daya River, Odisha, through the analysis of various physicochemical and chemical parameters, and its association with ichthyofaunal diversity. Water samples were collected from selected locations from November 2023 to April 2024, representing pre-monsoon, monsoon, post-monsoon, and winter seasons. A total of 41 fish species belonging to 7 orders, 16 families, and 28 genera were recorded, with Cyprinidae being the most dominant family. Labeo rohita showed the highest abundance in terms of total catch. The water quality remained within permissible limits, although notable seasonal fluctuations were observed in parameters such as dissolved oxygen, BOD, pH, and transparency. Winter season showed better water quality and higher fish diversity, while the monsoon season exhibited increased organic load and turbidity. The ecological indices indicated seasonal shifts in species composition, with signs of pressure from anthropogenic activities such as overfishing and pollution. Conservation and proper management strategies are essential to sustain the ecological balance and protect the native fish diversity of the Daya River..

Keywords: *Physicochemical parameters, Ichthyofaunal diversity, Water quality, Seasonal variation, Freshwater ecosystem*

How to Cite: Amar Kumar Sahoo, Nirmal Chandra Biswal, Ram Prasad Biswal, (2025) MRI as a Monitoring Tool for Detecting Therapeutic Response in the Recurrence of Carcinoma Cervix, *Journal of Carcinogenesis*, *Vol.24, No.5s*, 728-739

1. INTRODUCTION

Freshwater lotic ecosystems are indispensable for maintaining ecological homeostasis and supporting anthropogenic welfare, as they are pivotal in sustaining biodiversity and delivering diverse ecosystem services (Sutton and Anderson, 2020). Rivers, as dynamic fluvial conduits, not only facilitate hydrological transport but also underpin crucial biogeochemical cycling, nutrient sequestration, and habitat provisioning. Nevertheless, escalating anthropogenic stressors, including rapid urban sprawl, intensive agricultural intensification, industrial proliferation, and the pervasive impacts of climate change, exert unprecedented pressure on these aquatic matrices (Bibi et al., 2016). Over time, these perturbations have profoundly altered the physicochemical characteristics of riverine waters, culminating in water quality degradation. This deterioration significantly impairs ecosystem functionality and disrupts the delicate equilibrium of riverine ecotones (Wang et al., 2010).

Globally, a significant proportion of the human population faces critical deficiencies in access to potable water and adequate sanitation. Approximately one-sixth of the world's inhabitants, equating to 1.1 billion individuals, lack access to safe drinking water, while 2.4 billion people are without sufficient sanitation infrastructure. This pervasive issue is exacerbated by anthropogenic pollution stemming from domestic, industrial, and agricultural effluents, which collectively degrade public health and environmental integrity (EPHA, 2009). A foundational approach to assessing the ecological health of freshwater ecosystems involves the quantitative analysis and interpretation of key physicochemical parameters. These indicators serve as proxies for water quality (Ehiagbonare and Ogundiran, 2010) and encompass measurements such as temperature, pH, dissolved oxygen (DO), biochemical oxygen demand (BOD),.

chemical oxygen demand (COD), total dissolved solids (TDS), turbidity, and the concentrations of nitrates and phosphates. Each parameter offers distinct insights into the water body's condition, influencing diverse ecological processes from the metabolic rates of aquatic biota to nutrient cycling and the predisposition to eutrophication (Rawat, 2017).

Temperature profoundly influences the kinetics of biochemical reactions and metabolic rates within aquatic organisms. Simultaneously, pH dictates the solubility of essential nutrients and the bioavailability of potential toxins. The concentration of dissolved oxygen is critical for sustaining aerobic life, while biochemical oxygen demand (BOD) and chemical oxygen demand (COD) serve as proxies for the organic pollutant load. Total dissolved solids (TDS) and turbidity are indicators of particulate matter in suspension. Furthermore, the levels of nitrates and phosphates, key nutrients, are pivotal in assessing the risk of eutrophication and subsequent hypoxia. Collectively, these physiochemical parameters are fundamental to a comprehensive ecohydrological assessment of freshwater ecosystems.A growing body of research underscores the critical importance of monitoring key physiochemical parameters within aquatic environments. Early investigations revealed that even minor deviations in pH and dissolved oxygen (DO) concentrations can profoundly disrupt fundamental biogeochemical cycles, triggering cascading detrimental effects throughout aquatic food webs (Khan et al., 2021). More recent studies, utilizing advanced high-frequency monitoring methodologies, have elucidated that both spatial and seasonal variations in these parameters are frequently attributable to a confluence of natural environmental fluctuations and anthropogenically-driven pressures. For instance, elevated biochemical oxygen demand (BOD) and chemical oxygen demand (COD) values are commonly correlated with the discharge of urban wastewater and agricultural runoff (Kumari et al., 2013). Similarly, heightened concentrations of nitrate and phosphate are demonstrably linked to the application of fertilizers in adjacent agricultural areas. These collective findings unequivocally emphasize that the systematic monitoring of physicochemical indices is indispensable for accurately assessing water quality and identifying the root causes of aquatic ecosystem degradation (Gupta et al., 2017).

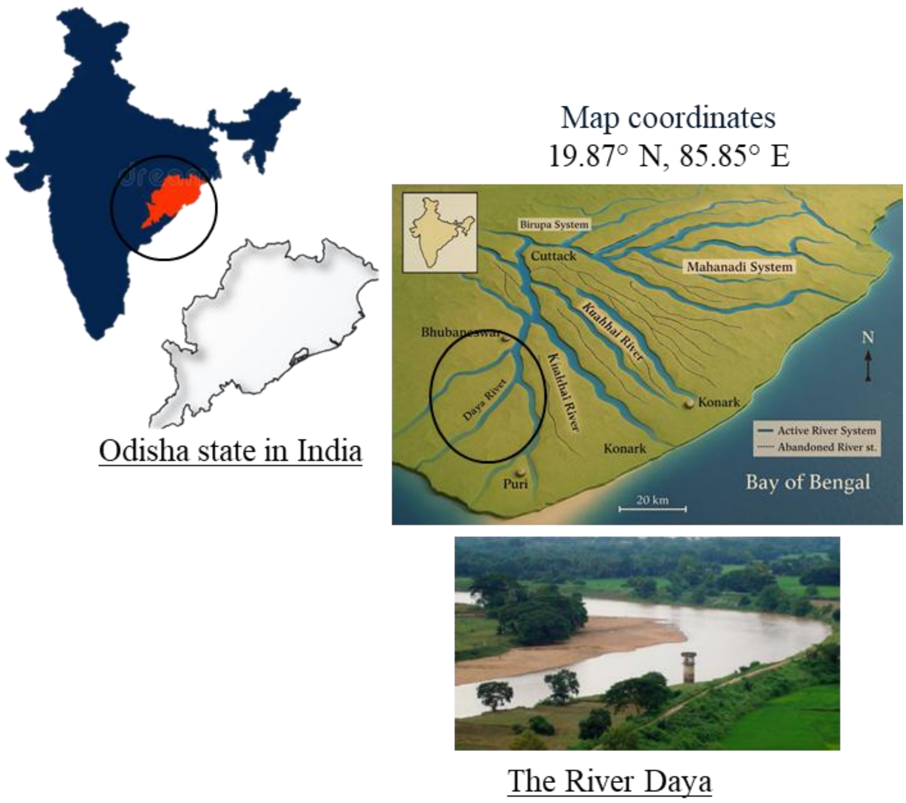

Figure.1 Map and Google satellite imagery of The River Daya

The Daya River in Odisha exemplifies the intricate environmental challenges faced by aquatic ecosystems. This river traverses varied physiographic zones, interfacing with both agrarian communities and burgeoning urban agglomerations, thereby incurring exposure to a heterogeneous array of anthropogenic pollutants. These include, but are not limited to, untreated domestic wastewater, agricultural diffuse pollution, and industrial effluents (Pradhan et al., 2024). Such persistent environmental perturbations possess the propensity to induce substantial alterations in the physicochemical characteristics of the riverine milieu, consequently impacting both ambient water quality and the ecological integrity of indigenous aquatic biota. Despite extensive limnological investigations into major Indian river systems, there remains a notable lacuna in comprehensive scientific inquiry specifically pertaining to the Daya River (Das et al., 2021). Previous scholarly endeavours have predominantly focused on isolated water quality parameters, such as fluctuations in nitrate concentrations or dissolved oxygen levels, often precluding an integrated and holistic assessment of multiple interacting physicochemical variables. Furthermore, the consequential effects of these water quality dynamics on the river's ichthyofaunal diversity and its fish populations have been largely understated (Khanna and Ishaq, 2013). Given the well-established sensitivity of aquatic organisms, particularly fish assemblages, to subtle shifts in ambient water quality, elucidating the intricate nexus between physicochemical parameters and ichthyofaunal diversity is paramount for the formulation of efficacious ecosystem management strategies (Jacob et al., 2023).

This investigation seeks to bridge existing knowledge gaps by comprehensively evaluating the physicochemical characteristics and ichthyofaunal diversity of the Daya River. The study will systematically quantify crucial water quality parameters, such as temperature, pH, dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), total dissolved solids (TDS), turbidity, nitrates, and phosphates. These measurements will be conducted at multiple sampling points along the river's course, across various seasons, to delineate temporal fluctuations and pinpoint periods of elevated pollution stress. Concurrently, the research will assess the diversity and abundance of piscine species inhabiting the river, examining their correlation with observed alterations in the physicochemical milieu.

2. MATERIALS AND METHODS

Study Area

This investigation focused on the Daya River, a major distributary within the Mahanadi River system in Odisha, India, originating from the Kuakhai River (**Figure.1**). The Daya River commences near Saradeipur in the Khurda district, following a southeasterly trajectory before concluding its course in Chilika Lake, the largest brackish water lagoon in Asia. The river traverses diverse environments, ranging from its relatively undisturbed upper reaches to its more impacted midstream and downstream segments, which are subject to anthropogenic influences such as urbanization, agricultural practices, and industrialization. To assess the spatial variability in anthropogenic pressures and baseline environmental conditions, three sampling sites were strategically chosen along the river's length. One site was positioned near the river's proximal end, representing pristine conditions with minimal human disturbance. The remaining two sites were situated distally, reflecting the cumulative effects of surrounding human activities **.**

Sampling Sites and Collection

To account for spatial and temporal variability in water quality, physicochemical parameters were monitored monthly in the Daya River from November 2023 to April 2024. Sampling occurred during early morning hours (08:00–10:00) to mitigate the influence of diurnal fluctuations on parameters such as water temperature and dissolved oxygen (DO). The measured parameters included air temperature, water temperature, pH, dissolved oxygen, free carbon dioxide, alkalinity, conductivity, chloride, and total dissolved solids. These analyses followed established methodologies (Welch, 1952; Talling et al., 1980; APHA, 1990). Concurrently, aquatic biodiversity was assessed, specifically focusing on ichthyofauna. Monthly fish collections were conducted from September 2023 to June 2024 using various fishing gear. Fish specimens were examined in both fresh and preserved states, in the field and laboratory, respectively. Taxonomic identification of fish species adhered to the framework proposed by Hubbs and Nelson (2006), with adaptations based on the works of Talwar and Jhingran and Jayaram (Armantrout et al., 1994; Jayaram, 1999). Further support for fish identification was drawn from earlier literature (Day and Achilles, 2012).

3. DATA ANALYSIS

Statistical variations in physicochemical parameters were assessed via **ANOVA**, conducted using PAST version 2.17c (Hammer et al., 2001). The proportional representation of fish communities across different sites was determined using Microsoft Excel.

4. RESULTS AND DISCUSSION

The Daya River exhibited distinct seasonal variations in its physicochemical properties from November 2023 to April 2024, reflecting the river's dynamic response to seasonal climatic shifts. Air and water temperatures displayed pronounced fluctuations, with air temperature ranging from a minimum of 22.80 ± 1.40°C in winter to a maximum of 32.50 ± 2.00°C during the monsoon. Similarly, water temperature varied from 23.10 ± 1.50°C in winter to 30.10 ± 2.40°C in the monsoon, a typical thermal pattern for tropical river systems driven by solar radiation and ambient temperature shifts. Dissolved oxygen (DO), a critical indicator of aquatic ecosystem health, showed an inverse correlation with temperature. DO concentrations peaked in winter (8.10 ± 0.50 mg/L) due to enhanced oxygen solubility at cooler temperatures and increased photosynthetic activity in clearer waters. Conversely, monsoon season exhibited the lowest DO levels (6.30 ± 0.55 mg/L), likely attributable to elevated water temperatures and increased microbial decomposition of organic matter. Biochemical Oxygen Demand (BOD), indicative of the organic load and microbial respiration, mirrored the DO trend inversely. BOD values were highest during the monsoon (5.50 ± 0.35 mg/L), signifying an increased organic burden, while winter recorded the lowest BOD (3.20 ± 0.30 mg/L), consistent with reduced biological degradation and cleaner water conditions.

Variations in dissolved inorganic carbon concentrations were observed across the seasons, ranging from 6.30 ± 0.35 to 7.10 ± 0.25 mg/L. The monsoon period exhibited slightly elevated levels, potentially attributable to enhanced microbial decomposition and the breakdown of organic detritus. The hydrogen ion concentration (pH) of the lotic system consistently remained within the World Health Organization's permissible limits for drinking water (6.5−8.5). Seasonal fluctuations were minimal, with a mean pH of 6.90 ± 0.08 during the monsoon and 7.30 ± 0.07 in winter, indicating the river's persistent eucapnic to mildly acidobasic state throughout the investigation. The reduction in pH during the monsoon season may be influenced by allochthonous inputs from acidic precipitation and the degradation of organic matter, whereas the subtle shift towards alkaline conditions in winter could be a consequence of increased photosynthetic activity and diminished hydrological inflow (Dey et al. 2015). Water column transparency, inversely correlated with suspended particulate matter and turbidity, reached its nadir during the monsoon season (40.10 ± 3.50 cm) due to increased sediment loading from runoff and heightened hydrodynamic turbulence. Conversely, peak transparency was recorded in winter (67.30 ± 3.20 cm), coinciding with reduced flow velocity and lower suspended sediment concentrations. Seasonal atmospheric moisture content mirrored regional climatic patterns, peaking during the monsoon (75.20 ± 4.80 mmHg) owing to elevated aerial humidity, and reaching its lowest point during the pre-monsoon period (60.80 ± 2.90 mmHg) (Rahman et al., 2024).

The physicochemical parameters of the Daya River exhibit distinct seasonal variability. Total alkalinity peaks in winter (30.10 ± 1.50 mg/L), attributed to reduced dilution and the consequent accumulation of bicarbonates and carbonates. Conversely, the monsoon season sees the lowest alkalinity (27.20 ± 1.90 mg/L), likely a result of dilution from rainfall and surface runoff.

Total hardness shows a modest increase post-monsoon (29.20 ± 1.50 mg/L), potentially due to the leaching of minerals from the surrounding geological formations, while remaining relatively stable during pre-monsoon and winter periods (Sarkar and Saha, 2021). Total Dissolved Solids (TDS) and Total Suspended Solids (TSS) concentrations are significantly influenced by seasonal flow patterns. The highest concentrations of TDS (32.10 ± 3.20 ppm) and TSS (65.00 ± 3.10 ppm) are observed during the monsoon, indicating an amplified input of sediments, minerals, and anthropogenic pollutants from the surrounding catchment. These concentrations subsequently decrease during winter and pre-monsoon, as sedimentation processes intensify and surface runoff diminishes. Specific conductivity, a proxy for ionic content and salinity, reaches its zenith during the monsoon (0.72 ± 0.05 mS), reflecting an increased influx of ions driven by rain-induced erosion and surface runoff. The lowest conductivity is recorded in winter (0.65 ± 0.03 mS), suggesting reduced dissolved ion concentrations due to limited external inputs and more stable hydrological conditions (Ghule et al., 2022). Salinity demonstrates minimal seasonal fluctuation, ranging from 0.98 ± 0.06 ppt in pre-monsoon and winter to 1.10 ± 0.04 ppt in monsoon, a phenomenon potentially linked to mineral inflow and minor tidal influences from adjacent estuarine regions. Collectively, these seasonal variations in the Daya River's physicochemical parameters indicate that monsoon months are characterized by elevated nutrient loading, turbidity, and microbial activity. In contrast, winter conditions are associated with enhanced water clarity, improved oxygen levels, and greater chemical stability (Girija et al., 2007). These fluctuations underscore the profound impact of seasonal hydrology and temperature on the river's overall water quality and ecological integrity **(Table 1)**.

Table 1. Monthly average variation of physicochemical parameters of river daya during the study period (November 2023- April 2024) [Mean±SD].

Parameter	Pre-Monsoon	Monsoon	Post-Monsoon	Winter
Water Temperature (°C)	28.50 ± 1.25 [a]	30.10 ± 2.40 [a]	27.80 ± 1.60 [a]	23.10 ± 1.50 [a]
Air Temperature (°C)	30.20 ± 1.60 [a]	32.50 ± 2.00 [a]	29.00 ± 1.70 [a]	22.80 ± 1.40 [a]
Transparency (cm)	60.50 ± 4.10 [a]	40.10 ± 3.50 [a]	65.20 ± 3.00 [a]	67.30 ±3.20 [a]
pH	7.10 ± 0.05	6.90 ± 0.08 [a]	7.20 ± 0.06 [a]	7.30 ± 0.07 [a]
Humidity (mmHg)	60.80 ± 2.90 [a]	75.20 ± 4.80 [a]	72.50 ± 3.30	62.00 ± 3.10 [a]
Dissolved Oxygen (mg/L)	7.80 ± 0.40 [a]	6.30 ± 0.55 [a]	7.90 ± 0.60 [a]	8.10 ± 0.50 [a]
BOD (mg/L)	3.70 ± 0.25 [a]	5.50 ± 0.35 [a]	4.00 ± 0.40 [a]	3.20 ± 0.30 [a]
Free CO2 (mg/L)	6.40 ± 0.30 [a]	7.10 ± 0.25 [a]	6.30 ± 0.35 [a]	6.80 ± 0.40 [a]
Total Alkalinity (mg/L)	28.50 ± 1.10 [a]	27.20 ± 1.90 [a]	29.00 ±1.30 [a]	30.10 ± 1.50 [a]
Total Hardness (mg/L)	26.80 ± 1.00 [a]	27.50 ± 1.20 [a]	29.20 ± 1.50 [a]	28.00 ± 1.10 [a]

TDS (ppm)	24.00 ± 1.30 [a]	32.10 ± 3.20 [a]	27.50 ± 2.50 [a]	25.80 ± 2.00 [a]
TSS (ppm)	58.20 ± 1.80 [a]	65.00 ± 3.10[a]	61.80 ± 2.30 [a]	59.40 ± 1.90[a]
Specific Conductivity (mS)	0.68 ± 0.03	0.72 ± 0.05	0.70 ± 0.04	0.65 ± 0.03
Salinity (ppt)	0.98 ± 0.06[a]	1.10 ± 0.04	1.00 ± 0.05	0.98 ± 0.04

[a]**Superscript indicates significant difference within and among the seasons (P<0.05). Figures in parenthesis shows the range variation**.

The Daya River's ionic and nutrient composition exhibits pronounced seasonal fluctuations, providing insights into the interplay between hydrological cycles and geochemical processes. Specifically, concentrations of magnesium (Mg^{2+}) and calcium (Ca^{2+}), key determinants of total water hardness and indicators of geological weathering, demonstrate distinct seasonal patterns. Magnesium concentrations peaked during the pre-monsoon season (16.22 ± 0.83 mg/L), subsequently reaching their nadir post-monsoon (12.87 ± 0.79 mg/L). This observed decline is likely attributable to the dilution effect of increased monsoonal runoff. Similarly, calcium concentrations were maximal in the pre-monsoon period (18.54 ± 0.40 mg/L), with the lowest values recorded during winter (15.24 ± 0.11 mg/L). These seasonal variations in both Mg^{2+} and Ca^{2+} are indicative of enhanced leaching from bedrock and pedogenic sources within the catchment. This process is more pronounced during drier periods due to reduced hydrological dilution, thereby increasing the solute load in the river (Adhikari et al. 2007; Wendelaar et al. 1983).

Ionic concentrations of sodium and potassium exhibited remarkable seasonal stability. Sodium levels fluctuated minimally, ranging from 0.58 ± 0.02 to 0.64 ± 0.04 mg/L, while potassium concentrations varied between 1.20 ± 0.04 and 1.34 ± 0.04 mg/L. The peak potassium concentration observed during the post-monsoon season is potentially attributable to the liberation of ions from decomposing organic matter and agricultural runoff. Despite their subtle seasonal variations, these cations play a crucial role in the sustenance of aquatic flora and serve as indicators of both natural geological processes and anthropogenic influences.

Chloride concentrations displayed more pronounced seasonal variability. Levels increased from 5.73 ± 0.46 mg/L in the pre-monsoon period to 8.08±0.34 mg/L during winter (Saha et al., 2022). This winter surge in chloride content may be linked to diminished riverine discharge and elevated evaporation rates, leading to a concentration of dissolved salts. Notably, chloride levels were also comparatively high during the monsoon (7.98 ± 0.69 mg/L), likely a consequence of surface runoff introducing domestic and agricultural effluence into the fluvial system. Bicarbonate concentrations, a primary determinant of total alkalinity, demonstrated an inverse seasonal pattern, decreasing during the monsoon (23.40 ± 2.02 mg/L) and increasing in the pre-monsoon (27.97 ± 1.12 mg/L). This trend is consistent with the dilutional impact of monsoon precipitation and augmented carbonate weathering during the dry season. Similarly, sulfate concentrations reached their zenith during the monsoon (6.23 ± 0.67 mg/L), probably due to agricultural runoff and atmospheric deposition, and were at their nadir in winter (4.81 ± 0.26 mg/L), reflecting reduced external inputs and stable hydrological conditions (Sarma and Dutta 2012).

The Daya River exhibits distinct seasonal fluctuations in nutrient and trace metal concentrations, reflecting the interplay of hydrological cycles, anthropogenic activities, and biological processes. Nitrate concentrations peaked during the pre-monsoon period (1.27 ± 0.05 mg/L), declining significantly in the post-monsoon season (0.67 ± 0.04 mg/L). This reduction is likely attributable to dilution effects from increased rainfall and enhanced biological assimilation by phytoplankton and aquatic macrophytes during the monsoon. Conversely, elevated pre-monsoon levels suggest the accumulation of nitrates, potentially stemming from agricultural runoff and the decomposition of organic matter.

A similar trend was observed for phosphate concentrations, with maximal values recorded in the pre-monsoon (0.83 ± 0.25 mg/L) and minimal concentrations during the monsoon (0.50 ± 0.07 mg/L). The decrease during high flow periods is likely due to the binding of phosphates to suspended sediments and subsequent biological uptake.

In contrast, total nitrogen concentrations remained relatively consistent but displayed a slight increase in winter (1.66 ± 0.15 mg/L). This winter elevation may be linked to reduced microbial denitrification rates in cooler temperatures and the progressive accumulation of nitrogen from decomposing organic material, as noted by Ganga et al. (2012). Zinc concentrations exhibited a consistent decline from pre-monsoon (0.37 ± 0.02 mg/L) to winter (0.29 ± 0.02 mg/L). The observed reduction in zinc during winter and post-monsoon periods is likely a consequence of increased precipitation and sedimentation, coupled with diminished industrial and agricultural discharges. While overall zinc levels remained within established safe limits, their seasonal variability points towards episodic inputs or natural geogenic leaching exacerbated by periods of heightened hydrological activity **(Table 2)**.

Collectively, these seasonal variations in the Daya River's chemical parameters underscore the profound influence of hydrometeorological regimes, prevailing land use practices, and in-stream biological dynamics. The elevated concentrations of specific ions and nutrients during the pre-monsoon and monsoon seasons are indicative of increased surface runoff, terrestrial leaching, and agricultural nutrient loading. Conversely, the winter season is characterized by more stable and diluted chemical profiles, reflecting reduced external anthropogenic inputs and slower hydrological flow conditions. Understanding these seasonal nutrient dynamics is paramount for developing effective water quality management strategies for the Daya River.

Table 2. Chemical parameters of river daya during the study period (November 2023- April 2024) [Mean ± SD].

Parameter	Pre-Monsoon	Monsoon	Post-Monsoon	Winter
Magnesium (Mg/L)	16.22 ± 0.83 [a]	15.92 ± 0.43 [a]	12.87 ± 0.79 [a]	15.08 ± 0.57[a]
Sodium (Mg/L)	0.58 ± 0.02	0.61 ± 0.01	0.64 ± 0.04	0.61 ± 0.03
Potassium (Mg/L)	1.24 ± 0.03	1.20 ± 0.04	1.34 ± 0.04	1.25 ± 0.04
Calcium (Mg/L)	18.54 ± 0.40 [a]	17.21 ± 0.29 [a]	17.35 ± 0.29 [a]	15.24 ± 0.11 [a]
Chloride (Mg/L)	5.73 ± 0.46 [a]	7.98 ± 0.69 [a]	7.80 ± 0.41 [a]	8.08 ± 0.34 [a]
Bicarbonate (Mg/L)	27.97 ± 1.12 [a]	23.40 ± 2.02 [a]	26.32 ± 1.14 [a]	26.61 ± 0.86 [a]
Sulphate (Mg/L)	5.88 ± 0.10 [a]	6.23 ± 0.67 [a]	5.34 ± 0.35 [a]	4.81 ± 0.26 [a]
Nitrate (Mg/L)	1.27 ± 0.05	0.72 ± 0.13 [a]	0.67 ± 0.04	0.76 ± 0.07 [a]
Phosphate (Mg/L)	0.83 ± 0.25 [a]	0.50 ± 0.07 [a]	0.53 ± 0.06 [a]	0.60 ± 0.08 [a]
Nitrogen (Mg/L)	1.42 ± 0.13 [a]	1.49 ± 0.05	1.51 ± 0.01	1.66 ± 0.15 [a]
Zinc (Mg/L)	0.37 ± 0.02	0.36 ± 0.06 [a]	0.29 ± 0.03	0.29 ± 0.02

[a]Superscript indicates significant difference within and among the seasons ($P<0.05$). Figures in parenthesis shows the range variation.

Table 3. Ichthyofauna diversity of Daya river, Odisha , IndiaSl. No.	**Order**	**Family**	**Genus**	**Species**	**Total Catch (1 Year)**	**Mean/Year**	**% of Total**
1	*Cypriniformes*		*Labeo*	*Labeo rohita*	240	240	8.69 %
2			*Cirrhinus*	*Cirrhinus mrigala*	217	217	7.84 %
3			*Catla*	*Catla catla*	197	197	7.12 %
4			*Labeo*	*Labeo calbasu*	170	170	6.15 %
5			*Labeo*	*Labeo bata*	140	140	5.07 %

6		*Cyprinidae*	*Salmophasia*	*S. bacaila*	120	120	4.34%
7			*Garra*	*G. mullya*	93	93	3.38%
8			*Puntius*	*P. ticto*	87	87	3.14%
9			*Puntius*	*P. conchonius*	83	83	3.02%
10			*Crossocheilus*	*C. latius*	70	70	2.53%
11			*Amblypharyngodon*	*A. mola*	67	67	2.41%
12			*Puntius*	*P. amphibius*	63	63	2.29%
13			*Puntius*	*P. pulchellus*	60	60	2.17%
14			*Puntius*	*P. stigma*	50	50	1.81%
15			*Barilius*	*B. vagra*	47	47	1.69%
16			*Rasbora*	*R. daniconius*	43	43	1.57%
17			*Chela*	*C. bacaila*	40	40	1.45%
18	*Siluriformes*	*Bagridae*	*Rita*	*R. rita*	57	57	2.05%
19			*Mystus*	*M. vittatus*	53	53	1.93%
20			*Mystus*	*M. tengara*	52	52	1.87%
21			*Sperata*	*S. aor*	50	50	1.81%

22			*Sperata*	*S. seenghala*	48	48	1.75%
23			*Mystus*	*M. bleekeri*	47	47	1.69%
24			*Mystus*	*M. cavasius*	45	45	1.63%
25	*Channiformes*	*Channidae*	*Channa*	*C. marulius*	43	43	1.57%
26			*Channa*	*C. punctata*	42	42	1.51%
27			*Channa*	*C. striata*	40	40	1.45%
28	*Osteoglossiformes*	*Notopteridae*	*Notopterus*	*N. notopterus*	37	37	1.33%
29			*Chitala*	*C. chitala*	35	35	1.27%
30	*Siluriformes*	*Siluridae*	*Wallago*	*W. attu*	33	33	1.21%
31			*Ompok*	*O. bimaculatus*	32	32	1.15%
32	*Synbranchiformes*	*Mastacembelidae*	*Macrognathus*	*M. aculeatus*	30	30	1.09%
33			*Mastacembelus*	*M. pancalus*	28	28	1.03%
34	*Nemacheiliformes*	*Nemacheilidae*	*Acanthocobitis*	*A. botia*	27	27	0.97%
35	*Gobiiformes*	*Gobiidae*	*Glossogobius*	*G. giuris*	26	26	0.94%
36	*Perciformes*	*Ambassidae*	*Chanda*	*C. nama*	25	25	0.92%
37	*Synbranchiformes*	*Synbranchidae*	*Monopterus*	*M. cuchia*	25	25	0.89%

38	*Perciformes*	*Anabantidae*	*Anabas*	*A. cobojius*	24	24	0.87%
39	*Perciformes*	*Anabas*	*Anabas*	*A. testudineus*	23	23	0.84%
40	*Siluriformes*	*Clariidae*	*Clarias*	*C. batrachus*	23	23	0.82%
41	*Beloniformes*	*Belonidae*	*Xenentodon*	*X. cancila*	22	22	0.80%

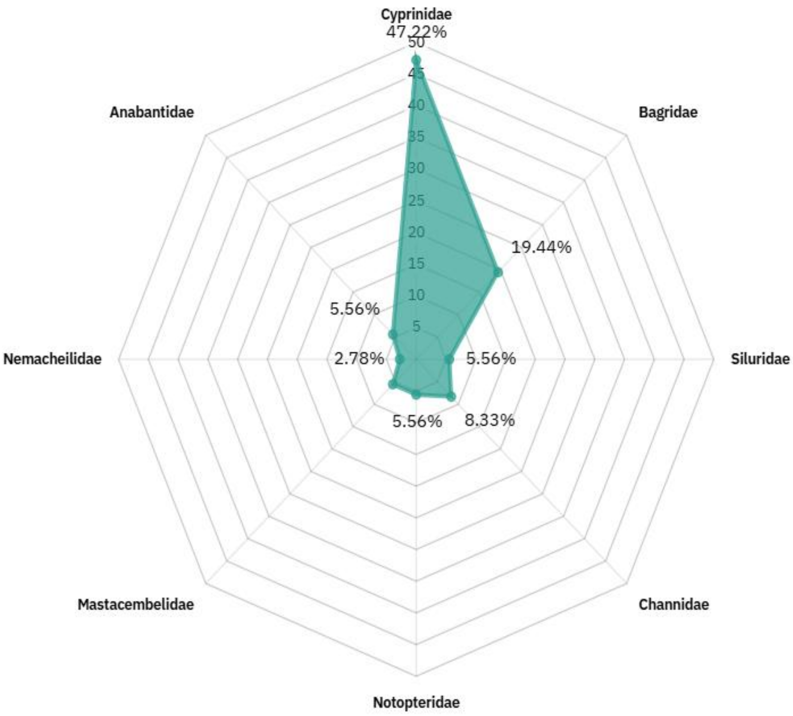

Figure.2. Fish (Family) Population diversity of Daya River

During a year-long ichthyological survey, the Daya River exhibited substantial fish diversity, cataloging 41 species across 9 orders, 15 families, and 32 genera. This species richness, quantified by total catch data, underscores their ecological significance within the lotic ecosystem (**Table 3**).

The Cypriniformes order, particularly the Cyprinidae family, overwhelmingly dominated the catch composition. *Labeo rohita* emerged as the most abundant species, accounting for 240 individuals (8.69% of the total catch), followed closely by *Cirrhinus mrigala* (217 individuals; 7.84%) and *Catla catla* (197 individuals; 7.12%). Other prominent cyprinids included *Labeo calbasu* (6.15%) and *Labeo bata* (5.07%), alongside smaller taxa such as *Salmophasia bacaila*, *Garra mullya*, and various *Puntius* species, each contributing between 1.81% and 4.34% to the total catch. This prevalence of cyprinids suggests that the river's physicochemical parameters are highly conducive to their growth, potentially augmented by nutrient influx from agricultural runoff.

Species like *Crossocheilus latius*, *Amblypharyngodon mola*, and several *Puntius* species (e.g., *P. ticto*, *P. conchonius*, *P. stigma*) demonstrated consistent presence, indicative of stable populations and diverse niche utilization. Species exhibiting mid-level abundance, such as *Barilius vagra* (1.69%), *Rasbora daniconius* (1.57%), and *Chela bacaila* (1.45%), suggest intricate ecological interactions among shoaling and benthopelagic species. The order Siluriformes displayed considerable diversification, encompassing representatives from the Bagridae, Siluridae, and Clariidae families. Dominant among these were *Rita rita*, *Mystus vittatus*, *Sperata aor*, and *Wallago attu*, each contributing between 1.21% and 2.05% of the total catch. The notable presence of these demersal, predatory catfishes implies a robust benthic community (Mukherjee et al. 2015). Furthermore, the consistent occurrence of multiple *Mystus* species (*M. tengara*, *M. bleekeri*, *M. cavasius*) points to favorable breeding and foraging habitats within the river (Sarkar and Saha 2021).

The ichthyofaunal assessment revealed a moderate prevalence (1.45–1.57%) of predatory Channiformes species, including *Channa marulius*, *C. punctata*, and *C. striata*. The adaptive physiological characteristics of these air-breathing fishes, specifically their tolerance for hypoxic or stagnant aquatic environments, suggest localized deoxygenation or reduced hydrological flow within certain riverine stretches.

Further analysis identified Osteoglossiformes, represented by *Notopterus notopterus* (1.33%) and *Chitala chitala* (1.27%). The presence of these phylogenetically ancient lineages, indicative of specialized ecological niches, underscores the ecological continuity and minimal anthropogenic disturbance in specific river segments. Conversely, species from Synbranchiformes, Perciformes, Nemacheiliformes, Gobiiformes, and Beloniformes exhibited lower abundances, each contributing less than 1% to the total catch. This group included *Macrognathus aculeatus*, *Monopterus cuchia*, *Anabas testudineus*, *Acanthocobitis botia*, *Glossogobius giuris*, and *Xenentodon cancila*. Despite their low quantitative representation, their occurrence signifies significant habitat heterogeneity and a robust ecological equilibrium within the lotic system. The presence of burrowing and air-breathing taxa such as *M. cuchia* and *Clarias batrachus* further implies ephemeral habitat desiccation or seasonal hydrological connectivity with floodplains, particularly during monsoon periods. In summary, the observed ichthyofaunal composition, characterized by the numerical dominance of cyprinids and siluriforms, the inclusion of air-breathing species, and the representation of diverse ecological guilds, indicates that the Daya River sustains a moderately diverse and functionally robust fish community. The species assemblage also functions as a bioindicator, reflecting anthropogenic impacts such as nutrient enrichment, moderate fishing pressure, and seasonal hydrological alterations that collectively influence the aquatic biodiversity of the ecosystem. Consequently, long-term monitoring of these patterns is imperative for formulating effective sustainable fisheries management and conservation strategies within the region, as supported by Nair et al. (1989).

The ichthyofaunal assemblage of the Daya River exhibited a direct correlation with the observed seasonal fluctuations in its physicochemical parameters. Optimal ranges for water temperature (23.10 $\pm$ 1.50∘C in winter to 30.10 $\pm$ 2.40∘C in monsoon), dissolved oxygen (6.30 $\pm$ 0.55 to 8.10 $\pm$ 0.50 mg/L), and pH (6.90 $\pm$ 0.08 to 7.30 $\pm$ 0.07) established conducive conditions for supporting a diverse array of piscine species. Elevated DO concentrations during the winter period coincided with heightened fish activity and the prevalence of oxygen-sensitive species such as *Labeo rohita* and *Catla catla*, which constituted the dominant portion of the ichthyocatch. Conversely, the monsoon season, despite a reduction in DO, fostered a greater abundance of resilient and air-breathing fishes, including *Channa punctata* and *Clarias batrachus*, indicative of adaptive physiological strategies to cope with hypoxic conditions and augmented organic loads.

Water clarity, which experienced a significant reduction during monsoon (40.10 $\pm$ 3.50 cm) attributable to sediment influx, likely impacted visual predators but favored benthic and detritivorous species like *Mystus vittatus* and *Sperata aor*. The oscillations in nutrient concentrations, specifically nitrate, phosphate, and bicarbonate, appeared to influence the primary productivity and trophic base for fish, thereby sustaining a complex food web. For instance, increased nitrate and phosphate levels during the pre-monsoon phase may have stimulated algal proliferation, benefiting herbivorous and omnivorous species such as *Puntius ticto* and *Amblypharyngodon mola*. Furthermore, the marginal increase in conductivity and salinity during monsoon suggested elevated ionic inputs, potentially enhancing mineral bioavailability for fish metabolism. The relatively stable pH and moderate hardness and alkalinity values observed across seasons supported calcium carbonate deposition for shell formation, osmoregulation, and reproductive success among numerous teleost species. The convergence of these physicochemical conditions ostensibly promoted a structurally diverse and ecologically balanced ichthyofaunal community, underscoring the indispensable role of water quality in shaping biodiversity within the Daya River ecosystem.

5. CONCLUSION

The current investigation of the Daya River revealed substantial seasonal variations in physicochemical and chemical parameters, exerting a direct influence on the ichthyofaunal diversity and distribution. Water quality metrics, including temperature, dissolved oxygen (DO), pH, and nutrient concentrations, largely remained within permissible limits across most seasons. This suggests a moderately healthy aquatic ecosystem, conducive to fish survival and reproduction. Elevated dissolved oxygen levels observed during the winter and post-monsoon periods correlated with a greater abundance of oxygen-sensitive fish species. Conversely, reduced DO and increased organic matter during the monsoon season appeared to favor the proliferation of hardy and air-breathing species. A total of 41 fish species, encompassing 7 orders and 16 families, were documented. The family Cyprinidae was notably dominant, featuring economically and ecologically significant species such as *Labeo rohita, Catla catla*, and *Cirrhinus mrigala*. Seasonal fluctuations in parameters like transparency, nutrient levels, and suspended solids demonstrated a close association with shifts in fish abundance and species composition, underscoring the dynamic interplay between water quality and aquatic biodiversity.

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