**The review’s comments and final recommendation for the editor and authors:**

**Dear editor and author(s),**

**Have a nice day.**

**I have reviewed the manuscript.**

**This study investigates the association between environmental variables and fish diversity in four dams in Chhattisgarh. While it provides valuable baseline data, several shortcomings limit its scientific rigor and practical relevance.** **Therefore, the present manuscript requires necessary revisions to improve.**

**After making the mentioned corrections in the text of the manuscript and based on the review report, it will be eligible for acceptance and publication in the journal. Hence, the authors should revise the manuscript according to the comments and suggestions provided.**

**Final recommendation: The manuscript needs revision**

**A Study on relationship between water quality parameters ~~environmental conditions~~ and fish diversity in freshwater bodies of Chhattisgarh, Central India.**

**Abstract**

The present study was conducted to assess the diversity of fish fauna in four freshwater bodies of Chhattisgarh, Central India and its association with some environmental attributes. Four freshwater bodies viz; Khutaghat dam (D1), Kori dam(D2), Minimata dam (D3) and Khudia dam(D4) of Chhattisgarh were sampled for assessment of fish faunal diversity and its association with environmental factors. All the sampled freshwater bodies were the fish species were caught in nets by using boats. During the course of study water samples from each freshwater body was collected to analyze them for different physico-chemical properties (temperature, transparency, pH, water conductivity, total hardness, total alkalinity, total dissolved solids, dissolved oxygen, salinity, BOD and COD) through the standard protocols of APHA (2005). In order to reveal the association between the environmental factors and fish fauna Pearson’s Coefficient of correlation (two tailed) was conducted. The results reveal that a total of 49 fish species belonging to 09 orders, 18 families, 34 genera were found in the freshwater bodies of Chhattisgarh. Cyprinidae (42.85%), Bagridae & Clariidae (8.16%), Siluridae (6.122%), Schilbeidae, and Centropomidae & Anabantidae (4.08%) were the most dominated families. *Labeo rohita* was the most abundant (6.182%) freshwater fish species in the sampled freshwater bodies of Chhattisgarh. Despite the low fish diversity in the sampled freshwater bodies of Chhattisgarh, the Shannon’s index (H) varies from 2.36±0.08 (D4) to 2.90±0.09 (D3). A significant (p≤0.01; p≤0.05) correlation was reported between the physico-chemical properties of sampled freshwater bodies and fish diversity. These results illustrate that the fish diversity of freshwater bodies of Chhattisgarh is regulated by the environmental attributes. The results of this study clearly illustrate the requirement of prior management and conservation strategies for the freshwater bodies of Chhattisgarh Central India.

**Keywords:** Fish ~~diversity~~, Environmental variables, ~~Relationship~~, Diversity indices, Shannon’s index

**Introduction**

One important source of the earth’s biological diversity is supported by aquatic habitats (Dudgeon and Strayer, 2025). They contribute significantly to the biological diversity earth and serve as important reservoirs. Across different aquatic ecosystems inland freshwater bodies like ponds, lakes, dams etc play a significant role in preserving our natural heritage. Inland freshwater bodies have been extensively used by civilization throughout the ages, so few, if any, still exist in their native state **(Janse et al., 2015; Sadeghinezhad et al., 2021; Radkhah et al., 2022a; Radkhah and Eagderi, 2022).** Environmental conditions and biological variety of freshwater bodies are necessary for maintaining the health of an aquatic ecosystem (**Radkhah and Eagderi, 2022,** Wang, 2024). The diversity and population dynamics of water bodies is regulated by its physical, chemical and biological attributes. Only a single factor is not responsible for the aquatic biodiversity, but all these physical, chemical and biological properties are dependent on each other and conjointly influence the biodiversity of aquatic ecosystems. Thus, it becomes essential for the biodiversity studies of water bodies to record their physical and chemical properties. So, that the relationship between the hydrochemistry and aquatic biodiversity is disclosed. In addition, it becomes easy for us to determine the threshold of the physico-chemical properties within which the aquatic biodiversity flourishes. Environmental conditions of aquatic ecosystems, like dissolved oxygen, water pH, and water temperature across different seasons affect the diversity and distribution of aquatic biodiversity (Prakash, 2021; **Radkhah and Eagderi, 2022**). India has been also known by its diverse environmental conditions. Each region has its own environmental parameters in terms of aquatic habitats, which vary from place to place. This varied seasons and seasonal parameters result in the varied water physico-chemical across the year. Thus, variation in the physico-chemical properties of the water provides chance for different aquatic fauna including fish to survive.

Fish are the first known vertebrates, and they can only be found in water (**Radkhah et al., 2021; 2022b**). ~~Robertson, 1957).~~ The environmental conditions of the aquatic ecosystems play a vital role in maintaining the aquatic biodiversity. According to research, out of the 54000 vertebrate species that exist worldwide, over 35000 are fish species that are found in various aquatic habitats. There are over 450 families of freshwater fish worldwide (Mikkola, 2024). Due to its abundance in biodiversity, India is recognized as a mega diversity country. India, one of the countries with high levels of biodiversity, is ranked tenth in the world for freshwater megabiodiversity (Mittermeier, *et.al*., 1998). The diversity of fish species in India is mostly a result of the changing aquatic environment (Ghosh and Roy, 2022). Since the dams, reservoirs, lakes, and ponds in various rural and urban locations serve as spawning grounds for inland fresh water fish (Abbasov, *et.al*., 2022). There have been numerous reports of fishing in India's rural dams, reservoirs, lakes, and ponds. Fishes and other aquatic fauna have specific ecological requirements from their water bodies, which are fulfilled by the water bodies. This is the reason that some fish species or other aquatic fauna shows their presence in a specific season. Because, this season fulfills all the ecological requirements of the fish and other aquatic fauna in that season respectively. Thus, examining the diversity and dynamics of fish species with reference to the physico-chemical properties will help basic fundamental of ecology. Research into the variety and ecological relationships of various fish assemblages is essential for the scientific community nationwide. The present study deals with the ecological relationship between water bodies and its fish diversity in Chhattisgarh of Central India.

**Material and Methods**

**2.1. Selection of Freshwater Bodies**

To fulfill the objectives of present work four freshwater bodies [Khutaghat dam (D1), Kori dam (D2), Minimata dam(D3) and Khudia dam(D4)] were randomly selected (through simple random sampling technique) from Chhattisgarh of Central India to conduct this study. The morphometric features of selected freshwater bodies are given in Table-1. The study was carried out for two complete years from 2019 to 2021.

|  |
| --- |
| **Table-1**Morphometric features of sampled freshwater bodies of Chhattisgarh, Central India |
| **Morphometric features** | **Khutaghat Dam** | **Kori Dam** | **Minimata Dam** | **Khudia Dam** |
| LatitudeLongitude | 220 17’ 22’’ N820 17’ 01’’E | 22018’ 02’’ N810 58’ 00’’E  | 22036’ 15’’ N820 36’ 05’’E  | 22034’ 56’’ N81033’ 33’’E |
| Toposheet No. | 64 / J / 2, 3 & 4 | 64/F/15&16, 64/J/3&4 | 64J//1 & J//5 | 64/F/15&16, 64/J/3&4 |
| Full storage level (m) | 294.04M | 318.20M | 348.7M | 268.00M |
| Dead storage level (m)  | 283.46M | 311.50M | 335.4M | 266.00M |
| Catchment area (km2)  | 614 Km2 | 111.36 Km2 | 6730km2 | 82.87 Km2 |
| Gross storage capacity (x 106m3) | 195.15Mcft | 1199.45Mcft | 11120.00Mcft | 1000.20Mcft |
| Dead storage capacity (x 106m3) | 283Mcft | 138.71Mcft | 244.81 | 132.50Ha |
| Water spread area at FRL (ha) | 38.07Km | 718 Ha | 2128Ha | 650Ha |
| Mean depth (m) | 11.00M | 7.00M | 15.00M | 6.00M |
| Length of shore line(km) | 64.00Km | 60.00Km | 333.00Km | 40.00Km |

**2.2. Assessment of Fish Biodiversity**

To assess the fish diversity of freshwater bodies of Chhattisgarh a boat was hired and the sampled dams were visited and the fish samples were collected carefully throughout the study period. Thereafter different types of fish catching nets like cost net, gill nets, scoop net and a circular net with varying sizes (10mm to 200mm) were used to catch the fishes for further study. All the fish specimens were identified based on morphometric and meristic characters following Rahman (2007 and 2005) and Talwar and Jhingran (1991). Identified species were classified based on the classification system of Nelson (2006). Scientific names and authorities follow those of Froese and Pauly (2021). The abundance of different fish species was estimated in terms of individuals collected. Then the relative abundance of each identified fish species was calculated by the formula given by Rafiu, *et.al.,* (2025). Different diversity indices like; Shannon-Wiener Index of Diversity (H) was calculated by using equation of Shannon and Wiener (1949), Species Richness (d) was evaluated by using equation of Margalef, (1958), Simpsons Diversity Index (c) was calculated by using equation of Simpson, (1951) and Species Evenness (e) was calculated by the formula given by Pielou, (1966).

**2.3. Assessment of Physico-chemical properties of sampled freshwater bodies**

The physico-chemical parameters studied in the present investigation included temperature, transparency, pH, water conductivity, total hardness, total alkalinity, total dissolved solids, dissolved oxygen, salinity, BOD and COD measurements of the water bodies. These parameters were were analyzed by standard methods of APHA (2005). Four water samples were collected from four sites of each dam in every month of the year. Then the average value of these four sites against the month of year was presented in the tables.

**2.4. Data Analysis**

The data were tabulated and statistically analyzed by the analyses of variance (ANOVA) and the treatment means were compared using the Duncan Multiple Range Test (Duncan,1965) at (*P*≤0.05) level of significance. Pearson’s correlation coefficients were calculated to evaluate the parametric relationships between the physico-chemical parameters and fish diversity supposedly in interaction. The SPSS version 16.0 software was used to analyse the data.

**Results ~~and Analysis~~**

In the present study a comprehensive approach was used to carry out this study. All the precautions were followed to reach on reliable results. The sampled freshwater bodies (D1,D2,D3,&D4)were surveyed for their fish faunal diversity. Table-2 shows the detail of different fish species encountered in the present study. The sampled four freshwater bodies of Chhattisgarh were composed of 09 orders, 18 families, 34 genera and 49 fish species. Across different sampled Dams; Minimata dam reported 49 fish species, followed by Khutaghat dam (47 fish species), Kori dam (44 fish species) and Khudia dam (43 fish species). Cyprinidae(42.85%), Bagridae & Clariidae (8.16%), Siluridae (6.122%), Schilbeidae , and Centropomidae & Anabantidae (4.08%) were the most dominated families. *Labeo rohita* was the most abundant (6.182%) freshwater fish species, followed by *Labeo bata* (5.63%), *Qxygaster bacalica* (5.20%), *Amblypharayngdon mola* (4.72%), *Mystus tengara* (4.27%), *Rasbora daniconius* (379%), *Ompok pabda* (3.57%), and others in the sampled freshwater bodies of Chhattisgarh respectively. *Tilapia mossambicus* (0.018%) has reported its abundance as lowest across all the reported fish species in the sampled freshwater bodies.

**Table-2.**

Order, Family and Species of fish species reported during the study period in freshwater bodies of Chhattisgarh, Central India.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Order** | **Family** | **Species** | **Local Name** | **D1** | **D2** | **D3** | **D4** | **RA** |
| **Clupeiformes** | Clupeidae | *Gudusia chapra* | Chapra | + | + | + | - | 3.2434 |
| **Osteoglossiformes** | Notoperidae | *Notopeterus notopeterus* | Patola | + | - | + | - | 3.1216 |
| **Cypriniformes** | Cyprinidae | *Amblypharyngodon mola* | Dhai | + | + | + | + | 4.7205 |
| *Barilius bendelisis* | Chitri | + | + | + | + | 2.3602 |
| *Catla catla* | Catla | + | + | + | + | 2.6648 |
| *Cirrhinus mrigal* | Mrigal | + | + | + | + | 1.4770 |
| *Cirrhinus reba* | Reba | + | + | + | - | 1.1116 |
| *Crossocheilus latius* | Petali | + | + | + | - | 0.3654 |
| *Cyprinus carpio* | Carpio | + | - | + | + | 0.3350 |
| *Danio devario* | Amashaini | + | + | + | - | 1.1420 |
| *Esomus danricus* | Dadia | + | + | + | + | 2.8475 |
| *Garra gotyla* | Butwa | + | - | + | + | 0.4111 |
| *Labeo bata* | Bata | + | + | + | + | 5.6342 |
| *Labeo calbasu* | Calbasu | + | + | + | + | 2.4364 |
| *Labeo gonius* | Gonius | + | + | + | + | 2.6800 |
| *Labeo rohita* | Rohu | + | + | + | + | 6.1824 |
| *Oxygaster bacaila* | Sarangi | + | + | + | - | 5.2078 |
| *Puntius sarana* | Sarna | + | + | + | + | 1.2486 |
| *Puntius chola* | Kotri | + | + | + | + | 1.5532 |
| *Puntius ticto* | Sidhari | + | + | + | - | 0.9745 |
| *Puntius sophore* | Kotri | + | + | + | + | 2.6039 |
| *Tor tor* | Mahasher | + | + | + | - | 1.1268 |
| *Rasbora daniconius* | Dadu | + | + | + | + | 3.7916 |
| Cobitidae | *Lepidocephalichthys guntea* | Gimna | + | + | + | + | 3.4262 |
| Nemacheilidae |  *Nemacheilus botia* | Gimna | + | + | + | + | 1.8120 |
| Siluridae | *Ompok bimaculatus* | Lapchi | + | + | + | + | 2.9389 |
| *Ompok pabda* | Pabada | + | + | + | + | 3.5784 |
| *Wallago attu* | Paniha | + | + | + | + | 1.0202 |
| Bagridae | *Mystus seengala* | Tengra | + | - | + | + | 1.0507 |
|  | *Mystus tengara* | Tangna | + | + | + | + | 4.2789 |
|  | *Mystus aor* | Bade Tangna | + | + | + | + | 1.6141 |
|  | *Rita rita*  | Kokia | + | + | + | + | 0.6091 |
| Sisoridae | *Bagarius bagarius* | Rechha | + | + | + | + | 0.4720 |
| Schilbeidae | *Eutropiichthys vacha*  | Patara | + | + | + | + | 0.3502 |
|  | *Silonia silondia* | Gazza | + | + | + | + | 0.4263 |
| Saccobranchidae | *Heteropneutes fossilis* | Singhi | + | + | + | + | 1.4770 |
| Clariidae | *Clarias batrachus* | Mongri | + | + | + | + | 1.3095 |
| **Ophiocephaliformes** | Channidae | *Channa punctatus* | Khoksi | + | + | + | + | 3.1673 |
| *Channa striatus* | Khoksi | + | + | + | + | 2.9084 |
| *Channa gachua* | Karajiya | + | + | + | + | 3.2282 |
| *Channa marulius* | Khoksi | + | + | + | + | 0.5025 |
| **Beloniformes** | Belonidae | Xenentodon cancila | Sodhia | + | + | + | + | 1.5684 |
| **Perciformes** | Centropomidae | *Chanda nama* | Chandani | + | + | + | + | 1.2334 |
| *Chanda ranga* | Chandani | + | + | + | + | 1.1268 |
| **Gobiiformes** | Nandidae | *Nandus nandus* | Bhedo | + | + | + | + | 1.3552 |
| Anabantidae | *Anabas testudineus* | Rukh Chagha | + | + | + | + | 1.5227 |
| **Mastacembeliformes** | Mastacembelidae | *Mastacembelus armatus* | Baam | + | + | + | + | 0.7157 |
| *Mastacembelus puncalus* | Baam | + | + | + | + | 0.8832 |
| **Cichliformes** | Cichlidae | *Tilapia mossambicus* | Tilapia | + | - | + | + | 0.1827 |
| ***\*Note*: D1=** *Khutaghat Dam*, **D2** **=** *Kori Dam*, **D3=***Minimata Dam*, **D4** **=** *Khudia Dam*, **RA=** *Relative Abundance***+** = Present**-** = Absent |

The different diversity indices were calculated for each sampled freshwater body of Chhattisgarh. Table-3 provides the detail of different diversity indices of fish fauna across different seasons in Chhattisgarh of Central India. An average of 363±34.03 individuals of fish fauna were caught from Khutaghat dam (D1), 308±20.51 individuals of fish fauna were caught from Kori dam (D2), 320±31.74 individuals of fish fauna were caught from Minimata dam (D3), and 320±31.74 individuals of fish fauna were caught from Khudia dam (D4). The average species richness of Khutaghat dam was 47.00±2.00, Kori dam was 44.33±1.52, Minimata dam was 49.00±2.64 and Khudia dam was 43.0±3.51. Similarly, the Simpsons index(D) reported a similar trend with highest values recorded by Minimata dam and lowest values recorded by Khudiya dam. The Shannon’s diversity index (H) recorded highest average values in Minimata dam (2.90±0.09) followed by the values in Khutaghat dam (2.86±0.11), Kori dam (2.76±0.15), and Khudia dam (2.36±0.08) respectively. The results for the species evenness were inconsistent to those of Shannon’s diversity index (H). The overall results of the present study uncover that the across all of the sampled four freshwater bodies; Minimata dam has reported highest fish diversity, species evenness and species richness of fish fauna and Khudia dam has reported lowest fish diversity, species evenness and species richness of fish fauna.

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| **Table-3** Diversity indices of fish species in freshwater bodies of Chhattisgarh, Central India during 2019 -2021 |
| **S.No** | **Dam** | **Diversity Indices** | **Monsoon** | **Winter** | **Summer** | **Average** |
| **01** | **D1** | **Individuals (Mean)** | 325±3.88 | 390±5.25 | 375±2.14 | 363±34.03 |
| **Richness(S)** | 48.0±1.20 | 46.0±2.15 | 47.0±1.68 | 47.00±2.00 |
| **Simpsons index(D)** | 0.96±0.01 | 0.97±0.01 | 0.96±0.01 | 0.96±0.005 |
| **Shannon’s index(H)** | 2.75±0.12 | 2.98±0.07 | 2.87±0.04 | 2.86±0.11 |
| **Evenness (E)** | 0.94±0.02 | 0.97±0.01 | 0.96±0.01 | 0.95±0.01 |
| **02** | **D2** | **Individuals (Mean)** | 287±3.89 | 328±6.11 | 309±5.25 | 308±20.51 |
| **Richness(S)** | 45.0±1.28 | 43.0±2.05 | 44.0±1.50 | 44.33±1.52 |
| **Simpsons index(D)** | 0.94±0.02 | 0.98±0.01 | 0.95±0.01 | 0.95±0.02 |
| **Shannon’s index(H)** | 2.6±0.18 | 2.9±0.10 | 2.8±0.09 | 2.76±0.15 |
| **Evenness (E)** | 0.95±0.01 | 0.97±0.01 | 0.95±0.02 | 0.94±0.14 |
| **03** | **D3** | **Individuals (Mean)** | 284±5.84 | 344±6.96 | 332±4.32 | 320±31.74 |
| **Richness(S)** | 49.0±1.05 | 51.0±1.38 | 47.0±0.97 | 49.00±2.64 |
| **Simpsons index(D)** | 0.96±0.02 | 0.98±0.03 | 0.97±0.02 | 0.97±0.02 |
| **Shannon’s index(H)** | 2.8±0.14 | 2.98±0.11 | 2.94±0.12 | 2.90±0.09 |
| **Evenness (E)** | 0.96±0.02 | 0.98±0.01 | 0.97±0.02 | 0.97±0.02 |
| **04** | **D4** | **Individuals (Mean)** | 284±3.67 | 344±4.79 | 332±5.50 | 320±31.74 |
| **Richness(S)** | 42.0±1.30 | 45.0±1.50 | 45.0±1.10 | 43.0±3.51 |
| **Simpsons index(D)** | 0.92±0.02 | 0.91±0.01 | 0.90±0.02 | 0.91±0.01 |
| **Shannon’s index(H)** | 2.48±0.12 | 2.6±0.09 | 2.67±0.07 | 2.36±0.08 |
| **Evenness (E)** | 0.92±0.02 | 0.91±0.01 | 0.93±0.02 | 0.92±0.01 |
| ***\*Note*: D1=** *Khutaghat Dam*, **D2** **=** *Kori Dam*, **D3=***Minimata Dam*, **D4** **=** *Khudia Dam*,  |  |

In the present study ten physico-chemical properties i.e., temperature, transparency, pH, total hardness, total alkalinity, total dissolved solids, dissolved oxygen, salinity, BOD and COD of Khutaghat dam, Kori dam, Minimata dam, and Khudia dam of Chhattisgarh were evaluated during 2019 to 2021. Table-5 illustrates the different physico-chemical properties of sampled freshwater bodies of Chhattisgarh. All the recorded physico-chemical parameters were within the permissible limits of Fish Farming and Drinking Purpose. The physico-chemical parameters like water temperature, water transparency, water pH, water salinity and dissolved oxygen of all the sampled freshwater bodies (D1, D2, D3, & D4) doesn’t report any significant (p≤0.05; p≤0.01) difference. In contrast the physico-chemical parameters like water alkalinity (mg/l), total water hardness, total dissolved solids (mg/l), COD(mg/l) and BOD(mg/l) reported a significant(p≤0.05; p≤0.01) difference across the sampled freshwater bodies(D1,D2,D3,&D4) of Chhattisgarh central India.

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| **Table 4.** Physical and Chemical parameters of sampled fresh water bodies of Chhattisgarh during 2019-2021.Values are Mean±SE |
| **S.NO** | **PARAMETERS** | **D1** | **D2** | **D3** | **D4** | **ANOVA** **(one way)** |
| **01** | Temperature ( C) | 22.97±2.04 | 23.69±1.68 | 22.75±1.63 | 23.72±1.59 | NS |
| **02** | Transparency | 41.58±6.53 | 41.67±8.13 | 43.67±7.02 | 40.00±6.38 | NS |
| **03** | pH | 07.63±0.07 | 07.92±0.21 | 07.35±0.36 | 07.19±0.27 | NS |
| **04** | Alkalinity (mg/l) | 70.53±5.53 | 65.31±6.23 | 57.63±4.68 | 66.36±6.92 | \* |
| **05** | Total Hardness | 259.4±7.49 | 227.7±8.94 | 199.5±12.6 | 239.89±9.76 | \*\* |
| **06** | Salinity (g/l) | 02.90±0.34 | 03.32±0.41 | 03.15±0.39 | 03.02±0.35 | NS |
| **07** | Total dissolved solids (mg/l) | 353.38±6.80 | 289.7±32.9 | 284.9±17.2 | 295.8±7.46 | \* |
| **08** | Dissolved Oxygen(mg/l) | 06.24±0.41 | 06.55±0.49 | 06.50±0.48 | 06.07±0.45 | NS |
| **19** | COD(mg/l) | 25.87±1.91 | 26.74±1.63 | 25.93±1.54 | 23.38±1.62 | \* |
| **10** | BOD(mg/l) | 06.38±4.51 | 03.30±0.38 | 05.53±4.65 | 03.22±0.18 | \* |
| ***\*Note*: D1=** *Khutaghat Dam*, **D2** **=** *Kori Dam*, **D3=***Minimata Dam*, **D4** **=** *Khudia Dam*.The data shown are mean ± SE of four replicates **\***Statistically significant difference at *p≤ 0.05***\*\***Statistically significant difference at *p≤ 0.01***NS**: Not significant |

To find out the relationship between the physico-chemical properties and fish faunal diversity of sampled water bodies, the Pearson’s coefficient of correlation was calculated. Table-4 provides the relationship between physico-chemical properties and fish faunal diversity of Khutaghat dam, Kori dam, Minimata dam and Khudia dam of Chhattisgarh. It was observed that water temperature of all water bodies record a significant positive correlation (p≤0.05) with fish population, fish species richness, fish species diversity and species dominance of fish fauna. The water transparency of sampled water bodies recorded a significant positive correlation (p≤0.05) with fish populations, fish species diversity and species dominance of fish fauna. The water pH of sampled water bodies recorded a positive correlation with fish population fish species diversity, fish species richness, fish species evenness, and species dominance of fishes but it wasn’t significant. The total alkalinity of sampled water bodies recorded a significant positive correlation (p≤0.05) with total fish population, fish species diversity, fish species richness, fish species evenness, and species dominance of fishes. The total hardness of sampled water bodies recorded a significant negative correlation (p≤0.05) with fish species richness, species diversity and species dominance of fishes. The total salinity of sampled water bodies recorded a significant negative correlation (p≤0.05) with fish population, fish species evenness, fish species richness, species diversity and species dominance of fishes. The water conductivity of sampled water bodies recorded a significant positive correlation (p≤0.05) with species diversity and species dominance of fishes. The total dissolved solids of sampled water bodies recorded a significant positive correlation (p≤0.05) with fish population, fish species evenness, fish species richness, species diversity and species dominance of fishes. The dissolved oxygen (DO) of sampled water bodies recorded a significant negative correlation (p≤0.05) with fish population, fish species evenness, fish species richness, species diversity and species dominance of fishes. The chemical oxygen demand (COD) of sampled water bodies recorded a significant positive correlation (p≤0.05) with fish species richness, species diversity and species dominance of fishes. The biological oxygen demand (COD) of sampled water bodies recorded a significant positive correlation (p≤0.05) with total fish population, fish species richness, species diversity and species dominance of fishes. The overall results suggest that the physico-chemical properties affect significantly the fish faunal diversity of sampled water bodies. Thus any change in the physico-chemical properties of aquatic ecosystem alters the fish faunal diversity and population dynamics.

**Table-5.**

Shows Pearson’s Coefficient of correlation between different environmental attributes and fish diversityof freshwater bodies of Chhattisgarh, Central India

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **S.No** | **Parameters** | **Individuals** | **Richness** | **Diversity** | **Evenness** | **Dominance** |
| **01** | Temperature | **0.633\*** | **0.790\*** | **0.621\*** | 0.650 | **0.619\*** |
| **02** | Transparency | **0.594\*** | 0.496 | **0.677\*** | 0.592 | **-0.699\*** |
| **03** | pH | 0.501 | 0.458 | 0.561 | 0.522 | 0.339 |
| **04** | Total Alkalinity | **-0.669\*** | **-0.721\*** | **-0.647\*** | **-0.598\*** | **0.669\*** |
| **05** | Total Hardness | -0.544 | **-0.639\*** | **-0.605\*** | -0.691 | **-0.555\*** |
| **06** | Salinity | **-0.619\*** | **-0.597** | **-0.750\*** | **-0.619\*\*** | **-0.762\*** |
| **07** | Total dissolved solids | **0.653\*\*** | **0.719\*\*** | **0.597\*** | **0.671\*** | **0.608\*** |
| **08** | Dissolved Oxygen | **-0.655\*** | **-0.659\*\*** | **-0.637\*** | **-0.622\*** | **-0.735\*** |
| **09** | COD | 0.566 | **0.661\*** | **0.617\*** | 0.330 | **0.598\*** |
| **10** | BOD | **0.661\*** | 0.624 | **0.597\*** | **0.557\*** | **0.647\*** |

\*\* The Pearson correlation is significant at the 0.01 level (two tailed)

 \*The Pearson correlation is significant at the 0.05 level (two tailed)

**Discussion**

Across different aquatic species, fish species are regarded to be the health indicators of aquatic ecosystem (Li, et.al., 2018). The diversity of fish fauna in an aquatic ecosystem determines the balance between its structure and functioning. Fish provide some fundamental ecosystem services in an aquatic system. The ecological services provided by the fishes are not replaceable by any sort of technology. Thus the diversity of fish species of a nation has wide economic importance. As per reports, out of the 54000 vertebrate species that exist worldwide, over 35000 are fish species that are found in various aquatic habitats. But till today the complete documentation of fish fauna present in different freshwater bodies of India is lacking. The present study was conducted to examine the freshwater fish faunal diversity in Chhattisgarh of Central India. In this study we found 49 different fish species across four sampled freshwater bodies of Chhattisgarh, Central India. Some authors have reported that 96 fresh water fish species exist in Chhattisgarh (Patel, et.al., 2016). The results illustrated that Cyprinidae (44.87%) was most dominated families and *Labeo rohita* was the most abundant (6.182%) freshwater fish species in the freshwater bodies of Chhattisgarh. The dominance of these families could be in relation to their prolific breeding capabilities and high adaptation to varying environmental conditions (Mustapha,2010; Araoye, 1999). The results of the present are in consistent with those of Oyewo, (2005), Atile, et.al., (2016) and Abiodun and John, (2011).

Physico-chemical properties are the water quality indicators of freshwater bodies (Dessie, et.al., 2024). The different physico-chemical properties of freshwater bodies collectively make the environment suitable for biological activity. The regular monitoring of physico-chemical properties of freshwater bodies is essential for the management and protection of these aquatic ecosystems (Flura, et.al., 2016). In the present study ten physico-chemical properties viz temperature, transparency, pH, total hardness, total alkalinity, total dissolved solids, dissolved oxygen, salinity, BOD and COD of four fresh water bodies (Khutaghat dam, Kori dam, Minimata dam and Khudia dam of Chhattisgarh) were evaluated. The relationship between the physico-chemical properties and their fish faunal diversity of sampled freshwater bodies is given in Table-4. The different physico-chemical properties viz; temperature, pH , transparency , alkalinity , water hardness , water salinity , total dissolved solids , DO , COD , and BOD are the important indicators of water quality of freshwater bodies (Uddin, et.al., 2021; Amorim and Moura, 2021; Cooper, et.al., 2007; Boyd and Boyd, 2020; Rajkumar, et.al., 2018; Malik, et.al., 2016; Sarkar and Islam, 2019; Quesada, et.al., 2023; Tomar, et.al., 2022; Manekeu, et.al.,2023). These environmental variables of aquatic ecosystem affect its structure and functioning. The present study recorded a significant association between different environmental variables and fish faunal diversity. The study confirmed that with the change in the physico-chemical properties changes the fish diversity, abundance and distribution of freshwater bodies. According to Surchita and Palita, (2023) the physico-chemical properties of a freshwater body significantly affect the fish biodiversity of lentic water body of Eastern Ghats of India. Rehman, et.al., (2020) reported that physico-chemical properties of freshwater bodies affect the relative abundance of ichthyofaunistic diversity. Das, et.al., (2021) have reported a significant association between ichthyofauna diversity and physico-chemical properties of Dhir Beel in Dhubri district Assam of India. A significant association between physico-chemical properties of freshwater bodies and fish biodiversity have been reported by many authors (Saha, et.al., 2019; Kumar, et.al., 2020; Mehmood, et.al., 2023). The results of the present study can be used to monitor the current status of the sampled fresh water bodies of Chhattisgarh.

**Conclusion**

The aim of this study was to examine the diversity of fish fauna in four freshwater bodies of Chhattisgarh, Central India and its association with some environmental attributes. The results reveal that the sampled four freshwater bodies of Chhattisgarh were composed of 09 orders, 18 families, 34 genera and 49 fish species. Across different sampled Dams; Minimata dam reported 49 fish species, followed by Khutaghat dam (47 fish species), Kori dam (44 fish species) and Khudia dam (43 fish species). Cyprinidae(42.85%), Bagridae & Clariidae (8.16%), Siluridae (6.122%), Schilbeidae , and Centropomidae & Anabantidae (4.08%) were the most dominated families. *Labeo rohita* was the most abundant (6.182%) and *Tilapia mossambicus* (0.018%) has reported its abundance as lowest across all the reported fish species in the sampled freshwater bodies. The overall results of the present study uncover that the across all of the sampled four freshwater bodies; Minimata dam has reported more diversity, evenness and richness of fish species and Khudia dam has reported lowest diversity, evenness and richness of fish species. The present study recorded a significant association between different environmental variables and fish faunal diversity. Furthermore, the study confirms that with the change in the physico-chemical properties changes the fish diversity, abundance and distribution of freshwater bodies. The results of the present study can be used to monitor the current status of the sampled fresh water bodies of Chhattisgarh.

**Conflict of Interest**

Author don’t have any conflict of interest regarding the publication of this manuscript.

**Ethical Issues of Manuscript**

Not Required

**Highlights**

* Central India belongs to the tropical region of the country blessed by rich biodiversity.
* Chhattisgarh also known as herbal state is known for richness in biodiversity.
* The freshwater bodies of Chhattisgarh accommodate diverse aquatic flora and fauna including fish species.
* The present study reported a total of 49 freshwater fish species belonging to 18 families and 09 orders.
* The study confirmed a significant correlation between the physical and chemical aquatic environmental conditions with the diversity/richness of fish fauna.

**References**

Americian Public Health Association (A.P.H.A.) (2005). Standard Methods of Water and Wastewater. 21st Edn., American Public Health Association, Washington, DC., ISBN: 0875530478, pp: 2-61

Amorim, C. A., & do Nascimento Moura, A. (2021). Ecological impacts of freshwater algal blooms on water quality, plankton biodiversity, structure, and ecosystem functioning. *Science of the Total Environment*, *758*, 143605.

Araoye, P.A. (1999) Spatio-temporal distribution of the fish Synodontis schall (Teleostei: Mochokidae) in Asa lake, Ilorin, Nigeria. *Revista de Biología Tropical*, 47(4), 1061-1066.

Atile, J.I., Shima, J.N. and Akombo, P.M. (2016) Food and feeding, length-weight and condition factor of the catfish Synodontis membranaceus (Etiene Geoffroy Saint Hilaire, 1809) (Osteichthyes: Mochokidae) from Lower Benue River, Makurdi, Nigeria”, *Agriculture. Forestry and Fisheries,* 5(4), 87-96.

Boyd, C. E., & Boyd, C. E. (2020). Carbon dioxide, pH, and alkalinity. *Water Quality: An Introduction*, Springer. 177-203.

Cooper, T. F., Uthicke, S., Humphrey, C., & Fabricius, K. E. (2007). Gradients in water column nutrients, sediment parameters, irradiance and coral reef development in the Whitsunday Region, central Great Barrier Reef. *Estuarine, Coastal and Shelf Science*, *74*(3), 458-470.

Das, A. N., Sharma, D. K., & Ahmed, R. (2021). An Assessment of physico-chemical parameters of water in association with the ichthyofauna diversity of Dhir beel in Dhubri district of Assam, India. *International Journal of Ecology and Environmental Sciences*, *47*(3), 227-241.

Dudgeon, D., & Strayer, D. L. (2025). Bending the curve of global freshwater biodiversity loss: what are the prospects? *Biological Reviews*, *100*(1), 205-226.

Duncan, D. B. (1955) Multiple range and multiple F tests. *Biometrics,* 11, 1–42.

Flura, M. A., Akhery, N., Mohosena, B. T., & Masud, H. K. (2016). Physico-chemical and biological properties of water from the river Meghna, Bangladesh. *International Journal of Fisheries and Aquatic Studies*, *4*(2), 161-165.

Froese, R., & Pauly, D. (2021). FishBase. Retrieved May 1, 2021, from [www.fishbase.org](http://www.fishbase.org/)

Ghosh, S., & Roy, S. (2022). Climate change, ecological stress and livelihood choices in Indian Sundarban. *Climate change and community resilience*, *399*. doi.org/10.1007/978-981-16-0680-9.

Kumar, J., Alam, A., Sarkar, U. K., Das, B. K., Kumar, V., & Srivastava, S. K. (2020). Assessing the phytoplankton community and diversity in relation to physico-chemical parameters in a tropical reservoir of the River Ganga basin, India. *Sustainable Water Resources Management*, *6*, 1-15.

Li, T., Huang, X., Jiang, X., & Wang, X. (2018). Assessment of ecosystem health of the Yellow River with fish index of biotic integrity. *Hydrobiologia*, 814, 31-43.

Lingham-Soliar, T. (2015). *The vertebrate integument volume 2: structure, design and function*. Springer.

Malik, A., Abbas, G., Jabbar, A., Sajjad Shah, S., & Ali Muhammad, A. (2018). Effect of different salinity level on spawning, fertilization, hatching and survival of common carp, *Cyprinus carpio* (Linnaeus, 1758) in semi-artificial environment. *Iranian Journal of Fisheries Sciences,*17(4), 790-804.

Manekeu Tanetsa, A. E., Lekeufack, M., Edzigui Tsimi, M. L., Tsetagho, G. N., Longniang, R. C., & Fonkou, T. (2023). Eichhornia crassipes Efficacy in Secondary Wastewater Treatment in the Western Highlands of Cameroon. *The Scientific World Journal*, *2023*.

Margalef, R. (1958). Temporal succession and spatial heterogeneity in phytoplankton. In, Perspectives in Marine biology, Buzzati-Traverso (ed.), Univ. Calif. Press, Berkeley, pp. 323-347.

Pielou, E. C. (1966). The measurement of diversity in different types of biological collections. *Journal of Theoretical Biology*. 13, 131-144.

Mehmood, S., Ahmed, I., & Mushtaq, R. (2023). Physico-chemical Parameters and Freshwater Fish Diversity of Sip River Madhya Pradesh, India. *Uttar Pradesh Journal of Zoology*, *44*(17), 1-14.

Mittermeier, R. A., Gil, P., & Goettsch-Mittermeier, C. M. (1997). Earth’s biologically wealthiest nations. *Mexico City: Cemex*.

Mustapha, M.K. (2010) Fish fauna of Oyun reservoir, Offa, Nigeria: *Journal of Aquatic Sciences*, 25(1), 106-114.

Nelson, J. S. (2006). Fishes of the World 4th edition John Wiley & Sons. Nueva York.

Oyewo, S.D. (2005) A survey of fish species diversity and abundance in Dogon Ruwa water body of Kamuku National Park, Birnin Gwari, Kaduna State, Nigeria. Zaria: Ahmadu Bello University. M.Sc dissertation. 2005.

Patel, G., Chari, M. S., Kumar, S., Bhakta, D., Behera, S., Verma, N. K. & Ahmad, T. (2016). Fish fauna diversity of Mahanadi river in Raigarh district, Chhattisgarh. *Journal of Experimental Zoology- India*, *19*(1), 1285-1289.

Prakash, S. (2021). Impact of Climate change on Aquatic Ecosystem and its Biodiversity: An overview. *International Journal of Biological Innovations*, *3*(2).312-317.

Quesada, C. G., Herdman, J., Berasain, G. E., & Miranda, L. A. (2023). Influence of sewage discharge on dissolved oxygen concentration and fish diversity in the Girado stream and Chascomús lake. *Environmental Monitoring and Assessment*, *195*(12), 1433.

Rahman, A.K.A. (2005) Freshwater Fishes of Bangladesh", 2nd edition, Zoological Society of Bangladesh, Department of Zoology, University of Dhaka, Dhaka 1000, Bangladesh. 263 pp.

Rahman, A.K.A. (2007) Exotic fishes and their impact on environment”, 16th Annual General Meeting and National Conference 2007, Zoological Society of Bangladesh, 30 March, Dhaka, Bangladesh, pp. 26- 39.

Rehman, H. J. U., Khabir, M. N., Khan, A. S., Hassan, Z., Khan, I., & Khan, M. K. (2020). 49. Morphometric measurement, relative abundance and effect of physico-chemical parameters of water on ichthyofaunistic diversity of River Tochi District North Waziristan (Newly Merged District), Khyber Pakhtunkhwa. *Pure and Applied Biology (PAB)*, *9*(1), 501-506.

~~Robertson, J. D. (1957). The habitat of the early vertebrates.~~*~~Biological Reviews~~*~~,~~*~~32~~*~~(2), 156-187.~~

Saha, A., De, C., & Das, D. (2019). The study of correlation between physico-chemical parameters and ichthyofaunal diversity at raidak river flowing through the Coochbehar district of west Bengal, India. *Cosmos*, *9*, 9155-9168.

Sarkar, B., & Islam, A. (2019). Assessing the suitability of water for irrigation using major physical parameters and ion chemistry: a study of the Churni River, India. *Arabian Journal of Geosciences*, *12*, 1-16.

Shannon-Wiener, C. E., Weaver, W. & Weater, W. J. (1949). The mathematical theory of communication. The Mathematical Theory of Communication. EUA, University of Illinois Press, Urbana.

Shannon-Wiener, C. E., Weaver, W. & Weater, W. J. (1949). The mathematical theory of communication. The Mathematical Theory of Communication. EUA, University of Illinois Press, Urbana.

Simpson, G. G. (1951). The species concept. *Evolution.* 5:285-298

Surachita, S., & Palita, S. K. (2023). Evaluating the Effect of Physico-Chemical Parameters on Ichthyofaunal Diversity of a Lentic Waterbody in Eastern Ghats, India. *Proceedings of the National Academy of Sciences, India Section B: Biological Sciences*, 1-10.

Talwar, P. K., & Jhingran, A. G. (1991). *Inland fishes of India and adjacent countries* (Vol. 2). CRC press.

Tomar, G., Malik, D. S., Sharma, A. K., Kamboj, V., & Kumar, V. (2022). Assessment of Water Quality and Biodiversity Status of Alaknanda River at Garhwal, Uttarakhand: A Case Study. In *Environmental Pollution and Natural Resource Management* (pp. 121-136). Cham: Springer International Publishing

Uddin, M. G., Nash, S., & Olbert, A. I. (2021). A review of water quality index models and their use for assessing surface water quality. *Ecological Indicators*, *122*, 107218.

Wang, L. (2024). Advances in monitoring and managing aquatic ecosystem health: integrating technology and policy. *International Journal of Aquaculture*, *14(2),101-111*

Mikkola, H. (2024). Aquaculture and Fisheries as a Food Source in the Amazon Region—A Review. *Food & Nutrition Journal*, *9*(286), 1-26.

Rafiu, R. A., Adelodun, O. B., Adeosun, O., Amusat, A. I., Olawumi, Y. L., Oladeru, P. A., & Adewole, M. A. (2025). Composition, Distribution, Relative Abundance and Biodiversity of Fish Species of Ikere-George, Oyo State Nigeria. *Journal of Agricultural and Environmental Science Research*.

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**Please refer to these references to improve the manuscript:**

Radkhah, A.R. & Eagderi, S. 2022. Prevalence of fish lice, *Argulus* (Crustacea: Branchiura) in freshwater and two ornamental fishes of Iran. Journal of Fisheries. 10(3):103301. <https://doi.org/10.17017/j.fish.383>

Janse J.H., Kuiper J.J., Weijters M.J., Westerbeek E.P., J.T.A. Verhoeven. 2015. GLOBIO-Aquatic, a global model of human impact on the biodiversity of inland aquatic ecosystems. Environmental Science & Policy, 48: 99-114. <https://doi.org/10.1016/j.envsci.2014.12.007>

Sadeghinezhad E, Abbasi K, Radkhah A. 2021. Investigation of distribution and frequency of Prussian carp (Carassius gibelio) in Anzali Wetland. Journal of Ornamental Aquatics, 8(4) :45-52. URL: <http://ornamentalaquatics.ir/article-1-272-fa.html>

Radkhah, A. R. , Eagderi, S. and Poorbagher, H. (2022a). Investigation on the relationship between environmental factors and distribution of Kermanshah stone loach (Sasanidus kermanshahensis) in Dinor river using Generalized Additive Model (GAM). Journal of Animal Research (Iranian Journal of Biology), 35(3), 178-189. <https://animal.ijbio.ir/article_2153.html?lang=en>

**Please refer to these references to improve the manuscript:**

Radkhah A R, Eagderi S, Poorbagher H. 2022b. Investigation of environmental factors affecting the abundance and biodiversity of fish communities in Dinor River, Kermanshah province. Journal of Aquatic Ecology, 12 (2) :87-95. URL: <http://jae.hormozgan.ac.ir/article-1-1006-en.html>

Radkhah, Eagderi S, Poorbagher H.2021. Investigating the factors affecting on declining of Luciobarbus capito stocks in the Caspian Sea basin (Case study: Sefidrood River) and proposing solutions for its protection. Journal of Applied Ichthyological Research, 8 (5): 102-108. URL: <http://jair.gonbad.ac.ir/article-1-791-en.html>