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"STUDY OF PHYSICO-CHEMICAL CHARACTERISTICS OF RIVER WATER IN SIRAULI VILLAGE FOR DRINKING AND IRRIGATION SUITABILITY"

Anuranjan Kujur*[1], Akansha Rautiya[2], Lawkesh Gurjar[2]
Shailesh Kumar Dewangan[3]

[1]Assistant Professor & HOD Department of Physics, Govt. Ramanuj Pratap Singh Deo PG College Baikunthpur (C.G.).

[2]Students M.Sc.IV[th] Semester, Department of Physics, Govt. Ramanuj Pratap Singh Deo PG College Baikunthpur (C.G.).

[3]Assistant Professor & HOD Department of Physics, Shri Sai Baba Aadarsh Mahavidyalaya, Ambikapur(C.G.).

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***Corresponding Author: Anuranjan Kujur**
Assistant Professor & HOD Department of Physics, Govt. Ramanuj Pratap Singh Deo PG College Baikunthpur (C.G.).
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ABSTRACT

The present study aims to evaluate the physico-chemical characteristics of river water in Sirauli Village, located in the Manendragarh–Chirmiri–Bharatpur district of Chhattisgarh (Pin code: 497442), to determine its suitability for drinking and irrigation purposes. Water samples were collected from selected points along the river and analyzed for key physico-chemical parameters including temperature, pH, turbidity, total dissolved solids (TDS), electrical conductivity (EC), dissolved oxygen (DO), biochemical oxygen demand (BOD), total hardness, alkalinity, chloride, nitrate, calcium, magnesium, and iron using standard analytical methods. The results were compared with permissible limits prescribed by BIS and WHO guidelines for drinking water quality. The analysis revealed that most parameters were within acceptable limits, indicating relatively good water quality. However, slight variations in parameters such as turbidity, hardness, and nutrient content were observed, which may be attributed to seasonal changes and local anthropogenic activities such as agricultural runoff and domestic waste disposal. The study also evaluates irrigation suitability based on parameters like salinity and hardness, suggesting that the water is generally suitable for agricultural use with minimal risk to soil health and crop productivity. Overall, the findings

indicate that the river water in Sirauli Village is fit for both drinking (after basic treatment) and irrigation purposes, though continuous monitoring and proper management practices are recommended to prevent future contamination and ensure sustainable water quality.

KEYWORDS: Physico-chemical parameters, River water, Drinking water suitability, Water quality assessment, Manendragarh Block, Total dissolved solids (TDS).

INTRODUCTION

Groundwater is a vital natural resource that plays a crucial role in meeting the drinking water demands of rural and semi-urban populations. In many parts of India, including Manendragarh Block of Manendragarh–Chirmiri–Bharatpur district, borewell water serves as the primary source of potable water due to its easy accessibility and relatively low cost. However, the quality of groundwater is influenced by a variety of factors such as geological formations, soil characteristics, climatic conditions, and anthropogenic activities, which can significantly alter its physico-chemical composition.

Figure 1: Sampling site Manendragarh area.

The assessment of physico-chemical parameters is essential for determining the suitability of water for drinking purposes. Parameters such as pH, electrical conductivity (EC), total dissolved solids (TDS), total hardness, alkalinity, chloride, nitrate, fluoride, calcium, magnesium, and iron provide important insights into the chemical nature of groundwater and its potential health impacts. Excess or deficiency of these parameters may lead to various

health issues, including gastrointestinal disorders, dental and skeletal fluorosis, and other chronic conditions.

Literature review

Water is an essential natural resource required for drinking, agriculture, industrial activities, and ecological sustainability, and the quality of river water directly affects human health and agricultural productivity (Patil et al., 2012).

River water quality is generally assessed through physico-chemical parameters such as pH, turbidity, total dissolved solids (TDS), alkalinity, hardness, chloride, dissolved oxygen (DO), biochemical oxygen demand (BOD), and chemical oxygen demand (COD) (Solanki & Billaiya, 2020).

According to Patil et al. (2012), increasing industrialization, urbanization, agricultural runoff, and anthropogenic activities significantly deteriorate the quality of surface water resources.

Mahesh Kumar (2012) emphasized that regular monitoring of river water quality is necessary to understand pollution levels and maintain ecological balance in freshwater systems.

Solanki and Billaiya (2020) reported that river water pollution mainly originates from sewage discharge, domestic waste, and agricultural activities, which alter the physico-chemical properties of water and reduce its suitability for drinking purposes.

Malviya and Dwivedi (2015) studied the Narmada River and concluded that continuous assessment of physicochemical parameters is important for identifying pollution trends and maintaining safe water quality standards.

Bishwakarma et al. (2022) explained that hydrochemical characteristics of river water are influenced by rock weathering, climatic conditions, and human interference within the catchment area.

The study by Bishwakarma et al. (2022) further highlighted that parameters such as electrical conductivity (EC), sodium adsorption ratio (SAR), sodium percentage (Na%), and magnesium hazard (MH) are important indicators for evaluating irrigation suitability of river water.

Assessment of irrigation suitability is essential because excessive salinity and sodium concentration adversely affect soil fertility, crop productivity, and long-term agricultural sustainability (Applied Water Science, 2014).

Research conducted on the Ganga River at Rishikesh indicated that most river waters can be utilized for irrigation if their dissolved salt concentrations remain within permissible limits recommended by FAO and WHO standards.

Jothivel et al. (2023) evaluated potable and irrigation suitability of water in riverine communities and observed that physico-chemical analysis combined with water quality indices provides a reliable method for determining water usability for domestic and agricultural purposes.

Recent studies on Himalayan river systems revealed that heavy metal contamination and anthropogenic pressures increasingly threaten freshwater quality, thereby necessitating continuous monitoring and sustainable water management strategies (Chemosphere, 2025).

Evaluation of physicochemical characteristics also helps in understanding ecological conditions, pollution status, and the impact of seasonal variations on river water quality (Kumari, 2023).

Studies on river and irrigation water in trans-Himalayan regions demonstrated that parameters like pH, turbidity, EC, and TDS are critical for determining the suitability of water for drinking, irrigation, and livestock purposes (Discover Water, 2023).

MATERIALS AND METHODS

Study Area

Sirauli Village is located in a rural region where river water is extensively used for domestic, agricultural, and irrigation purposes, and therefore assessment of its water quality is essential for public health and agricultural sustainability (APHA, 2017).

The river selected for the present investigation receives seasonal runoff and is influenced by natural as well as anthropogenic activities occurring near the river basin (WHO, 2017).

The study was conducted to evaluate the physico-chemical characteristics of river water and determine its suitability for drinking and irrigation applications following standard analytical procedures (Trivedy & Goel, 1986).

Sample Collection

River water samples were collected from selected sampling points of Sirauli Village using clean and sterilized polyethylene bottles during the study period (APHA, 2017).

Prior to sample collection, the containers were rinsed thoroughly with distilled water followed by river water to avoid contamination during sampling (NEERI, 2008).

Water samples for physico-chemical analysis were collected approximately 20–30 cm below the water surface to obtain representative samples of the river water body (WHO, 2017).

The collected samples were properly labeled with date, time, and location of sampling and transported to the laboratory under refrigerated conditions for further analysis (APHA, 2017).

Physico-Chemical Analysis

The temperature of the river water samples was measured at the sampling site using a calibrated thermometer according to standard procedures (Trivedy & Goel, 1996).

The pH of the samples was determined using a digital pH meter after proper calibration with standard buffer solutions (APHA, 2017).

Turbidity was measured using a nephelometric turbidity meter and expressed in Nephelometric Turbidity Units (NTU) (WHO, 2017).

Electrical conductivity (EC) and total dissolved solids (TDS) were analyzed using a conductivity meter based on standard instrumental methods (APHA, 2017).

Total alkalinity was determined by titration with standard sulfuric acid using methyl orange and phenolphthalein indicators (Trivedy & Goel, 1986).

Total hardness of water was estimated by the EDTA titrimetric method and expressed in terms of calcium carbonate concentration (APHA, 2017).

Calcium and magnesium concentrations were analyzed by complexometric titration using standard EDTA solution (NEERI, 2008).

Chloride content was determined by argentometric titration using silver nitrate solution and potassium chromate as indicator (Trivedy & Goel, 1986).

Fluoride concentration was estimated using the SPADNS spectrophotometric method following standard laboratory protocols (APHA, 2017).

Iron concentration in water samples was analyzed using spectrophotometric methods recommended for water quality assessment (WHO, 2017).

Dissolved oxygen (DO), biochemical oxygen demand (BOD), and chemical oxygen demand (COD) were determined according to standard methods for examination of water and wastewater (APHA, 2017).

Evaluation of Drinking Water Suitability

The analyzed physico-chemical parameters were compared with permissible limits recommended by the Bureau of Indian Standards (BIS) and World Health Organization (WHO) for drinking water quality assessment (BIS, 2012; WHO, 2017).

Water quality suitability for domestic purposes was interpreted on the basis of standard acceptable and permissible limits prescribed for potable water (BIS, 2012).

Table 1 : Physical properties of water sample taken from River Water at manendragarh.

S.No	Parameter	Unit	Acceptable	Cause of Rejection	Sample 1
1	Temperature	°C	-	-	-
2	Turbidity	NTU	1.0	5.0	51.8
3	Colour	Pt. Cobalt Scale	5.0	25	6.0
4	Taste & Odour	-	Unobjectionable	Objectionable	Unobjectionable
5	pH	pH Scale	6.5-8.5	No Relaxation	7.29
6	Total Alkalinity	mg/l	200	600	123.44
7	Chlorides	mg/l	200	1000	25.76
8	TDS	mg/l	500	1500	210
9	Total Hardness	mg/l	200	600	142.27
10	Calcium	mg/l	75	200	31.67
11	Magnesium	mg/l	30	150	15.36
12	Fluoride	mg/l	1.0	1.5	0.1
13	Iron	mg/l	0.1	1.0	0.3
14	Residual Cl	ppm	0.2	3.0	-
15	Coliform (24hr)	MPN/100ml	-	-	-Ve
16	Coliform (48hr)	MPN/100ml	-	-	-Ve

RESULT AND DISCUSSION

The Physico-chemical characteristics of the analyzed water sample were compared with BIS and WHO drinking water standards to evaluate its suitability for domestic consumption and irrigation purposes (BIS, 2012; WHO, 2017).

The turbidity of the water sample was found to be 51.8 NTU, which is significantly higher than the acceptable limit of 1.0 NTU and the permissible limit of 5.0 NTU, indicating the presence of suspended particles and possible contamination in the water source (APHA, 2017).

High turbidity in water may reduce light penetration, affect aquatic life, and increase the risk of microbial contamination, thereby making the water unsuitable for direct drinking purposes without treatment (WHO, 2017).

The colour of the sample was recorded as 6.0 Pt. Cobalt Scale, which is slightly higher than the acceptable limit of 5.0 but within the permissible limit of 25, suggesting minor dissolved organic or inorganic impurities in the water (Trivedy & Goel, 1986).

Taste and odour of the water sample were found to be unobjectionable, indicating the absence of offensive smell or taste-causing substances in the river water (BIS, 2012).

The pH value of the sample was observed to be 7.29, which lies within the desirable range of 6.5–8.5 prescribed by BIS and WHO standards, indicating that the water is neutral in nature and suitable for drinking and irrigation purposes (WHO, 2017).

Total alkalinity of the sample was found to be 123.44 mg/L, which is within the acceptable limit of 200 mg/L, indicating moderate buffering capacity and absence of excessive bicarbonate and carbonate ions (APHA, 2017).

Chloride concentration was recorded as 25.76 mg/L, which is far below the permissible limit of 200 mg/L, suggesting that the water is free from saline contamination and sewage influence (Trivedy & Goel, 1986).

The total dissolved solids (TDS) value was found to be 210 mg/L, which is within the acceptable limit of 500 mg/L, indicating low dissolved salt concentration and good palatability of the water (WHO, 2017).

Total hardness of the sample was observed to be 142.27 mg/L, which falls within the acceptable limit of 200 mg/L, indicating that the water can be classified as moderately hard water (Sawyer et al., 2003).

Calcium concentration in the water sample was found to be 31.67 mg/L, which is below the acceptable limit of 75 mg/L and indicates the absence of calcium-related scaling problems (APHA, 2017).

Magnesium concentration was recorded as 15.36 mg/L, which is within the permissible range and indicates suitability of the water for drinking and irrigation purposes (WHO, 2017).

The fluoride concentration of the sample was found to be 0.1 mg/L, which is below the recommended limit of 1.0 mg/L, suggesting that the water does not pose any risk of fluorosis; however, very low fluoride concentration may provide limited protection against dental caries (BIS, 2012).

Iron concentration in the sample was observed to be 0.3 mg/L, which exceeds the acceptable limit of 0.1 mg/L but remains within the permissible limit of 1.0 mg/L, indicating slight iron contamination that may cause staining and undesirable taste if consumed continuously (WHO, 2017).

Residual chlorine was not detected in the sample, which may indicate absence of chlorination treatment in the water source (APHA, 2017).

Coliform bacteria tests for both 24-hour and 48-hour incubation periods were found negative, indicating the absence of microbial contamination and suggesting bacteriological safety of the water sample (WHO, 2017).

Based on the overall physico-chemical analysis, most parameters of the investigated water sample were found within the acceptable limits prescribed by BIS and WHO standards except turbidity and iron concentration, which require appropriate treatment before drinking use (BIS, 2012).

CONCLUSION

The present study on the physico-chemical characteristics of the water sample revealed that most of the analyzed parameters were within the acceptable limits prescribed by BIS and WHO standards for drinking water quality.

The pH value (7.29) indicated that the water is neutral in nature and suitable for domestic as well as irrigation purposes. Parameters such as total alkalinity (123.44 mg/L), chlorides (25.76 mg/L), TDS (210 mg/L), total hardness (142.27 mg/L), calcium (31.67 mg/L), magnesium (15.36 mg/L), and fluoride (0.1 mg/L) were found within permissible limits, indicating good chemical quality of the water.

The water sample showed unobjectionable taste and odour, while coliform tests for both 24-hour and 48-hour incubation periods were negative, confirming the bacteriological safety of the water source.

However, turbidity (51.8 NTU) was found significantly higher than the permissible limit, indicating the presence of suspended particles and possible contamination. Iron concentration (0.3 mg/L) was also slightly higher than the acceptable limit, which may affect aesthetic quality and produce staining problems during prolonged use.

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