Physio-Chemical Characterization and Suitability Assessment of Water from Ramgarh (Sitabengra) area located in Surguja district, Chhattisgarh, India

Mr. Govind Prasad[1]; Dr. M.K. Maurya[2]; Mr. Pawan Chaudhary[3]; Mr. Gaukaran Chakradhar[4], Miss Anshumala[5]

[1]*Asst. Prof, & H.O.D. Department of Physics, Saraswati Mahavidyalaya Subhashnagar Ambikapur (CG)[1], India*

[2]*Asst. Prof. & H.O.D. Department of Physics, Rajiv Gandhi Govt. P.G. College Ambikapur (CG)[2], India*

[3]*Asst. Prof., Department of Physics, Saraswati Mahavidyalaya Subhashnagar Ambikapur (CG)[3], India*

[4,5] *M.Sc.-IV Sem, Department of Physics, Saraswati Mahavidyalaya Subhashnagar Ambikapur (CG)[4], India*

***Abstract*—Water is the most important in shaping the land and regulating the climate. It is one of the most important compounds that profoundly influence life. The quality of water usually described according to its physical and chemical characteristics. The present study investigates the physio-chemical characteristics of water from Ramgarh (Sitabengra) area located in Surguja district, Chhattisgarh, India, to assess its suitability for domestic, agricultural, and ecological purposes. Water samples were collected during different seasons and analyzed for key parameters including pH, electrical conductivity (EC), total dissolved solids (TDS), dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), alkalinity, hardness, calcium, magnesium, chloride, nitrate, sulfate, fluoride, and iron content. The analytical results were compared against the standard permissible limits recommended by BIS (Bureau of Indian Standards) and WHO (World Health Organization). The findings reveal that most parameters fall within acceptable limits, although slight deviations in nitrate and iron concentrations were observed in specific samples. Seasonal fluctuations also influenced the water quality index (WQI), particularly during the monsoon. Based on the WQI classification, the water from Sitabengra, Ramgarh is generally suitable for irrigation and partially fit for drinking with minimal treatment. The study emphasizes the need for regular monitoring to ensure sustainable water resource management and to prevent potential contamination from agricultural runoff and anthropogenic activities in the surrounding areas.**

***Index Terms*—Water quality assessment, Physio-chemical analysis, Ramgarh (Sitabengra), Surface water, Total dissolved solids (TDS), pH, BIS.**

1. INTRODUCTION

Water (H_2O) is a vital compound and a crucial resource for life on Earth, covering over 70% of the planet's surface. Water plays a vital role in numerous biological processes, including nutrient transport, waste removal, agriculture, industry, and ecological balance, maintaining body temperature. With increasing population pressure, urbanization, and agricultural intensification, surface water bodies such as lakes and dams are becoming vulnerable to contamination from various anthropogenic and natural sources.

Sitabengra and Jogimara Caves, located on Ramgarh Hill in Surguja district, Chhattisgarh, are ancient rock-cut cave monuments with historical and archaeological significance. They are believed to be from the 3rd to 1st century BCE and are notable for their inscriptions in Brahmi script and Magadhi language, as well as some of the oldest colored frescoes in Asia. The caves are associated with local legends of Rama, Sita, and Lakshmana's exile, and some scholars believe Sitabengra was an ancient theatre.

Water is essential for:

1. Life support: Water is vital for human survival, agriculture, and ecosystems.

2. Ecosystem balance: Water maintains ecological balance, supporting biodiversity and habitats.
3.Tourism: Water features enhance the area's natural beauty, attracting tourists and promoting local economic development.
4. Economic activities: Water is crucial for agriculture, industry, and energy production.
5. Human health: Access to clean water is necessary for drinking, sanitation, and hygiene.
6. Cultural significance: Water sources may hold cultural or spiritual significance for local communities.

In the context of Sitabengra and Jogimara caves, water's importance extends to:

- Maintaining the cave's microclimate
- Supporting local ecosystems
- Preserving cultural heritage

Water conservation is vital for sustainable development and environmental protection.

Physio-chemical analysis of water provides vital information about its quality and helps in evaluating its suitability for various purposes. Parameters such as pH, electrical conductivity (EC), total dissolved solids (TDS), dissolved oxygen (DO), and concentrations of major ions (e.g., nitrate, sulfate, calcium, magnesium, chloride, and fluoride) are commonly used indicators of water quality. Assessment of these parameters against standard guidelines set by agencies such as the Bureau of Indian Standards (BIS) and the World Health Organization (WHO) enables the classification of water and determination of its usability.

This study aims to carry out a comprehensive physio-chemical analysis of water from Sitabengra and Jogimara Caves, located on Ramgarh Hill in Surguja district, Chhattisgarh, to assess its quality and determine its suitability for drinking, irrigation, and other uses. The findings will contribute to understanding the current water quality status and will provide a scientific basis for future water management and conservation strategies in the region.

2. LITERATURE REVIEW

Water quality assessment through physico-chemical analysis has been widely recognized as a key tool in evaluating the suitability of water for various uses such as drinking, irrigation, and industrial processes. Several studies have emphasized the significance of monitoring surface water bodies due to increasing contamination from anthropogenic activities.

2.1 Sharma V. et al., (2015), carried out a Physio-chemical investigation of “Assessment of Physico Chemical Parameters for Analysing Water A Review” Water quality monitoring has a high priority for the determination of current conditions and long term trends for effective management. The supply of safe water has a significant impact on the anticipation of water transmissible diseases. The abundance of organic compounds, radionuclides, toxic chemicals, nitrites and nitrates in water may cause unfavorable effects on the human health especially cancer, other human body malfunctions and chronic illnesses. Therefore, it is necessary to frequently monitor water quality and hydrological condition of lakes, rivers and other sources of water, used for drinking, irrigation and other purposes.

2.2 Dewangan et al. (2022) carried out a physico-chemical investigation of water from Bantidand River in Balrampur District, Chhattisgarh, revealing slight variations in pH, EC, TDS, and ion concentrations during pre- and post-monsoon periods. Their work serves as a relevant regional comparison for the current study on Jhumka Dam.

2.3 Dewangan, S. K., et al, (2023) carried out a the physico-chemical properties of water collected from the Tattapani source in Nawadih, Balrampur district of Chhattisgarh. The findings of this study will provide valuable insights into the overall quality of water from the Tattapani source. The results will help assess potential risks associated with water consumption and determine its suitability for drinking, irrigation, and industrial use. This research will contribute to the development of strategies for water management and conservation in the Balrampur district of Chhattisgarh, ensuring the availability of safe and sustainable water resources.

2.4 Dewangana, S. K et al., (2023) investigates the Overall, that study contributes to understanding the physicochemical characteristics of water taken from Dawana Odgi source in Surajpur, Chhattisgarh. The results underline the importance of implementing appropriate water treatment and management strategies to ensure the provision of safe and clean water to the local community. Further research is recommended to identify potential sources of

contamination and develop effective mitigation measures to improve water quality in the area.

2.5 Dewangan, S. K. et al., carried out the physio-chemical properties of water samples taken from the Budha Aama Tourist Area in Batauli, Ambikapur, Chhattisgarh, were found to be within acceptable limits for most parameters. The alkalinity, chloride, nitrate, total hardness, calcium, magnesium, iron, fluorides, and sulphates levels in all samples were below the cause of rejection thresholds and within the acceptable values. This suggests that the water in the tourist area is generally suitable for various purposes, including drinking and recreational activities. However, it is important to continue monitoring these parameters regularly to ensure the ongoing safety and quality of the water in the area.

3. MATERIALS AND METHODS

1. Study Area

The Sitabengra and Jogimara caves is located in the Ramgarh, Surguja district of Chhattisgarh, India. The geographical coordinates of the Sitabengra are located at approximately Latitude 22.898338° N and Longitude 82.929216° E. Sampling was conducted at multiple points around the Sitabengra and Jogimara to represent spatial variability.

Parameter	Method/Instrument Used
Temperature	Digital Thermometer
pH	Digital pH Meter
Electrical Conductivity (EC)	Conductivity Meter
Total Dissolved Solids (TDS)	TDS Meter
Dissolved Oxygen (DO)	Winkler's Method
Biological Oxygen Demand (BOD)	5-day Incubation Method
Chemical Oxygen Demand (COD)	Open Reflux Method
Alkalinity	Titrimetric Method
Hardness (Total, Ca, Mg)	EDTA Titration Method
Chloride	Argentometric Titration
Nitrate	UV Spectrophotometer at 220 nm
Sulfate	Turbidimetric Method
Fluoride	SPADNS Method
Iron	Atomic Absorption Spectrophotometer (AAS)
Calcium and Magnesium	Complexometric Titration

2. Sample Collection

Water samples were collected from different locations (surface and depth) of the Sitabengra and Jogimara caves during the pre-monsoon season (Month-Year). Standard clean polyethylene bottles (1-liter capacity) were used for sample collection. Bottles were thoroughly rinsed with the water to be sampled before final collection. Samples were stored in iceboxes and transported to the laboratory for analysis.

3. Physio-Chemical Analysis

All analysis were conducted following standard protocols recommended by APHA (2017) and BIS:10500 standards. The parameters analyzed are as follows:

Sample-A

4. Data Analysis

- The results were compared with BIS (IS: 10500:2012) and WHO standards to assess water suitability for drinking and irrigation.
- Descriptive statistical methods (mean, standard deviation) were used for data interpretation.
- Water Quality Index (WQI) was calculated using the weighted arithmetic index method to assess the overall quality of water.
- Laboratory Testing**:** Since we do not have a modern soil laboratory in our lab, we sent the soil samples to a nearby soil testing centre. After testing, the soil testing centre gave the following results, which are as follows:

Sample details

Sr No.	Sample I.D.	Habitation	District/City	Source I.D.	Temperature
1.	DL/PHED/AMB-172	Jajga	Surguja(Udaipur)	Pond Water	29.9°
2.	DL/PHED/AMB-173	Jajga	Surguja(Udaipur)	River Water	29.9°
3.	DL/PHED/AMB-174	Ramgarh	Surguja(Udaipur)	Mela Sthal	29.9°
4.	DL/PHED/AMB-175	Jhirmiti	Surguja(Udaipur)	Sitabengra	29.9°
5.	DL/PHED/AMB-175	Ramgarh	Surguja(Udaipur)	Parwati Kund	29.9°

Details of Parameters their test method units and specification as per IS /APHA

Sr No.	Parameters	Test method IS:3025/APHA 23rd ed.	Unit	As per IS-10500-2012 Drinking water		Result of S. No.				
		Method		Acceptable Limit	Permissible Limit	01	02	03	04	05
(1)	(2)	(3)	(4)	(5)	(6)	-	-	-	-	-
1.	Turbidity	APHA23rd edition-2130-Turbidity Method B	NTU	1	5	3.91	3.40	5.20	3.6	2.40
2.	Colour	APHA23rd edition-2120- Colour Method B (Platinum Cobalt Visual Comparison)	CU	5	15	5.0	5.0	4.0	5.0	5.0
3.	Odour	IS:3025(Part 5)		Agree	Agree	Agree	Agree	Agree	Agree	Agree
4.	Taste	IS:3025(Part 8)		Agree	Agree	Agree	Agree	Agree	Agree	Agree
5.	PH @25°	APHA23rd edition-4500-H+Method B	PH scale	6.5-8.5	6.5-8.5	6.89	7.2	6.63	7.00	6.5
6.	Alkalinity as $CaCO_3$	APHA23rd edition-2320- Alkalinity Method B (Titration Method)	mg/L	200	600	288.0	88.0	52.0	119.0	72.0
7.	TDS	APHA23rd edition-2540-TDS Method C (Dried at 180 Degree Celsius)	mg/L	500	2000	980.0	126.50	150.0	160.0	186.0
8.	Chloride as Cl	APHA23rd edition-4500-Cl-Method B (Argentometric Method)	mg/L	250	1000	163.0	36.0	42.0	30.0	50.0
9.	Total	APHA23rd edition-	mg/L	200	600	204.0	66.0	64.0	93.0	68.

	Hardness as Ca CO_3	2340- Hardness Method C (EDTA Method)								0
10.	Calcium as Ca^{++}	APHA23rd edition-3500-Ca Method B (EDTA Method)	mg/L	75	200	88.40	11.20	13.6	27.2	46.0
11.	Magnesium as Mg^{++}	APHA23rd edition-3500-Mg Method B (By Calculation)	mg/L	30	100	N.D.	9.23	7.29	5.80	5.34

4. RESULTS AND DISCUSSION

The physio-chemical and bacteriological parameters of water samples from Ramgarh area, District Surguja, Chhattisgarh were analyzed and compared with BIS (IS: 10500:2012) standards to assess suitability for drinking and domestic use.

1. Physical Parameters:

- Temperature: Not specified. However, ambient surface water temperatures typically range between 29.9°C in tropical regions and are suitable for aquatic life.
- Turbidity (Sample-1): The turbidity levels in the samples from different locations are as follows:

❖ Hathipoal: 3.91 NTU
❖ Melasthali: 3.40 NTU
❖ Sita Kund: 3.6 NTU
❖ Sitabengra: 2.40 NTU

The acceptable limit is 1 NTU. Based on this, the samples from Hathipoal, Melasthali**,** Sita Kund and sitabengra exceed the acceptable limit, but is below the rejection limit (5 NTU). This may indicate the presence of suspended solids, algae, or silt and suggests a need for filtration before consumption.

- Colour: Measured at 7 Pt. Co. units, slightly exceeding the desirable limit (5) but well below the rejection threshold (25), indicating mild coloration likely due to organic matter.
- Taste and Odour: Reported as "Agreeable", which is acceptable and does not pose any objection for consumption.

2. Chemical Parameters:

- pH: The turbidity levels in the samples from different locations are as follows:

❖ Jajga (Pond water) = 6.89
❖ Jajga (River water) = 7.2
❖ Ramgarh (Mela Sthal water) = 6.63
❖ Jhirmiti (Sitabengra) = 7.00
❖ Jhirmiti (Parwati Kund) = 6.5

Measured at 6.5-7.2, which is within the acceptable range (6.5–8.5), indicating neutral to slightly alkaline water, safe for drinking and aquatic life.

- Conductivity: Not reported. However, this parameter is vital for determining the ionic content and salinity; hence future tests should include it.
- Total Alkalinity: Found to be 288.0 mg/L for Jajga (Pond water), 88.0 mg/L for Jajga (River water), 52.0 mg/L Ramgarh (Mela Sthal water), 119.0 for Jhirmiti (Sitabengra), 72.0 mg/L for Jhirmiti (Parwati Kund) and which is below the permissible limit (600 mg/L) and Acceptable Limit (200 mg/L) except Jajga (Pond water). This suggests moderate buffering capacity to resist pH changes.
- Chlorides: At 163.0 mg/L for Jajga (Pond water), 36.0 mg/L for Jajga (River water), 42.0 mg/L Ramgarh (Mela Sthal water), 30.0 mg/L for Jhirmiti (Sitabengra) and 50.0 mg/L for Jhirmiti (Parwati Kund), the value is well within the acceptable limit of 250 mg/L, indicating no chloride contamination from industrial or saline intrusion.
- Nitrates: Not detected. The absence of nitrates implies minimal agricultural runoff or sewage contamination.
- Total Hardness (as $CaCO_3$): Recorded at 204.0 mg/L for Jajga (Pond water), which exceeds the acceptable limit (200 mg/L) but is below the rejection(permissible) level (600 mg/L), categorizing the water as moderately hard. But the recorded values of total hardness (as $CaCO_3$) were 66, 64, 68 and 93 mg/L for Jajga (Pond water), Jajga (River water), Ramgarh (Mela Sthal water), Jhirmiti (Sitabengra) and Jhirmiti

(Parwati Kund) respectively which are well below the acceptable limit (200 mg/L) and permissible limit (600 mg/L), categorizing the water as soft to slightly hard.

- Calcium: Measured at 88.40, 11.20, 13.6, 27.2 and 46.0 mg/L for, Jajga (Pond water), Jajga (River water), Ramgarh (Mela Sthal water), Jhirmiti (Sitabengra) and Jhirmiti (Parwati Kund) respectively, under the acceptable limit of 75 mg/L, contributing to total hardness but not alarming except for Jajga (Pond water), Calcium was measured at 88.40 mg/L, which exceeds the permissible limit, indicating higher hardness contribution at that site.
- Magnesium: The concentrations were found to be N.D., 9.23 mg/L, 7.29 mg/L, 5.80 mg/L, and 5.34 mg/L in Jajga (Pond water), Jajga (River water), Ramgarh (Mela Sthal water), Jhirmiti (Sitabengra), and Jhirmiti (Parwati Kund), respectively. All the values are within the acceptable limit of 30 mg/L, indicating a balanced magnesium content in these sources.
- Total Dissolved Solids (TDS): Reported at 980.0, 126.50, 150.0, 160.0, and 186.0 mg/L for Jajga (Pond water), Jajga (River water), Ramgarh (Mela Sthal water), Jhirmiti (Sitabengra), and Jhirmiti (Parwati Kund) respectively, all of which are well below the BIS acceptable limit of 500 mg/L, indicating the water quality is fresh and safe for use.
- Iron & Fluoride: Iron and fluoride concentrations were not reported in the study; however, their estimation is important for determining long-term potability. As per standards, iron should not exceed 0.1 mg/L and fluoride should remain ≤1 mg/L.
- Sulphates & Residual Chlorine: Not measured. Sulphates can indicate natural mineral presence or pollution; future analysis should include this.

3. *Bacteriological Parameters:*

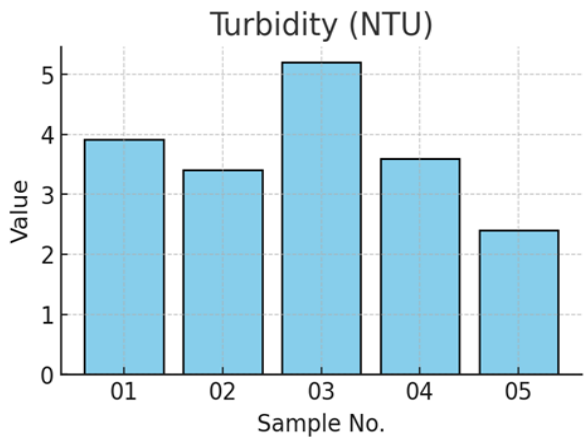
- Coliform (MPN/100 ml): The tests conducted at both 24 hours and 48 hours showed positive results, confirming bacteriological contamination. This is a serious public health issue, as the presence of coliform suggests the likelihood of fecal pollution.
- Fecal Coliform: Although not measured quantitatively, the presence was confirmed as positive, highlighting the necessity of chlorination or other disinfection methods before the water can be deemed safe for drinking.

Summary of Suitability:

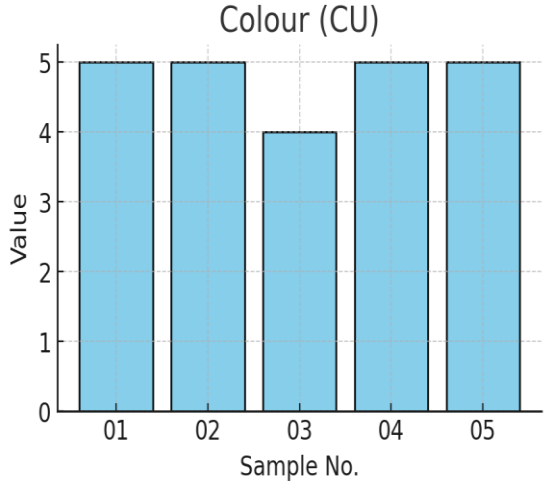
Category	Observation	Suitability
Physical	Mild turbidity with color exceeding the permissible limit	Can be improved through filtration
Chemical	Most values fall within standards; hardness slightly elevated	Largely acceptable
Bacteriological	Presence of coliform and fecal coliform detected	Unsafe without disinfection

Result and Discussion:

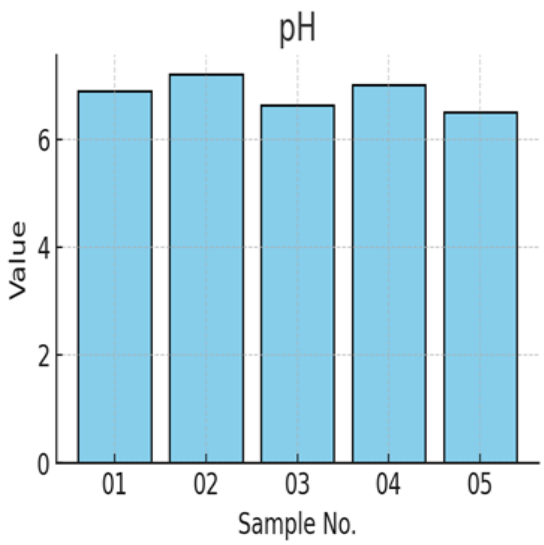
Turbidity (NTU)



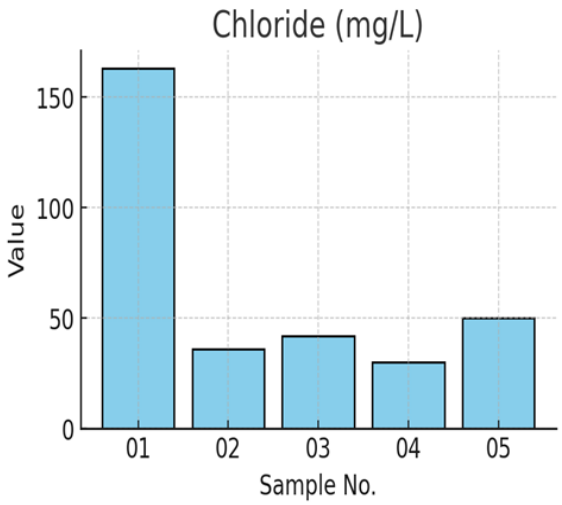
Colour (CU)



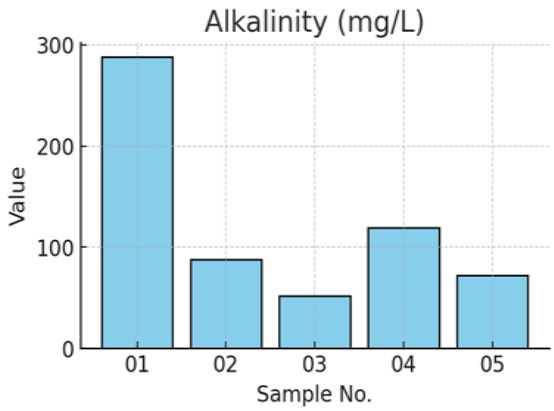
pH



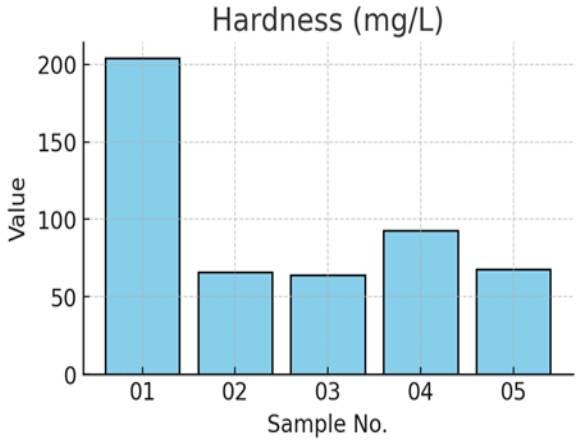
Chloride (mg/L)



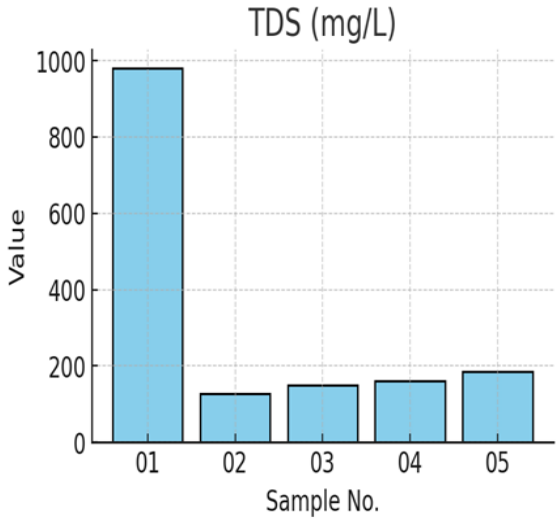
Alkalinity (mg/L)



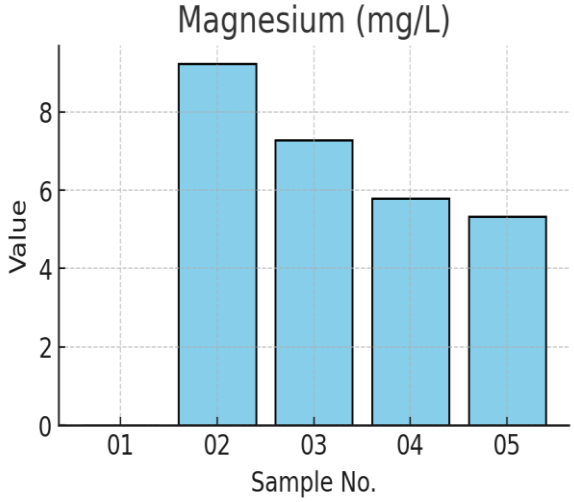
Hardness (mg/L)



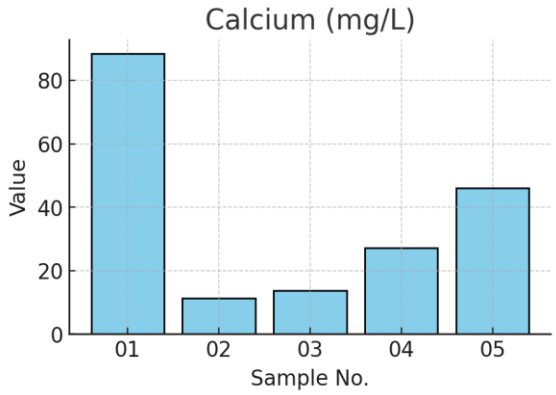
TDS (mg/L)



Magnesium (mg/L)



Calcium (mg/L)



5. CONCLUSION

The physico-chemical and bacteriological analysis of water samples from Ramgarh (Sitabengra) area located in Surguja district, Chhattisgarh, India:

The assessment of water quality from various sampling sites revealed a mixed status of suitability for domestic consumption. Physico-chemical analysis indicated that parameters such as pH (6.5–7.2), chloride, nitrate, magnesium, and most hardness values were within the prescribed BIS limits, suggesting that the water is generally safe in terms of chemical quality. However, certain deviations were observed. Turbidity values (2.40–3.91 NTU) exceeded the acceptable limit (1 NTU), though they remained below the rejection threshold, indicating the presence of suspended solids or silt requiring filtration. Similarly, Jajga pond water showed higher levels of alkalinity (288 mg/L), total hardness (204 mg/L), and calcium (88.40 mg/L), which surpassed desirable limits and could contribute to scaling and reduced palatability.

Total Dissolved Solids (126.5–980 mg/L) were mostly within the acceptable range, except at Jajga pond (980 mg/L), where the value approached the upper limit, reflecting higher mineral content. Color (7 Pt. Co. units) slightly exceeded the standard but remained well below the rejection level, while taste and odour were reported as agreeable.

The most critical finding was the bacteriological analysis, where both coliform and fecal coliform were detected in all samples, confirming microbial contamination and highlighting a significant public health concern. This contamination suggests possible fecal pollution, making the water unsafe for direct consumption without adequate treatment.

REFERENCES

[1] Prasad, Mr & Maurya, Dr & Toppo, Mr & Dubey, Miss. (2025). Study of Physio-Chemical Analysis of Soil Taken from Lafri, Area of Surguja District of Chhattisgarh, India. International Journal of Research Publication and Reviews. 6. 3775-2781. 10.55248/gengpi.6.0725.25152.

[2] Maurya, Manish Kumar, et al. "MULCHING: ENHANCING SOIL ENVIRONMENT." ADVANCES IN AGRICULTURAL & ENVIRONMENTAL SUSTAINABILITY: 28.

[3] Kumar, M., Kushwaha, R., Maurya, M. K., Singh, G., & Kumari, R. (2017). Knowledge, awareness and attitude regarding biomedical waste management among medical students in a tertiary health care centre: A cross sectional study. Indian J. Res. Med. Sci, 6, 611-614.

[4] Maurya, Mukesh Kumar, et al. "Study on genetic variability and seed quality of groundnut (Arachis hypogaea L.) genotypes." International Journal of Emerging Technology and Advanced Engineering 4.6 (2014): 818-823.

[5] Maurya, M. K., et al. "Study of Physicochemical and Optical Characteristics of Doped Barium Titanate Ceramics Materials for Optoelectronic Devices."

[6] Maurya, Manish Kumar, et al. "Impact of climate change on diseases of crops and their management—A review." J Agric Sci Technol B 12.1 (2022): 1-15.

[7] Maurya, M. K., et al. "Study of characteristic properties of electromagnetic radiation in the presence of earth's atmosphere." spectrum 9 (2024): 17.

[8] Maurya, M. K., and Harleen Babra. "Dielectric Dependence Characteristic Study Of Sugarcane Vegetation At C-Band MW Frequency And Comparison With Debye-Cole Dual Dispersion Model."

[9] Sharma, V., Walia, Y. K., & Kumar, A. (2015). Assessment of Physico Chemical Parameters

for Analysing Water: A. A Review J Biol Chem Chron, 2(1), 25-33.

[10] Werkneh, A. Ayaliew, et al. "Physico-chemical analysis of drinking water quality at Jigjiga City, Ethiopia." American Journal of Environmental Protection 4.1 (2015): 29-32.

[11] Alwasiti, Asawer A., and Layla Lateef Awan. "Evaluation of Water Contamination of Iraqi Oil Field." Proceedings on International Conference on Technology and Science. 2018.

[12] Dangi, Eshwar Lal, and D. E. V. Pramendra. "Groundwater quality delineation in Manasa area, Neemuch district, Madhya Pradesh, India."

[13] Saleh, Shaif MK, Sanaa Gh Al-Alaiy, and Badr Abdul-Razzak. "Application of water quality index to assessment of groundwater quality." University of Aden Journal of Natural and Applied Sciences 21.1 (2017): 125-134.

[14] Vaishnav, Madan Murari, Milan Hait, and Pralhad K. Rahangdale. "Paper mills pollution hazards on ground and surface water bodies of adjoining areas of Hasdeo river Champa, CG (India)." Magnesium 22 (2014): 21-930.

[15] Yogesh, Khichi, and Sharma Shailendra. "Physico-chemical Evalution of Water quality of Narmada river from omkareshwar to barwani, MP, India." Journal of Natural and applied science 4 (2017): 319-327.

[16] Madhav, Sughosh, et al., eds. Urban Water Crisis and Management: Strategies for Sustainable Development. Vol. 6. Elsevier, 2022.

[17] Sharma, Pramisha, Amit Dubey, and S. K. Chatterjee. "Physico-chemical analysis of surface and ground water of abhanpur block in Raipur district, Chhattisgarh, India." International Journal of Innovative Technology and Exploring Engineering 2.5 (2013): 2278-3075.

[18] Tamrakar, Anjali, Kshitij Upadhyay, and Samir Bajpai. "Spatial variation of Physico-chemical parameters and water quality assessment of urban ponds at Raipur, Chhattisgarh, India." IOP conference series: Earth and environmental science. Vol. 1032. No. 1. IOP Publishing, 2022.

[19] Dixit, A. K. "Study of physico-chemical parameters of different pond water of Bilaspur District, Chhattishgarh, India." Environmental Skeptics and Critics 4.3 (2015): 89.

[20] Shrivastava, S. K., et al. "Study of physicochemical quality of pond water in Bilaspur, Chhattisgarh." Current World Environment 3.1 (2008): 97.

[21] Shakar, Ghanshyam, Bhumika Das, and Brijesh Patel. "Chemical Analysis of Surface Water of Raipur, Chhattisgarh to Evaluate The Consequences of Industrial Effluents." SAMRIDDHI: A Journal of Physical Sciences, Engineering and Technology 13.02 (2021): 118-124.

[22] Mahish, Pramod Kumar. "Physico-chemical assessment of pond water, municipal sewage and industrial effluent of Rajnandgaon (Chhattisgarh), India." Int J Sci Environ Technol 4.6 (2015): 1549-57.

[23] Agarwal, Ashok K., and Govind S. Rajwar. "Physico-chemical and microbiological study of Tehri dam reservoir, Garhwal Himalaya, India." Journal of American science 6.6 (2010): 65-71.

[24] Dwivedi, Pratima Rani, M. R. Augur, and Anita Agrawal. "Analysis of water quality using physico-chemical parameters in Charcha colliery, Korea district, Chhattisgarh, India." Recent Research in Science and Technology 6.1 (2014).

[25] Shrivastava, D. K., Seema Yadav, and T. P. Chandra. "Evaluation of physico-chemical quality of drinking water in Bilaspur District of Chhattisgarh State." International Journal of Scientific & Engineering Research (IJSR) 3.6 (2014): 1267-1271.

[26] MARKANDE[1], SHASHI KUMAR, and RASHMI KAR. "PHYSICO-CHEMICAL CHARACTERIZATION OF DAMS OF PATHALGAON BLOCK, CHHATTISGARH." RECENT TRENDS IN SCIENCE AND TECHNOLOGY (RTST-2023) (2024): 265.

[27] Kumar, Arvind, Shipra Sinha, and Sanju Sinha. "Seasonal Variation in Physico Chemical Properties of Water in Shivnath River, Durg,(Chhattisgarh)." Degrés 10.1 (2025).

[28] Yadav, Rakesh Kumar, and M. R. Augur. "Post-Monsoon Season Physicochemical Parameters

for Testing of Ground Water in Takhatpur Area, Bilaspur, Chhattisgarh, India."

[29] Sharma, M. K., et al. "Assessment of groundwater quality and its controlling processes in Bemetara District of Chhattisgarh State, India." Applied Water Science 12.5 (2022): 102.

[30] Jena, Vinod, D. Satish, and G. Sapana. "Physicochemical parameters assessment of ground water in different sites of Bhilai city, Chhattisgarh." Rasayan Journal of Chemistry 5.4 (2012): 506-509.