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An Analysis of the Physico-Chemical Properties of Water of Banki Dam, Khairbar Region, Ambikapur, District- Surguja, Chhattisgarh, India

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ABSTRACT

This research investigates the physico-chemical characteristics of water from the Banki Dam in the Khairbar region of Ambikapur, situated in the Surguja district of Chhattisgarh, India. The study aims to assess the suitability of the dam water for domestic and agricultural use by analyzing its physical and chemical properties. Water samples were collected and examined for key parameters including pH, alkalinity, hardness, total dissolved solids (TDS), chlorides, nitrates, iron, fluoride, sulphates, specific conductivity, turbidity, and bacteriological quality. The results were evaluated in comparison with standards prescribed by the Bureau of Indian Standards (BIS) and the World Health Organization (WHO). Findings revealed that most of the parameters fell within acceptable limits, with slight deviations in iron concentration and turbidity. The water is classified as soft, with low TDS and conductivity, indicating good mineral balance and suitability for both consumption and irrigation. Absence of microbial contamination further strengthens its quality. The study concludes that while the Banki Dam water is largely safe, regular monitoring and minimal treatment interventions are recommended to maintain its quality.

1. INTRODUCTION

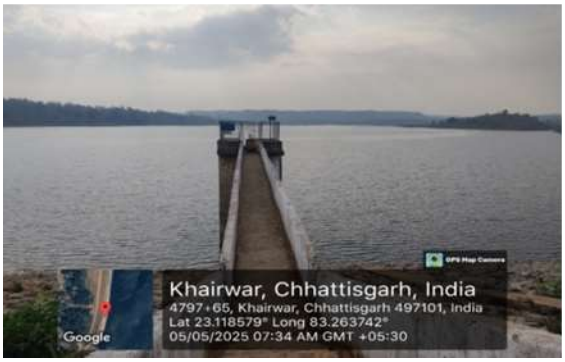
Water is one of the most vital natural resources necessary for the survival of all forms of life. It plays a critical role not only in sustaining human life but also in agricultural productivity, industrial activities, and ecological balance. In recent decades, increasing anthropogenic activities have led to the degradation of water quality across the globe. Monitoring the physico-chemical properties of water is essential for ensuring its suitability for drinking, irrigation, and other uses.

The present study is focused on analyzing the water quality of Banki Dam, located in the Khairbar region of Ambikapur, in Surguja district, Chhattisgarh, India. This reservoir is a significant source of water for the surrounding rural areas, supporting both domestic and agricultural needs. Therefore, regular assessment of water quality is crucial to prevent health hazards and maintain ecological balance.

The assessment involves a detailed analysis of the physical and chemical characteristics of the water sample (Result 2) collected from the dam, compared against the acceptable and permissible limits set by national and international agencies. The goal of the study is to evaluate whether the water is fit for consumption and irrigation purposes and to understand the factors contributing to any deviation from the standard limits.

2. STUDY AREA DESCRIPTION

Banki Dam, situated in the Khairbar region near Ambikapur in the Surguja district of Chhattisgarh, is a crucial water body that caters to the needs of a large rural population. Geographically, the dam lies in a region with rich lateritic soil and is surrounded by agricultural fields, forest cover, and semi-urban settlements.



The region experiences a tropical climate with distinct summer, monsoon, and winter seasons. The average annual rainfall in the area is about 1200–1400 mm, mostly received during the monsoon months of June to September. Due to its geographical location and environmental conditions, the dam is subject to run-off from nearby agricultural fields, domestic waste discharge, and seasonal variations that can influence its water quality.

Being a primary source of irrigation and household water use, it becomes imperative to periodically test the water from this dam for potential contamination and variation in its physico-chemical properties.

3. MATERIALS AND METHODS

3.1 Sample Collection

Water samples were collected from Banki Dam (Result 2) following standard sampling procedures. Samples were collected in clean, sterilized containers and analyzed in a certified laboratory. The tests were conducted for both physical and chemical parameters.

3.2 Parameters Analyzed

Chemical Parameters:

- pH @25°C
- Alkalinity (as $CaCO_3$)
- Total Dissolved Solids (TDS)
- Chloride (as Cl^-)
- Total Hardness (as $CaCO_3$)

- Calcium (as Ca^{2+})
- Nitrate (as NO_3^-)
- Iron (as Fe^{2+})
- Fluoride (as F^-)
- Residual Chlorine
- Sulphate (as SO_4^{2-})
- Specific Conductivity @25°C
- Bacteriological analysis

Physical Parameters:

- Turbidity
- Colour
- Odour
- Taste

3.3 Standard Guidelines for Comparison

The results were compared with standards provided by:

- Bureau of Indian Standards (BIS:10500)
- World Health Organization (WHO)

Both the acceptable and permissible limits were taken into account during the analysis.

4. ANALYSIS OF PHYSICO-CHEMICAL PARAMETERS

4.1 pH @25°C

- Result: 7.2 (within 6.5–8.5)
- Interpretation: Neutral to slightly alkaline, suitable for drinking and irrigation.

4.2 Alkalinity as $CaCO_3$

- Result: 66.0 mg/L (below 200 mg/L)
- Interpretation: Low buffering capacity, not a concern.

4.3 Total Dissolved Solids (TDS)

- Result: 127.0 mg/L (below 500 mg/L)
- Interpretation: Excellent quality, low mineral content.

4.4 Chloride as Cl^-

- Result: 23.0 mg/L (below 250 mg/L)
- Interpretation: Low, indicates no saline or sewage contamination.

4.5 Total Hardness as $CaCO_3$

- Result: 72.0 mg/L (below 200 mg/L)
- Interpretation: Soft water, suitable for household and agricultural use

4.6 Calcium as Ca^{2+}

- Result: 32.0 mg/L (below 75 mg/L)
- Interpretation: Moderate level, beneficial mineral content.

4.7 Nitrate as NO_3^-

- Result: 25.6 mg/L (below 45 mg/L)
- Interpretation: Moderate, possibly from agricultural runoff.

4.8 Iron as Fe^{2+}

- Result: 0.38 mg/L (above 0.3 mg/L but below 1.0 mg/L)
- Interpretation: Slightly high, may cause staining but not hazardous.

4.9 Fluoride as F^-

- Result: 0.12 mg/L (below 1.0 mg/L)
- Interpretation: Safe, low levels.

4.10 Residual Chlorine

- Result: Not Detected
- Interpretation: No disinfection residue; microbial safety needs confirmation.

4.11 Sulphate as SO_4^{2-}

- Result: 36.8 mg/L (below 200 mg/L)
- Interpretation: Well within safe limits.

4.12 Bacteriological

- Result: Absent
- Interpretation: Safe from bacterial contamination.

4.13 Specific Conductivity @25°C

- Result: 198.0 µS/cm
- Interpretation: Low conductivity, confirming low TDS.

4.14 Turbidity

- Result: 4.1 NTU (above 1 NTU but below 5 NTU)
- Interpretation: Acceptable but should be filtered.

4.15 Colour

- Result: 5.0 Hazen Units (at limit)
- Interpretation: Acceptable visually.

4.16 Odour and Taste

- Result: Agreeable

- Interpretation: Good aesthetic quality.

5. DISCUSSION

The water quality parameters analyzed in this study indicate that the Banki Dam water (Result 2) is generally safe for consumption and agricultural use. Most parameters fall well within the acceptable and permissible limits set by BIS and WHO standards. However, a few indicators highlight potential concerns requiring continuous monitoring.

For example, the iron content (0.38 mg/L) slightly exceeds the BIS acceptable limit (0.3 mg/L), which, while not directly hazardous to health, could cause taste, color, and staining issues. Similarly, turbidity is slightly above the acceptable threshold but within the permissible limit, suggesting the presence of suspended particles that should be removed through basic filtration.

The absence of bacteriological contamination and residual chlorine points to no recent disinfection but also no microbial threat at the time of sampling. However, the absence of residual chlorine warrants caution, as it could mean the water is prone to microbial contamination if not treated before distribution.

TDS, hardness, sulphates, nitrates, and fluoride all register within safe and often ideal limits, indicating minimal risk of contamination from industrial or heavy agricultural sources. The relatively low conductivity and TDS suggest a low concentration of dissolved salts, supporting the classification of the water as soft and ideal for both drinking and irrigation.

6. CONCLUSION

The study concludes that the water from Banki Dam in the Khairbar region is largely suitable for drinking and agricultural purposes, based on the physico-chemical analysis . All key parameters, except for marginal iron and turbidity levels, are within safe limits. There is no evidence of microbial contamination, and the aesthetic quality of the water is acceptable.

These findings underscore the importance of routine water quality monitoring to ensure long-term sustainability and to detect any emerging threats from natural or anthropogenic sources.

7. RECOMMENDATIONS

- Implement regular water quality monitoring programs.
- Install basic filtration systems to reduce turbidity.
- Introduce periodic disinfection to ensure microbial safety.
- Educate local populations on safe water handling and storage practices.
- Encourage sustainable agricultural practices to prevent nitrate and iron contamination.

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