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# "Assessment of Physico-Chemical Characteristics of Borewell Water in Manendragarh Block and Its Suitability for Drinking Purposes"

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**Abstract:**

Groundwater is one of the primary sources of drinking water in rural and semi-urban regions, including Manendragarh Block of Manendragarh–Chirmiri–Bharatpur district, Chhattisgarh. The present study aims to assess the physico-chemical characteristics of borewell water and evaluate its suitability for drinking purposes. A total of representative borewell water samples were collected from different locations within the study area and analyzed using standard analytical methods. The physico-chemical parameters such as pH, electrical conductivity (EC), total dissolved solids (TDS), total hardness, alkalinity, chloride, nitrate, fluoride, calcium, magnesium, and iron were determined. The obtained results were compared with the permissible limits prescribed by the Bureau of Indian Standards (BIS) for drinking water quality. The analysis revealed that most parameters were within acceptable limits; however, certain locations exhibited elevated levels of hardness, TDS, and iron, which may pose health concerns if consumed over prolonged periods. The study highlights the influence of geological formations and local anthropogenic activities on groundwater quality. Overall, the borewell water in the Manendragarh Block is found to be moderately suitable for drinking, with some sites requiring appropriate treatment before consumption. The findings of this study will be useful for local authorities and policymakers in implementing effective water management and treatment strategies to ensure safe drinking water supply.

**Keywords:** Physico-chemical parameters; Borewell water, Groundwater quality, 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.

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.


**Figure 1: Sampling site Manendragarh area.**

In recent years, increasing population growth, urbanization, and agricultural activities have exerted pressure on groundwater resources, leading to deterioration in water quality. In regions like Manendragarh, where dependence on borewell water is high, regular monitoring and evaluation of water quality become imperative. Despite its importance, limited scientific data is available regarding the groundwater quality of this region, highlighting the need for systematic investigation.

Therefore, the present study aims to assess the physico-chemical characteristics of borewell water in Manendragarh Block and evaluate its suitability for drinking by comparing the observed values with standard guidelines such as those prescribed by the Bureau of Indian Standards (BIS) and the World Health Organization (WHO). The findings of this study will contribute to a better understanding of groundwater quality in the region and assist in developing appropriate water management and treatment strategies to ensure safe and sustainable drinking water supply.

**Literature review:**

Groundwater is considered one of the most important sources of fresh water for domestic and drinking purposes, especially in rural and semi-urban regions of India, where borewell water is widely used (Solanki & Billaiya, 2020)

Several researchers have emphasized that the quality of groundwater is primarily determined through physico-chemical parameters such as pH, electrical conductivity (EC), total dissolved solids (TDS), hardness, alkalinity, and major ions, which help in assessing its suitability for human consumption (Abinandan et al., 2014)

A study conducted in Chandrapur district, Maharashtra, analyzed borewell water samples and reported that parameters like TDS, hardness, chloride, nitrate, fluoride, and iron play a significant role in determining water quality, and comparison with Bureau of Indian Standards (BIS) is essential for evaluating potability (Gowardipe, 2025)

Similarly, research carried out in Kagal Tahsil, Maharashtra, indicated that several borewell water samples exceeded permissible hardness limits, making them unsuitable for drinking without treatment, thereby highlighting the need for regular monitoring (Godghate et al., 2013)

Dhok (2016) reported that groundwater quality in Baramati city was significantly affected by anthropogenic activities, with many samples showing high TDS and electrical conductivity values beyond permissible limits, rendering a large proportion of samples unsuitable for direct consumption

Studies from different regions of India have also shown that seasonal variations, geological formations, and land-use changes strongly influence groundwater chemistry, and advanced techniques such as Water Quality Index (WQI) and statistical analysis are often used to evaluate overall water quality (Evaluation Study, 2021)

Furthermore, regional assessments have demonstrated that borewell water quality must be evaluated using both physical and chemical parameters, including turbidity, temperature, dissolved oxygen, and major ions, to ensure compliance with World Health Organization (WHO) standards for safe drinking water (Regional Study, 2021)

**Materials and Methods:**

**Study Area and Sampling Sites**

Water samples were collected from selected borewells located in different villages and residential areas of Manendragarh Block. The selection of sampling sites was based on population density, usage of borewell water, and spatial distribution to obtain representative samples of the study area (Pandya et al., 2010)

**Sample Collection and Preservation**

Borewell water samples were collected in clean, sterilized polyethylene bottles following standard sampling procedures. Prior to sampling, borewells were pumped for 3–5 minutes to remove stagnant water and obtain fresh groundwater samples (Dahunsi et al., 2014; Parks et al., 2004)

Samples were collected during daytime and transported to the laboratory in insulated containers to minimize changes in physico-chemical properties. When immediate analysis was not possible, samples were preserved at low temperature (around 4°C) to maintain stability (Rajkumar et al., 2011)

**Analytical Methods**

The physico-chemical parameters of borewell water were analyzed using standard methods recommended by the **American Public Health Association (APHA)**. These methods are widely accepted for water quality analysis and ensure comparability of results (APHA, 1995)

The following parameters and methods were used:

- **pH**: Measured using a digital pH meter (potentiometric method) (Shivaprasad et al., 2014)
- **Electrical Conductivity (EC)**: Determined using a conductivity meter (Gowardipe, 2025)
- **Total Dissolved Solids (TDS)**: Measured using a TDS meter (Shivaprasad et al., 2014)
- **Total Hardness (TH)**: Estimated by EDTA complexometric titration method (Pandya et al., 2010)
- **Calcium and Magnesium**: Determined by titrimetric methods (Pandya et al., 2010)
- **Chloride**: Determined by argentometric titration using silver nitrate (Pandya et al., 2010)
- **Alkalinity**: Measured by titration method using standard acid (Shivaprasad et al., 2014)
- **Nitrate and Sulphate**: Determined using spectrophotometric methods (Shivaprasad et al., 2014)
- **Iron and other metals**: Analyzed using atomic absorption spectrophotometer where required (Environmental Study, 2023)

All reagents used were of analytical grade, and distilled water was used for preparation of solutions to ensure accuracy (Pandya et al., 2010)

**Quality Control and Data Analysis**

All instruments were calibrated prior to analysis, and measurements were performed in triplicate to ensure precision and reliability of results (Shivaprasad et al., 2014)

The obtained results were compared with drinking water standards prescribed by the Bureau of Indian Standards (BIS: IS 10500) and World Health Organization (WHO) to evaluate the suitability of borewell water for drinking purposes (Gowardipe, 2025)

**Table 1 : Physical properties of water sample taken from borewell Water at manendragarh**

| Parameter | Unit | Acceptable | Cause of Rejection | Sample 1 |
|---|---|---|---|---|
| Temperature | °C | - | - | - |
| Turbidity | NTU | 1.0 | 5.0 | 51.8 |
| Colour | Pt. Cobalt Scale | 5.0 | 25 | 6.0 |
| Taste & Odour | - | Unobjectionable | Objectionable | Unobjectionable |
| pH | pH Scale | 6.5-8.5 | No Relaxation | 7.29 |
| Total Alkalinity | mg/l | 200 | 600 | 123.44 |
| Chlorides | mg/l | 200 | 1000 | 25.76 |
| TDS | mg/l | 500 | 1500 | 210 |
| Total Hardness | mg/l | 200 | 600 | 142.27 |
| Calcium | mg/l | 75 | 200 | 31.67 |
| Magnesium | mg/l | 30 | 150 | 15.36 |
| Fluoride | mg/l | 1.0 | 1.5 | 0.1 |
| Iron | mg/l | 0.1 | 1.0 | 0.3 |
| Residual Cl | ppm | 0.2 | 3.0 | - |

**Result and discussion:**

The physico-chemical analysis of borewell water sample from Manendragarh Block was carried out and the results were compared with the drinking water standards prescribed by BIS (IS 10500) and WHO guidelines.

The turbidity value of the sample was found to be **51.8 NTU**, which is significantly higher than the acceptable limit of 1.0 NTU and even exceeds the permissible limit of 5.0 NTU. High turbidity indicates the presence of suspended particles such as silt, clay, and organic matter, which may harbor microorganisms and reduce water quality, making it unsuitable for drinking without proper treatment (WHO, 2017).

The colour of the water sample was **6.0 Pt-Co units**, which is within the permissible limit (25) but slightly above the acceptable limit (5). This suggests the presence of dissolved organic matter or iron compounds, which may affect the aesthetic quality of water (BIS, 2012).

The pH value of **7.29** lies within the acceptable range of 6.5–8.5, indicating that the water is neutral and suitable for drinking in terms of acidity and alkalinity balance (WHO, 2017).

Total alkalinity was recorded as **123.44 mg/L**, which is well within the acceptable limit (200 mg/L). This indicates a moderate buffering capacity of water and absence of excessive carbonate and bicarbonate ions (APHA, 1995).

The chloride concentration of **25.76 mg/L** is much lower than the acceptable limit of 200 mg/L, suggesting no significant contamination from sewage or saline intrusion (BIS, 2012).

Total dissolved solids (TDS) were found to be **210 mg/L**, which falls within the desirable limit (500 mg/L), indicating good palatability and low mineralization of the water (WHO, 2017).

Total hardness of the sample was **142.27 mg/L**, which is within the acceptable limit (200 mg/L). This indicates that the water is moderately hard and does not pose significant scaling or health issues (Sawyer & McCarty, 2003).

Calcium and magnesium concentrations were **31.67 mg/L** and **15.36 mg/L**, respectively, both within acceptable limits. These ions contribute to hardness but are essential minerals for human health when present in moderate concentrations (WHO, 2017).

Fluoride concentration was found to be **0.1 mg/L**, which is below the acceptable limit (1.0 mg/L). While low fluoride reduces the risk of fluorosis, extremely low levels may not provide adequate protection against dental caries (WHO, 2017).

Iron content in the sample was **0.3 mg/L**, exceeding the acceptable limit (0.1 mg/L) but within the permissible limit (1.0 mg/L). Elevated iron may cause staining, unpleasant taste, and may promote the growth of iron bacteria (BIS, 2012).

Residual chlorine was not detected in the sample, which indicates absence of disinfection. This may increase the risk of microbial contamination if the water is not treated before consumption (WHO, 2017).

**Conclusion:**

The present study evaluated the physico-chemical characteristics of borewell water from Manendragarh Block to determine its suitability for drinking purposes based on standard guidelines.

The analysis revealed that most of the parameters such as **pH (7.29), 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 to be within the acceptable limits prescribed by drinking water standards. This indicates that the groundwater is generally chemically safe and suitable for consumption.

However, certain parameters showed deviations from desirable limits. The **turbidity (51.8 NTU)** was extremely high, exceeding even the permissible limit, which indicates the presence of suspended impurities and possible microbial contamination risk. Additionally, the **iron concentration (0.3 mg/L)** exceeded the acceptable limit, which may cause aesthetic issues such as staining, unpleasant taste, and potential operational problems in water supply systems. The **colour (6.0 Pt-Co)** was slightly above the acceptable limit but within permissible range, indicating minor aesthetic concerns.

The absence of **residual chlorine** suggests that the water is not disinfected, which may increase the risk of biological contamination if consumed without treatment.

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