

Original Research Article

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## Studies of Physicochemical and Bacteriological Characteristics of Drinking Water Quality in Shahdol University

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### ABSTRACT

#### Keywords

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The study conducted at Shahdol University and College aimed to assess the quality of tap water by analyzing its physical, chemical, and biological properties. Water samples were collected in triplicate from each station, and their average values for temperature, turbidity, electrical conductivity, suspended solids, and total solids were determined. The findings revealed that all physical parameters of the tap water samples met the standard limits set by the World Health Organization (WHO), indicating good quality water. Similarly, the chemical parameters of the tap water samples were within WHO recommendations. Microbiological analysis showed no colonies present, and total coliform bacteria levels were within WHO guidelines. Among the stations, S1 exhibited superior characteristics for drinking water compared to others. The study confirmed that tap water samples from S1, S2, and S3 in operation at Shahdol University and College met the requirements for water intended for human consumption. This underscores the importance of regular monitoring and maintaining water quality in educational institutions to ensure the health and well-being of students and staff.

### Introduction

The provision of safe drinking water is paramount for ensuring the well-being of individuals and communities. It serves as a fundamental resource indispensable for safeguarding public health and fostering sustainable economic development (Liu *et al.*, 2023).

According to the World Health Organization (WHO), safe drinking water is defined as water that has undergone treatment and poses no significant risk to the health of consumers in the immediate or long term (García-Ávila *et al.*, 2018). Monitoring the quality of tap

water within the distribution system and assessing the risk of its sanitary safety loss are critical components of managing collective water supply systems.

In the specific context of educational institution, understanding the physiochemical characteristics of drinking water quality is of utmost importance. The water distribution network serving the institutions likely comprises pipes of various materials, such as fiber cement, grey cast iron, and ductile cast iron with cement mortar or PVC coating (Liu *et al.*, 2017). Over time, the aging infrastructure of these pipelines can contribute to deterioration in the taste, color, odor, and turbidity of the

water being delivered to the university community from treatment plants (Świetlik and Magnucka, 2023). Safe water supplied by waterworks must meet certain criteria, which are usually divided into three main categories: physical, chemical, and microbiological.

Physically, water must be odorless, tasteless, and colorless. From a chemical point of view, it is required that the water is free from toxic substances, heavy metals, excess minerals, and organic substances and pH. Additionally, it should be free of any microbes (Domoń *et al.*, 2024).

Drinking water quality should remain constant from the drinking water supply to the consumer's tap. Thus, physical, chemical and biological parameters must be controlled in order to comply with certain regulatory limits.

There are communities and individuals who are unaware of their exposure to health risks from water contaminated with toxic chemicals, microbes, and others (Olatunde *et al.*, 2022). This research aimed to assess alterations in tap water quality in educational institutions and compare among them. Throughout the monitoring process, a thorough examination of the physical and chemical properties of the water samples was conducted. The study evaluated the stability of water in terms of its physical, chemical and biological characteristics, which are crucial factors ensuring suitable water quality for consumers.

## **Materials and Methods**

The research was carried out in three different educational institutions that differed in the location (location information is presented in Table 1).

### **Study Site**

#### **Sampling Station 1**

The Water sample was collected from dispenser tap at Pandit S.N. Shukla University Shahdol, Nawalpur Village Campus Madhya Pradesh, India (S1).

#### **Sampling Station 2**

Water sample was collected from the dispenser tap at Pandit S.N. Shukla University Shahdol, Shahdol Campus, Madhya Pradesh, India (S3).

#### **Sampling Station 3**

Water sample was collected from the dispenser tap at Shahdol College.

#### **Sample Collection**

Two liters of tap water samples were collected on 5-litre jerry Cans at each location to ensure the purity of the samples. Prior to collection, the water taps were allowed to run for 3 to 4 minutes, facilitating the removal of any superficial impurities and adhering strictly to the guidelines outlined by the World Health Organization (WHO).

Subsequently, the collected samples were transported and preserved to the laboratory facilities of the Madhya Pradesh Pollution Control Board (MPPCB) Shahdol for subsequent examination.

Each sample underwent rigorous triple testing procedures to ensure the utmost precision and reliability of the data obtained, thereby laying the groundwork for meticulous analysis across all relevant parameters.

The water quality analysis of tap water samples collected from different educational institutions (S1, S2 and S3) have been carried out for physical parameters analysis including Temperature, Turbidity, Electrical conductivity (EC), Suspended Solids (SS), and Total Solids (TS) and Chemical parameters analysis such as pH, Chloride, Calcium Hardness, Magnesium Hardness, Total Hardness, Alkalinity, BOD and COD.

The samples were analyzed using standard procedures (APHA *et al.*, 2005) (Kumar and Puri, 2012) and compared with WHO and Indian Standard guidelines (Table 2).

#### **Sample Analysis**

##### **Physical parameters**

The temperatures of all tap water samples were measured by using Digital PH Meter (Systronics, 361). Turbidity and electrical conductivity were measured using Digital Nephelo-Turbidity Meter (Systronics, 135) and Digital Conductivity Meter (Systronics, 304), respectively. Suspended solids and Total solids were calculated with the help of weighing balance (Sartorius, CPA224S Balance).

## **Chemical Parameters**

The pH of the water sample was carried out by using calibrated pH meter (Digital PH Meter 361, Model No.: 361). Total hardness, calcium hardness and magnesium hardness of tap water samples were carried out by using titration method with EDTA solution. The chloride and alkalinity were determined volumetrically and by titrating the water sample with standard H<sub>2</sub>SO<sub>4</sub> using indicator respectively. Biochemical oxygen demand (BOD) and Chemical oxygen demand (COD) were estimated by using alkali azide method and dichromate refluxion method of all tap water samples respectively.

## **Biological parameters**

The total coliform bacteria were assessed using the membrane filtration method. Tap water samples of 100 mL each were filtered through sterile filter paper (pore size of 0.45 µm) and then incubated in an incubator at 37 °C for 24-48 hours in Endo agar media.

Following incubation, colonies of total coliform bacteria were counted. We used both NC; negative control (free of coliform bacteria) and PC; positive control (contain coliform bacteria) for this study.

## **Statistical analysis**

The average value of each physical, chemical and biological parameters were plotted and analyzed using Graph Pad Prism (6.0 version). Total coliform bacteria were quantified by Most Probable Number (MPN) test. Biological parameters were performed in duplicates.

## **Results and Discussion**

Water samples were collected in Triplicate from each station. The tap water samples were evaluated for their physical, chemical, and biological properties. The average value of temperature, turbidity, electrical conductivity, suspended solids and total solids (Figure 1A to 1E) of each tap water findings are detailed in Table 3. In our study, each tap water samples physical parameters were found to be within the standard limits provided by the WHO (Table 3).

The chemical parameters were also observed within the WHO recommendations in each water sample (Figure 2A to 2H). The results of each tap water samples for chemical parameters were presented in Table 4.

No colonies were observed in each tap water samples. The total coliform bacteria in each tap water samples were observed within the recommendations of WHO (not detected in 100 mL).

S1 sample was registered better for drinking when compared to others. The obtained test results conclude that the tested tap water samples used at S1, S2 and S3 met the requirements for water intended for human consumption.

Analyzing physicochemical and microbiological parameters of drinking water in educational institutions like Shahdol University and College an institution of higher education in Madhya Pradesh, India is crucial for ensuring the health and well-being of students and staff. Temperature, turbidity, electrical conductivity, suspended solids, and total solids were measured (Figure 1A to 1E), and their average values were documented in Table 3.

Results indicated that all physical parameters of the tap water samples were within the standard limits provided by the World Health Organization (WHO), suggesting good quality water in terms of these parameters. Chemical parameters were also evaluated, and the results were found to be within the WHO recommendations for each water sample (Table 4). This suggests that the tap water samples met the standards for chemical composition set by the WHO for drinking water.

No colonies were observed in any of the tap water samples, indicating the absence of microbial contamination. The total coliform bacteria levels were found to be within the WHO recommendations (not detected in 100 mL), further confirming the absence of microbial contamination in the tap water samples. The results suggest that S1 sample had better overall quality for drinking water compared to the other stations (S2 and S3).

Based on the obtained test results, it was concluded that the tap water samples used at all three stations (S1, S2, and S3) met the requirements for water intended for human consumption, as per WHO standards. This study provides valuable insights into the quality of drinking water at Shahdol University and College, ensuring the health and well-being of its students and staff. It also demonstrates the importance of regular monitoring and analysis of water quality in educational institutions to maintain safe drinking water standards.

**Table.1** Location of Sampling Station

S.No.	Sampling Station (SS)	Geo-coordinate of SS	
1	Pandit S.N. Shukla University Shahdol, Nawalpur Village Campus Madhya Pradesh, India (S1)	23.288008°	81.455754°
2	Pandit S.N. Shukla University Shahdol, Shahdol City Campus Madhya Pradesh, India (S2)	23.298149°	81.351417°
3	College, Shahdol, Madhya Pradesh, India (S3)	23.305042°	81.346071°

**Table.2** Drinking Water Standards as per WHO and Indian System (Kumar and Puri, 2012)

S.No.	Parameters	Drinking water Indian standards	Drinking water WHO standards
1	Temperature	10 - 22	-
2	Turbidity	1 - 5	less than 5
3	Electrical Conductivity	200 - 800	1000
4	Suspended Solids	less than 50	1 - 50
5	Total Solids	less than 50	less than 50
6	pH	6.5 - 8.5	6.5 - 8.5
7	Chloride	250	250
8	Alkalinity	200	-
9	Calcium Hardness	75	200
10	Magnesium Hardness	30	30-100
11	Total Hardness	300	200 - 500
12	BOD	4.0	less than 5
13	COD	200	less than 200

**Table.3** Evaluation of Physical parameters of the drinking water

S.No.	Parameters	Sample 1	Sample 2	Sample 3
1	Color	Color less	Color less	Colorless
2	Temperature	19.1°C	22.1°C	26.9°C
3	Turbidity	0.9 NTU	0.2 NTU	2.2 NTU
4	Conductivity	400 µmhos/cm	390 µmhos/cm	220 µmhos/cm
5	Suspended Solid	5.54 mg/L	10.85 mg/L	18.36 mg/L
6	Total Solids	30.13 mg/L	29.04 mg/L	39.47 mg/L

**Table.4** Evaluation of Chemical parameters of drinking water

S.No.	Parameters	Sample 1	Sample 2	Sample 3
1	pH	7.94	7.55	6.67
2	Total hardness	184 mg/L	252 mg/L	192 mg/L
3	Alkalinity	150 mg/L	200 mg/L	170 mg/L
4	Calcium Hardness	176 mg/L	184 mg/L	164 mg/L
5	Magnesium Hardness	8 mg/L	68 mg/L	28 mg/L
6	Total hardness	184 mg/L	252 mg/L	192 mg/L
7	BOD	0.2 mg/L	0.5 mg/L	0.8 mg/L
8	COD	112.08 mg/L	103.68 mg/L	100.8 mg/L

Figure.1

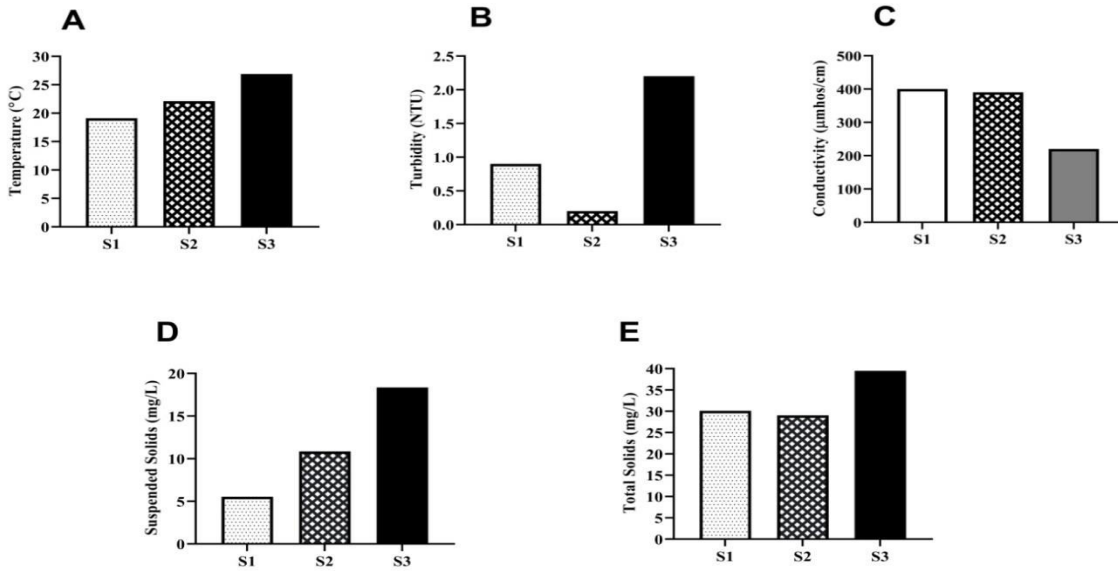
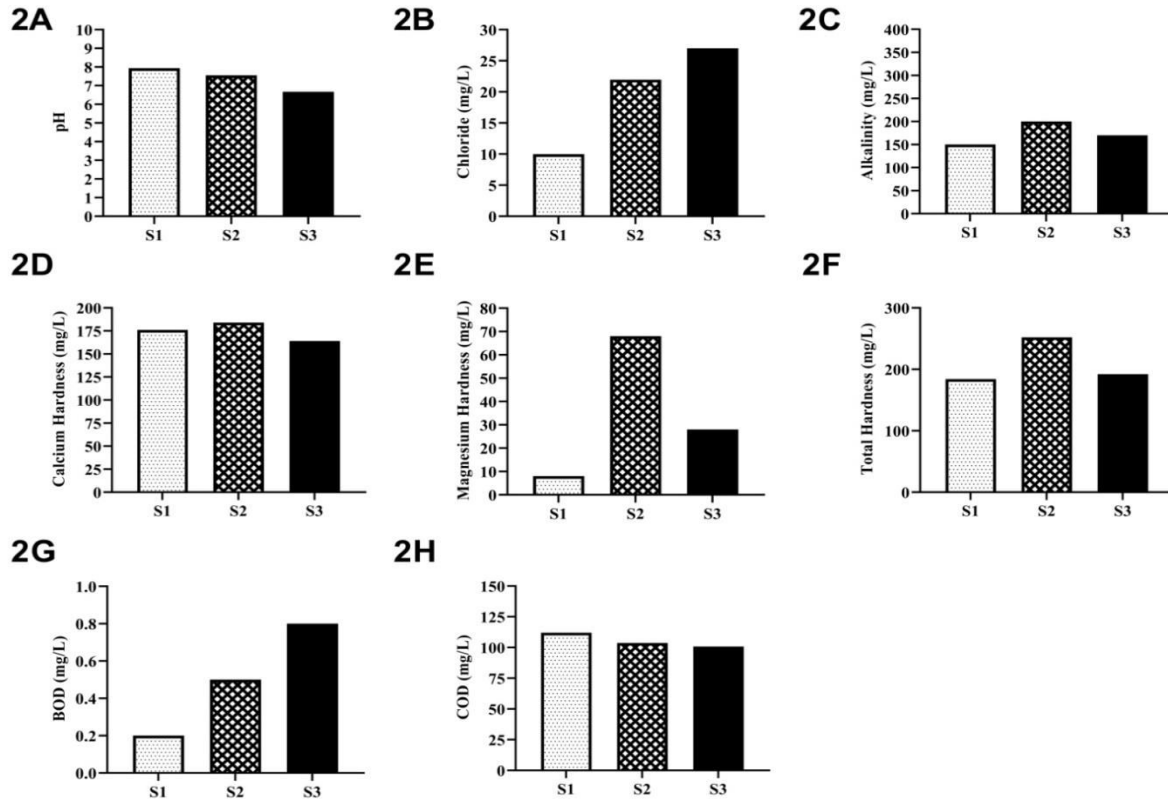


Figure 1: Physical parameters analysis of tap water. 1A: Temperature; 1B: Turbidity; 1C: Electrical Conductivity; 1D: Suspended Solids; 1E: Total Solids

Figure.2



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## Author Contribution

Abhishek Soni: Investigation, formal analysis, writing—original draft. Aditi Tiwari: Validation, methodology, writing—reviewing. Shalini Choudhary:—Formal analysis, writing—review and editing. Manisha Shukla: Investigation, writing—reviewing.

## Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

## Declarations

**Ethical Approval** Not applicable.

**Consent to Participate** Not applicable.

**Consent to Publish** Not applicable.

**Conflict of Interest** The authors declare no competing interests.

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