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Metal and Microbiological Analysis of Drinking Water Quality in Bideha and Sahidnagar Municipalities of Dhanusha District of Nepal

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Abstract

The primary objectives of this study were to compare the drinking water quality in the Dhanusha District, specifically in the Bideha and Sahidnagar Municipalities, using the Nepal Drinking Water Quality Standards (NDWQS, 2022), and to identify any potential health risks associated with physicochemical and microbiological contamination. 14 groundwater samples were taken from hand pumps in the two Municipalities as part of the cross-sectional study design. Using standard titration and experimental techniques, each sample was examined for physicochemical parameters, including Iron, calcium, and magnesium. Escherichia coli (E. coli) and total coliforms were measured using the membrane filtering technique to evaluate the microbiological quality. The major findings showed that most physicochemical parameters were within NDWQS limits: iron (0.11–0.22 mg/L), calcium (33.67–56.11 mg/L), and magnesium (1.94–15.06 mg/L). However, total coliforms (60–195 CFU/100 mL) and E. coli (2–10 CFU/100 mL) were detected in several samples, indicating faecal contamination and potential health risks. These results emphasize the need for routine microbiological monitoring, improved sanitation practices, and community education to ensure safe drinking water in Bideha and Sahidnagar Municipalities.

Keywords: Community, contamination, metal, microbiological, water quality

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Introduction

Human survival and health depend on water, and preventing waterborne illnesses requires having access to clean drinking water (World Health Organization, 2017). Groundwater is the primary supply of drinking water in low-income nations like Nepal, particularly in the Terai region. However, natural geochemical processes, agricultural runoff, and inadequate sanitation frequently jeopardize the quality of this water (Todd & Mays, 2005).

Although tube wells and hand pumps are widespread in Nepal, current research has shown that they are susceptible to contamination. While another hydrogeochemical investigation revealed significant turbidity, iron, and total coliform levels surpassing NDWQS (Kandel et al., 2025), heavy metals like Cd, Cr, Fe, and Pb were found in Kathmandu Valley dug-well water. In the same vein, a 2025 assessment of the Mahakali River revealed that iron and ammonium levels were above drinking limits, rendering the water unfit for human consumption. Alam et al. (2024) found that while the majority of the wells in Rautahat fulfilled Nepal's national standard, 29% of them exceeded the WHO's arsenic guideline in the Terai of Nepal.

These results demonstrate how urgently both physicochemical and microbiological parameters must be regularly monitored in accordance with the Nepal Drinking Water Quality Standards (Merrill et al., 2011). Considering this, the current study compares and assesses the drinking water quality in the Dhanusha District's Bideha and Sahidnagar Municipalities, offering a local evaluation and guaranteeing adherence to national criteria. No previous studies have been conducted by others on the metal and microbiological analysis of drinking water quality in Bideha and Sahidnagar Municipalities of Dhanusha district. The main objective of this work is to calculate the amount of different metals in the drinking water of Bideha and Sahidnagar Municipalities of Dhanusha district of Nepal, and their microbiological analysis.

Materials and Methods

Materials

The reagents and equipment were employed for physicochemical and microbiological studies to compare the drinking water quality in the Dhanusha District's Bideha and Sahidnagar Municipalities. Analyses were conducted using standard laboratory glassware such as volumetric flasks, conical flasks, pipettes, beakers, funnels, and filter paper. Water samples were collected in clean, labeled sample bottles. Petri dishes were used for microbiological experiments.

Methods

For the magnesium test, specific reagents such as Eriochrome Black T and Calmagite were utilized, while 1,10-Phenanthroline and Thiocyanate (SCN^-) were employed for the iron test. For the calcium test, Arsenazo III and o-Cresolphthalein were used, alongside appropriate oxidizing and buffering solutions as required. The concentrations of iron, calcium, and magnesium were determined using a Biobase BKUV 1000 single-beam UV-Vis spectrophotometer from China, following methods outlined in APHA Methods 3500-Fe, 3500-Ca, and 3500-Mg, respectively. Gloves, lab coats, safety glasses, and notebooks were among the equipment needed for laboratory safety and documentation. The location of the study site is shown in Figures 1a and 1b, respectively.

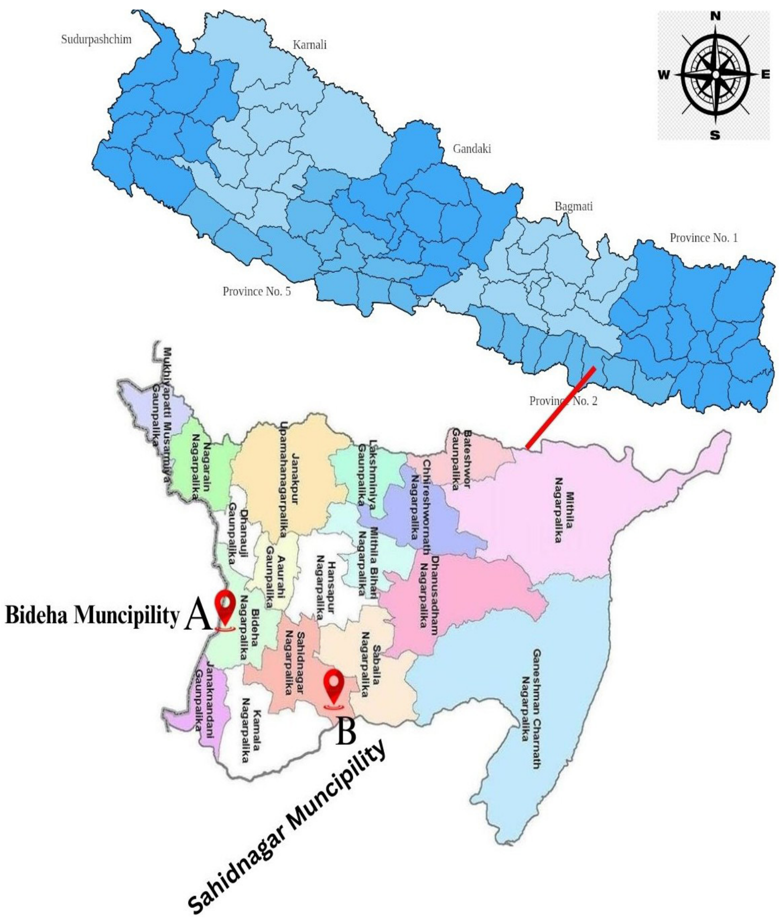

Figure 1a: Location of the Bideha and Sahidnagar Municipality

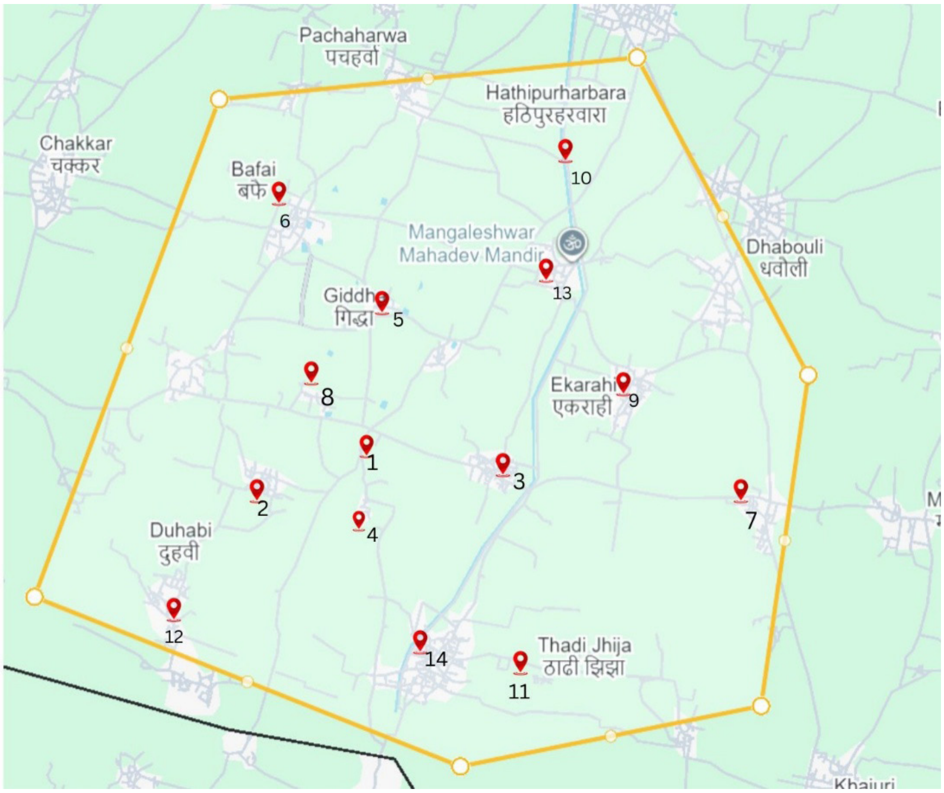

Figure 1b: Location of the sample collection site

Results and Discussion

Comparison of Physico-chemical and microbiological Parameters of water with NDWQS

The analysis of physical, chemical, and microbiological parameters of drinking water samples from handpumps in Dhanusha, Nepal, was done and compared with the Nepal Drinking Water Quality Standards (NDWQS, 2022). The chemical parameters analyzed were iron, calcium, and magnesium. Microbiological tests focused on E. coli and total coliform. Due to growing urbanization, farming, and climate change, regular groundwater monitoring is increasingly important to protect public health. The results of the analysis are shown in Table 1.

Table 1: Physico-chemical and microbiological parameter values of water samples

Parameters	Units	Experimental Range	NDWQS
Iron	mg/L	0.11 – 0.22	≤ 0.3 mg/L
Calcium	mg/L	33.67 – 56.11	≤ 200 mg/L
Magnesium	mg/L	1.94 – 15.06	≤ 70 mg/L
Total coliform	Total coliform	60 – 195	0 CFU/100 mL
E.coli	CFU/100 mL	2 – 10	0 CFU/100 mL

Iron Concentration

Iron concentrations in the 14 groundwater samples ranged from 0.11 mg/L to 0.22 mg/L. Most samples showed iron levels around 0.11 to 0.16 mg/L, with a few samples (11, 12, and 14) reaching 0.22 mg/L. Overall, iron levels were generally low but showed slight variations across the sampling sites (Merrill et al., 2011).

The Iron concentration for each study site and its variation across the locations are shown in **Figure 2.**

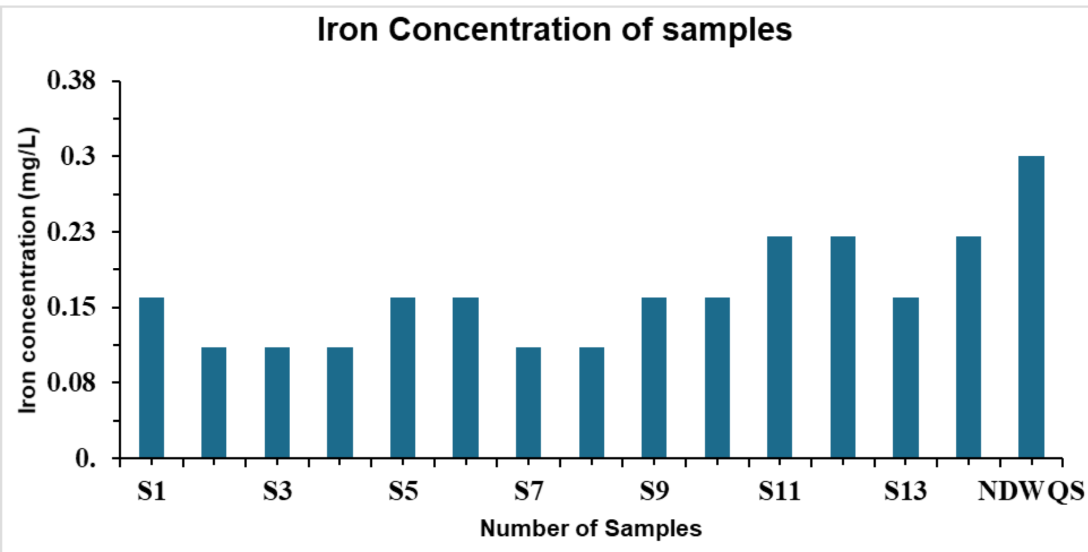

Figure 2: Sample-wise variation of Iron concentration

Calcium Concentration

Calcium levels in the 14 groundwater samples ranged from 33.67 mg/L to 56.11 mg/L. Most samples showed moderate calcium content, typical of mineral-rich groundwater. These values generally meet common drinking water standards but may contribute to water hardness (MUNGAI, 2014; Sunitha et al., 2013).

The calcium concentration for each study site and its variation across the locations are shown in **Figure 3**.

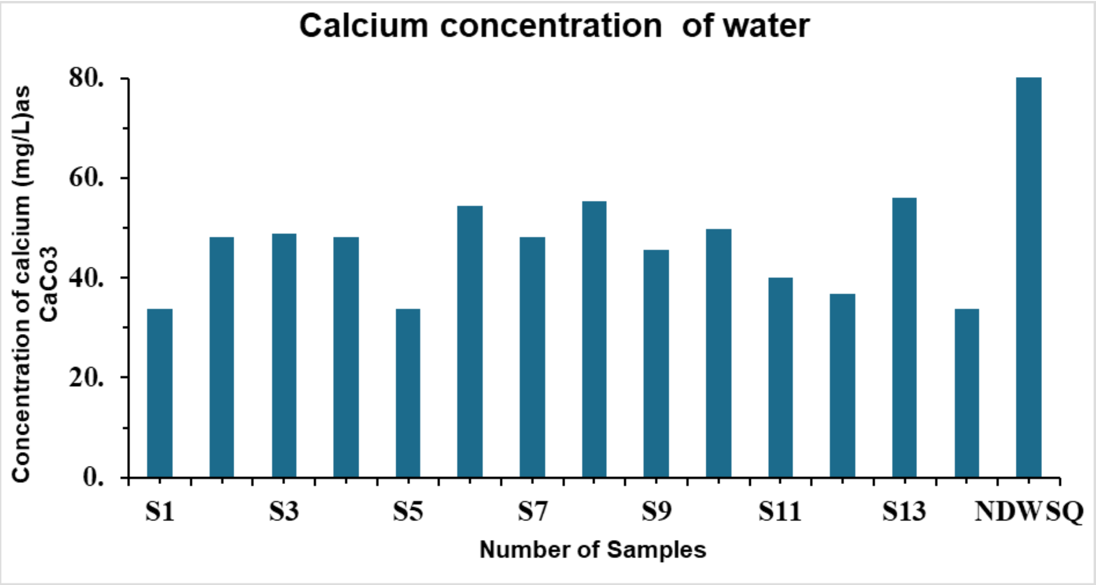

Figure 3: Sample-wise variation of calcium concentration

Magnesium Concentration

The 14 groundwater samples had magnesium concentrations ranging from 16.98 mg/L (S11) to 31.06 mg/L (S13). S6 and S13 exhibited the greatest magnesium concentrations, whereas most samples had moderate amounts, often ranging from 20 to 30 mg/L (Mohammed et al., 2025). These variances show that the groundwater's mineral concentration varied between the study locations. The magnesium concentration for each study site and its variation across the locations are shown in **Figure 4.**

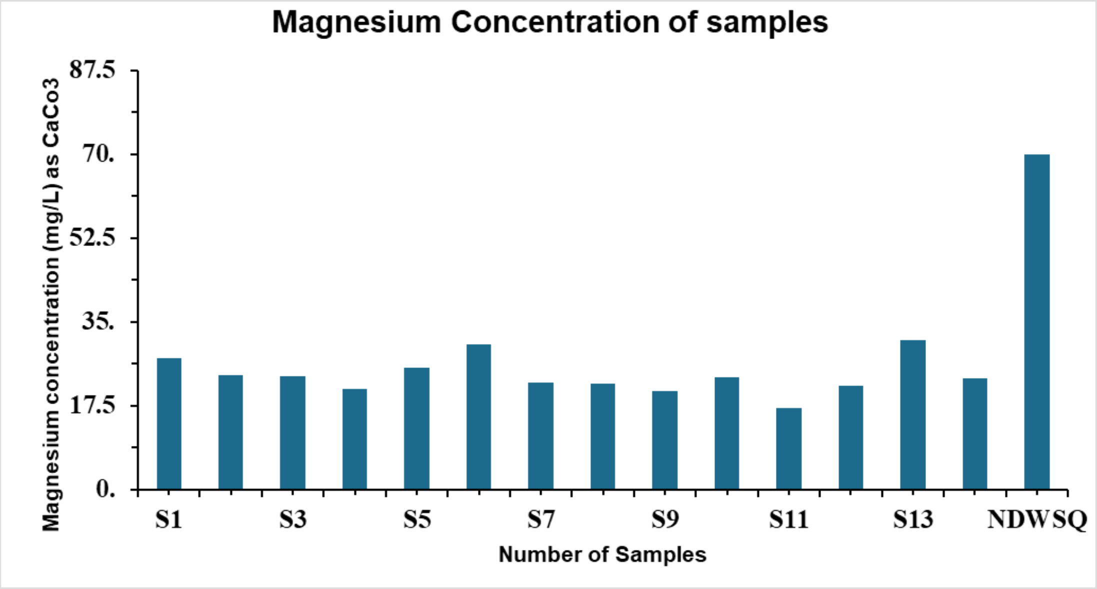

Figure 4: Sample-wise variation of magnesium concentration

Total Coliform and E. coli

Total coliform bacteria were present in all groundwater samples, with counts ranging from 60 CFU/100 mL (Sample 6) to 195 CFU/100 mL (Sample 5). These values exceed the NDWQS (2022) safe limit of 0 CFU/100 mL, indicating possible contamination. E. coli was detected in Samples 1, 2, 5, and 6, with counts between 2 and 10 CFU/100 mL (Jabeen et al., 2022). The presence of E. coli also exceeds the permissible limit, showing recent fecal contamination and potential health risks. The Total coliform and E. coli count for each study site, and their variation across the locations, is shown in **Figure 5**.

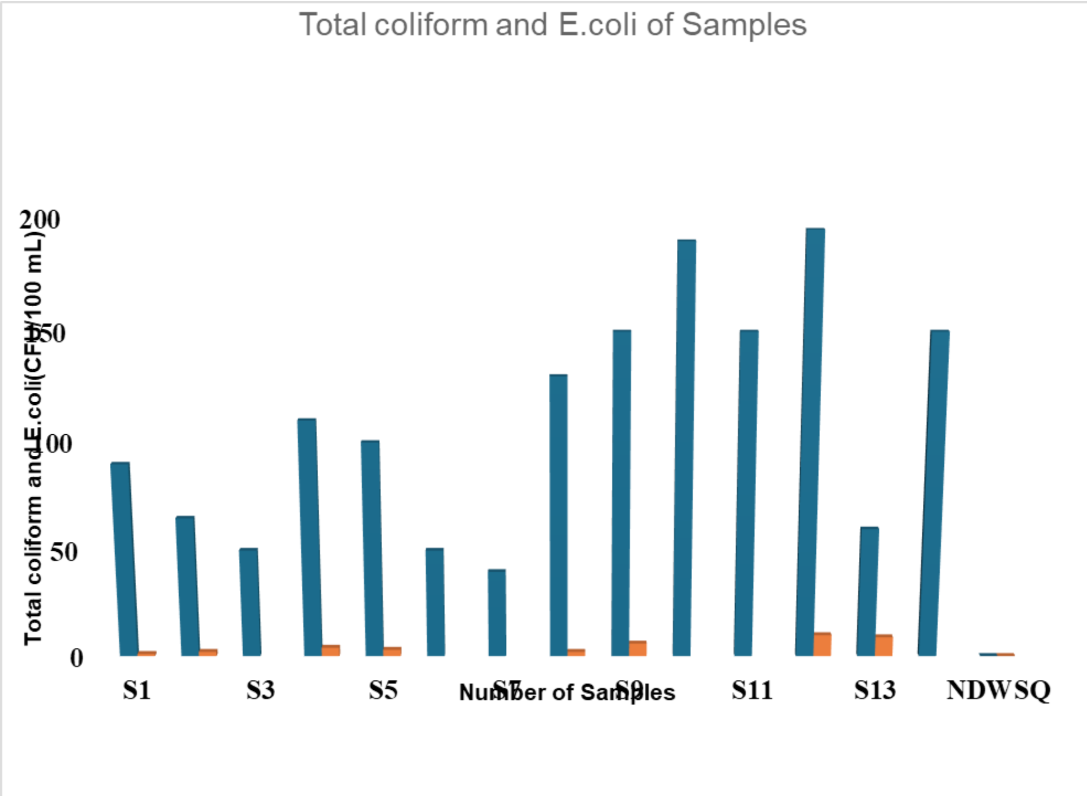

Figure 5: Sample-wise variation of total coliform and E. coli Count

The study area was conducted in Bideha Municipality and Sahid Municipality of Dhanusha District, Nepal (Jha et al., 2025). These areas include both rural and semi-urban communities, where most households rely on groundwater from handpumps for drinking and domestic purposes. The region has a subtropical climate with hot summers, mild winters, and a monsoon season that significantly affects groundwater recharge.

For this study, a total of 14 groundwater samples were collected specifically from handpumps in Bideha Municipality and Sahid Municipality. These locations were selected because they represent communities with high dependence on untreated groundwater and limited access to centralized water treatment. The Municipalities cover a mix of agricultural land and settlements, and the soil and terrain influence the groundwater availability and quality.

The population of these Municipalities relies heavily on handpump water for daily use, making assessing water quality crucial for public health. Sampling was carried out during the [specify season, e.g., pre-monsoon season] to capture typical groundwater conditions.

Conclusion

The physicochemical assessment of the study area's groundwater, including parameters such as iron, calcium, and magnesium, aligns favorably with the Nepal Drinking Water Quality Standards (NDWQS, 2022) and indicates general suitability for domestic use, the bacteriological quality reveals a critical public health concern. In the tested sample, Iron concentrations in the 14 groundwater samples ranged from 0.11 mg/L to 0.22 mg/L, Calcium levels in the 14 groundwater samples ranged from 33.67 mg/L to 56.11 mg/L, and the 14 groundwater samples had magnesium concentrations ranging from 16.98 mg/L (S11) to 31.06 mg/L (S13). Total coliform bacteria were present in all groundwater samples, with counts ranging from 60 CFU/100 mL (Sample 6) to 195 CFU/100 mL (Sample 5). The total amount of iron, calcium, and magnesium is lower than the NDWQS, 2022 data. It is better in terms of metal present in the drinking water of Bideha and Sahidnagar Municipalities of Dhanusha District of Nepal, but the coliform bacteria present in a small range in the sampling was carried out during the [specify season, e.g., pre-monsoon season] to capture typical groundwater conditions, as compared to NDWQS, 2022 data. So, it is harmful to drink directly from the source. For better drinking, it needs to be purified by adding a chemical or heating the drinking water before the drink, or other electro filtrating method.

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