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Comprehensive Analysis of Drinking Water Readily Accessible in Bangladesh

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Abstract

The study was conducted to assess and generate information on the quality of bottled and jarred drinking water available in the markets of Bangladesh, analyzing 35 branded bottled water and 250 jarred water samples from 18 districts. Parameters examined included total dissolved solids, chloride, nitrite, nitrate, lead, chromium, iron, pH, and microbial content (total and fecal coliform). The samples were analyzed in triplicate at accredited laboratories. Bottled water TDS (total dissolved solids) levels ranged from 8 to 240 mg/L, well below the Bangladesh standard of 500 mg/L, likely due to reverse osmosis technology reducing mineral content. TDS levels in jarred water ranged from 62 to 474 mg/L, with 11% of samples exceeding 300 mg/L. Although these higher levels were observed, they remain within acceptable limits for safe consumption. Chloride concentrations were acceptable, ranging from 1.97 to 55 mg/L for bottled water and 3.99 to 91.97 mg/L for jarred water. Other chemical parameters (NO_2, NO_3, Pb, Cr, and Fe) were undetectable. pH values of both bottled (6.36 to 7.70) and jarred (6.73 to 7.75) were within the safe range of 6.4 to 7.4. Microbial analysis revealed that bottled water was almost free of contamination (<1.8 MPN/100 mL), posing no health risk. In contrast, jarred water contained significant microbial contamination, with total coliform ranging from 17-1600 MPN/1000 mL and Fecal coliform from 11 to 240 MPN/100 mL, raising health concerns. The study also highlighted discrepancies between labeled and actual mineral compositions in bottled water, with many producers misrepresenting information to suit trade interests. Correct labeling remains a major problem, as traders often fail to meet mandatory standards. The findings highlight the need for stricter regulatory enforcement to ensure consumer safety and accurate labeling.

Keywords: Bangladesh, Bottled, Jarred, Drinking Water, Qualitative, Quantitative.

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Introduction

Water is a fundamental resource essential for sustaining life, ecosystems, and human health (Hossain 2015, Zaman et al. 2017). Water is a natural resource useful for people as well as for the environment (Uddin et al. 2023, Ahmed et al. 2024). Access to safe drinking water, a basic human right (Oliveira 2017), is vital for health and well-being, directly influencing the achievement of several Sustainable Development Goals (SDGs), including SDG 3 (Good Health and Well-being), SDG 6 (Clean Water and Sanitation), SDG 12 (Responsible Consumption and Production), and SDG 17 (Partnerships for the Goals) (Gimelli et al. 2018). Water quality, defined by its chemical, physical, and biological composition (Rocha et al. 2015), directly affects human health (Keeler et al. 2012). However, in many regions, including Bangladesh, ensuring the availability of safe and clean drinking water remains a critical challenge (Dey et al. 2019). Industrial pollution, agricultural runoff, poor waste management, and inadequate water resource management have severely contaminated Bangladesh's water, with surface water quality deteriorating due to heavy metals, pesticides, and various organic, inorganic, and micropollutants (Haque et al. 2023). In response to concerns about the safety of tap water, especially in urban areas, the demand for bottled and jarred drinking water in Bangladesh has increased significantly (Hoque et al. 2016). Consumers view these products as safer alternatives, marketed as purified and free from harmful contaminants (Kooy and Walter, 2019). Despite this perception, questions remain about the actual safety and quality of bottled water in Bangladesh (Chakraborti et al. 2015). Bottled and jarred water, produced by companies ranging from multinationals to small local enterprises, typically undergoes purification processes such as filtration, reverse osmosis, and UV sterilization to meet safety standards (Hurst 2019). However, waterborne diseases remain a concern worldwide, including in Bangladesh (Pichel et al. 2019). Contamination can stem from improper production and processing methods, inadequate water treatment, poor storage conditions, and ineffective regulatory oversight (Mohiuddin 2019, Islam and Mostafa 2021). Research in other countries has found that even commercially available bottled water can be contaminated with harmful substances such as bacteria, heavy metals, and chemical residues (Chowdhury et al. 2016, Jagaba et al. 2021). This problem is of particular concern in Bangladesh, where inconsistent regulatory frameworks and challenges in enforcing quality control measures exacerbate risks. Water quality is assessed using both qualitative and quantitative methods. Qualitative assessments evaluate sensory characteristics such as taste, odor, color, and appearance (Dietrich et al. 2015), which, although subjective, provide insights into the acceptability of water (Smith et al. 2018). Consumers often rely on sensory assessments as indicators of water quality. In contrast, quantitative assessments measure the concentration of specific physical, chemical, and microbiological parameters in water (Neale et al. 2021). Key parameters include microbial contamination (e.g., total coliforms, *E. coli*, and other pathogens), chemical pollutants (e.g., nitrates, arsenic, lead, and pesticides), and physical properties (e.g., pH, total dissolved solids, and turbidity) (Abanyie et al. 2023, Fida et al. 2023). Combining qualitative and quantitative assessments provides a comprehensive understanding of water safety (Mirchi 2013).

Bottled mineral water, in particular, contains various minerals and trace elements derived from geological processes, contributing to its unique taste or therapeutic properties (Brian 2014). However, the growing number of bottled water brands raises concerns about product quality and safety. Contaminants, variations in mineral content, and discrepancies in labeling and branding can pose health risks (Khadra 2020). Therefore, a thorough assessment of the qualitative and quantitative characteristics of bottled and jarred water in Bangladesh is imperative (Icyimpaye 2019). Research on bottled and jarred drinking water quality in Bangladesh is limited, but some reports indicate the presence of contaminants in some products (Pourfadakari et al. 2022). Additionally, the widespread use of plastic containers for storage presents challenges, including the potential release of harmful substances (Vanapalli et al. 2021). Considering the growing consumption of these products, rigorous quality assessments are urgently needed. This study aims to comprehensively assess bottled and jarred drinking water in the Bangladeshi market. Its objectives are to evaluate sensory characteristics, measure key chemical and microbiological contaminants, compare results with national and international drinking water standards, and assess the accuracy of labeling information. The findings are intended to influence both consumer behavior and policymaking by providing a holistic approach to understanding and improving water security in Bangladesh.

Materials and Methods

Collection of bottled and jarred water samples

A comprehensive study assessed the quality of bottled and jarred water in Bangladesh. Water samples were randomly gathered from open markets, producers, wholesalers and retailers, and restaurants in 18 districts across the country. This study included Dhaka, Chattagram, Barisal, Khulna, Rajshahi, Cumilla, Feni, Rangpur, Dinajpur, Bogra, Sirajgonj, Pabna, Patuakhali, Savar, Gazipur, Mymensingh, Sylhet, and Norsingdhi (Fig. 1). A pre-tested structured questionnaire collected data on production, labeling, and marketing of bottled and jarred water. For the qualitative assessment, characteristics and microbiological studies were conducted on 35 branded bottled water samples (Table 1) and 250 jarred water samples from chosen markets. Farmgate, Gulistan, Sadar Ghat, Khilgaon, Mohammadpur, Mirpur, Uttara, Mohakhali, Keraniganj, Chokbazar, Gulshan, Banani, Jatrabari, Gabtoli Bus Stand, Savar, Asulia, Tongi, Gazipur, Motijheel, Newmarket, and Nilkhet, which consume large amounts of commercial drinking water, were prioritized. For the first time, three imported bottled drinking water samples were analyzed alongside local products to compare their quality. After collection, each sample was labeled with a unique code and stored in a cool, controlled environment until laboratory analysis. To protect consumer rights and encourage informed decisions, seven water samples were collected and labeled as follows: DMMD-003_7J, DGSTN-003_15J, and DSGHT-003_19J were jarred water samples, while SSML-002_1, SSHN-002_2, DLLA-003_5, and BAIFD-005_1 were bottled water samples. These identifiers help identify the collection source and simplify analysis.

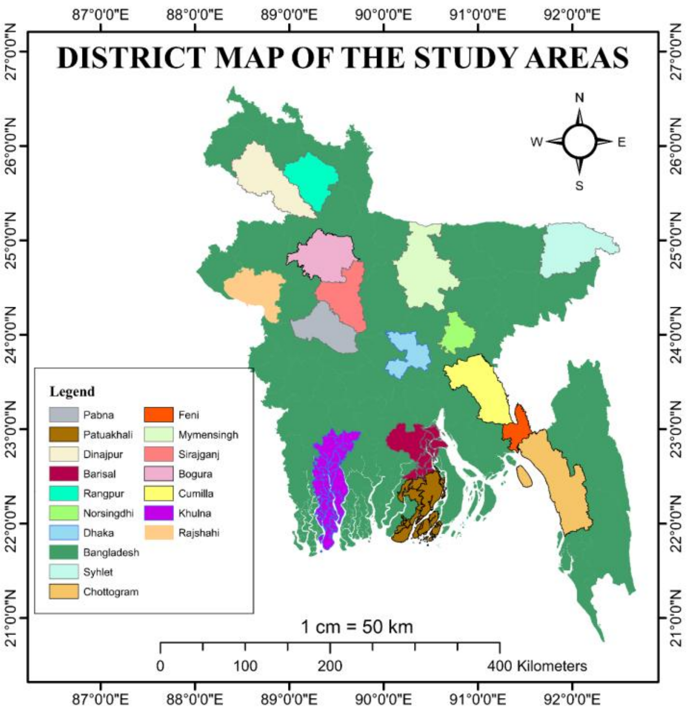

Fig. 1: Location map of the study area.

Table 1: A detailed list of bottled drinking water with trade name and producing company used for analysis.

Sl. No.	Trade name of samples	Producer company	Sl. No.	Trade name of samples	Producer company
1	ACME Premium Water	ACME Aquadate and Beverage Ltd.	19	Masafi Pure Natural* Drinking Water	Imported
2	ALMA	AST Beverage Ltd.	20	Mina Aqua	Gemcon Food & Agricultural Products Ltd.
3	Blu Drinking Water	Mymensingh Agro Ltd.	21	Mughal Drinking Water	Mughal Pure Water Industries Ltd.
4	Britannia Drinking Water	Britannia Foods & Beverage Ltd.	22	MUM Drinking Water	Pertex Beverage Ltd.
5	Confidence Drinking Water	Confidence Food and Beverage Limited	23	Mamia Drinking Water	Mashrifa Food Products Ltd .
6	Crystal Premium Drinking Water	Mymensingh Agro Ltd.	24	Muskan Drinking water	S A Beverage Ltd.
7	Doctor Khabar Pani	Quality Milk Products Industries Ltd.	25	Nectar Drinking Water	BD Thai Food and Beverage Ltd.
8	Eco Natural Drinking Water	PRAN Mymensingh Agro Ltd.	26	No .1 Drinking Water	United Mineral Water and PET Industries Ltd.
9	Everest Drinking Water	Everest Drinks and Dairy Products Ltd.	27	Oceania Pure Drinking Water	Mymensingh agro Ltd.
10	Evian Eau *Minerale Naturelle (Natural Mineral Water)	Imported & Marketed by Foodex International	28	Premium Drinking Water	Premium Beverage and Food Ltd.
11	Evian Natural* mineral water	Imported & Marketed by Elated Marketing Ltd.	29	Prince Pani	Paradise Food Products Ltd.
12	Fena Premium Water	Grand Consumer Bangladesh Ltd.	30	Rivera Pure Drinking Water	Aku Food and Beverage Ltd.
13	Jibon	Soti PET Industries Ltd.	31	Shanti Pure Drinking Water	Dhaka WASA

Contd. Table 1

14	Lilia Drinking Water	Roots Food and Beverage Ltd.	32	Shyamoli Drinking Water	Shyamoli Food and Beverage (Pvt.) Ltd.
15	MAA	Kohinoor Azad Food and Beverage Ltd.	33	Spa Drinking Water	Akij Food and Beverage Ltd.
16	Kinley	International Beverage Private Ltd.	34	Pani Drinking Water	PRAN Mymensingh Agro Ltd.
17	Aquafina	Pepsico and Transcom Beverages Ltd.	35	Saka*	Saka International Ltd.
18	Fresh Drinking Water	United Mineral Water and PET Industries Ltd.			

*Imported water samples.

Methods of water parameter analysis

The collected water samples underwent quantitative and qualitative analyses, focusing on key chemical and microbial parameters. The chemical properties assessed included pH, Total Dissolved Solids (TDS), chloride, lead, nitrite, nitrate, chromium, and iron. Microbial analysis was conducted to measure the presence of total coliform and fecal coliform bacteria, indicative of potential contamination. All chemical and microbial analyses were conducted in the accredited laboratories of SGS Bangladesh Ltd., following established standard analytical procedures. The methods employed followed the guidelines outlined in the American Public Health Association (APHA), Standard Methods for the Examination of Water and Wastewater, 22nd Edition (2012), which included: pH measurement: APHA 4500-H*B, Total Dissolved Solids (TDS): APHA 2540, Chloride concentration: APHA 4500-Cl-B, Nitrite analysis: APHA 4500-NO_2-B, Nitrate analysis: APHA 4500-NO_3-B, Heavy metal analysis (lead, chromium, iron): APHA ICP-OES/MS, Microbial analysis (total coliforms, fecal coliforms): APHA 9221-B, APHA 9221-E. These rigorous methodologies ensured the accuracy and reliability of the chemical and microbial assessments, allowing for a comprehensive water quality evaluation. Graphical representations of the analyzed parameters were generated using R programming to further visualize and interpret the results.

Results and Discussion

Chemical properties of water samples

The chemical and microbial properties of bottled and jarred water samples were evaluated, focusing on the concentrations of total dissolved solids (TDS), chloride, pH, nitrite, nitrate, lead (Pb), chromium (Cr), and iron (Fe). In Addition, microbial contamination was assessed via total coliform and fecal coliform counts. Table 2 presents a summary of the analytical results, comparing the chemical properties of bottled and jarred drinking water.

Table 2: Quantitative analysis of chemical parameters (mineral content) of bottled and jarred drinking water.

Elements/Minerals (mg/l)	Brand bottled water	Jarred water
TDS	8 - 240	62 - 474
Chloride	1.97 - 55	3.99 - 91.97
pH	6.36 - 7.70	6.73 - 7.75
Nitrite	ND	ND
Nitrate	0.17 - 0.22	-
Lead	ND	ND
Chromium	ND	ND
Iron	ND	ND

Drinking water quality standards, describing the ideal and maximum permissible levels for various physicochemical parameters, are summarized in Table 2 in accordance with Bangladesh Standards (BDS 1240:2001).

pH: The pH values of bottled (6.36–7.70) and jarred (6.73–7.75) water samples, presented in Table 1, were within the limits of the Bangladesh Drinking Water Standards (6.4–7.4), as indicated in Appendix B, and within the global recommended range of 6.5–8.5, confirming their suitability for human consumption. According to the Environmental Protection Agency (EPA 2019b), water with a pH below 6.0 can be corrosive and contain toxic metals, while a pH above 8.5 can be slippery to the touch, have a soapy taste, and leave deposits. However, one exception was noted: sample A from the Jere area recorded a pH below the recommended limit, which is consistent with Hauwa et al. (2013), which can cause gastrointestinal irritation in sensitive individuals.

Nitrate: Nitrate concentrations in bottled water ranged from 0.17 to 0.22 mg/L, well below the Bangladesh standard of 4.5 mg/L (Table 1 & 2). Although the observed levels were low, excessive nitrate consumption can pose health risks, particularly for infants and pregnant women, as it can interfere with oxygen transport in the blood (Ebdrup et al. 2022). Higher nitrate contamination is often linked to sources such as animal waste, unregulated wastewater disposal, or industrial and agro-food waste during water treatment (Akhtar et al. 2021).

Total dissolved solids (TDS): Bottled water samples had lower TDS concentrations (8–240 mg/L) compared to jarred water samples (62–474 mg/L) (Table 1), though both remained within Bangladesh drinking water standards, which have a maximum permissible level of 500 mg/L (Table 3) (BSTI 2018). About 90% of bottled water samples had TDS levels below 200 mg/L, while jarred water samples had higher levels, with 11% exceeding 300 mg/L (Table 4). The study highlights that almost all branded bottled drinking water samples had TDS concentrations between 8–240 mg/L, which is within the Bangladesh Standard of a maximum of 500 mg/L.

Table 3: Drinking water standards (ideal and maximum level) according to BDS (1240:2001).

Physicochemical parameter	Acceptable concentration (max) as per BDS
Smell/Flavour	Acceptable level
Taste	Acceptable level
Turbidity (NTU)	5.0
pH	6.4 – 7.4
Iron (Fe), mg/L	0.3
Chloride (Cl), mg/L	250
TDS, mg/L	500
Manganese (Mn), mg/L	0.5
Nitrate (NO_3), mg/L	4.5
Nitrite (NO_2), mg/L	NR
Cadmium (Cd), mg/L	0.003
Arsenic (As), mg/L	0.01
Lead (Pb), mg/L	0.01
Zinc (Zn), mg/L	3.0
Chromium (Cr), mg/L	0.05

Table 4: Range of TDS contents of analyzed samples of bottled and jarred drinking water.

Drinking water source (%)	TDS content (mg/l)				
	Up to 100.0	101-200	201-300	301-400	401-500
Bottled water	79.32	10.34	10.34	0	0
Jarred water	10.53	36.84	42.11	5.26	5.26

TDS is an indicator of water quality. According to WHO guidelines, a TDS <300 mg/L is classified as excellent and 300–600 mg/L as good (WHO, 2022). Higher TDS levels above 900 mg/L are considered unsafe for consumption (Table 5). Low TDS in bottled water may result from reverse osmosis (RO) technology, which reduces mineral content. Jarred water, generally not treated with RO, had higher TDS levels, contributing to a stronger taste due to the presence of dissolved salts.

Table 5: Qualitative classification of TDS according to WHO standards for drinking water.

Concentration of TDS (mg/l)	State of quality
Below 300	Excellent
300 – 600	Good
600 – 900	Least accepted but not disqualified
900 – 1200	Low grade and disqualified
Above 1200	Not acceptable at all

Chloride: Chloride, an essential electrolyte for fluid balance and renal function, ranged from 1.97 to 55 mg/L in bottled water and 3.99 to 91.97 mg/L in jarred water, within the Bangladesh standard of 250 mg/L. However, these levels are too low to meet the recommended daily intake requirement of 750 to 900 mg. Most bottled (83%)

and jarred (53%) water samples had chloride levels below 20 mg/L (Fig. 2). Inadequate chloride intake can cause dehydration, diarrhea, and vomiting (EPA 2019a), while excess blood chloride can lead to dehydration and high blood pressure (McCallum et al. 2015).

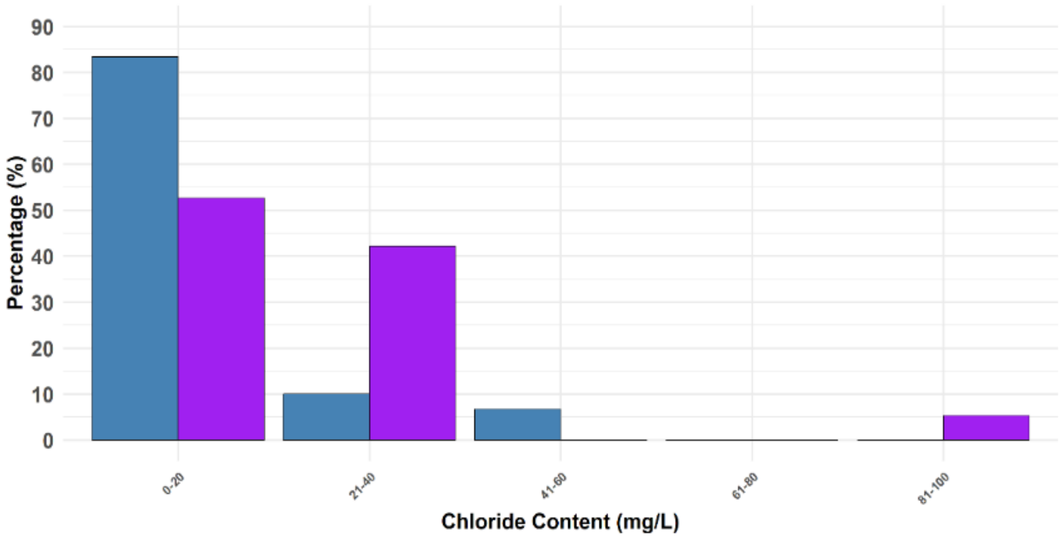

Fig. 2: Chloride content ranges in bottled and jarred water samples.

Microbe analysis of bottled and jarred drinking water

The presence of coliforms and fecal coliforms in drinking water poses serious health risks (Rahman et al. 2019, Wen et al. 2020). According to BSTI guidelines (BSTI 2018), their presence in drinking water is unacceptable. Microbial analysis revealed higher levels of Total coliforms and fecal coliforms in jarred water compared to bottled water, indicating a greater public health threat from jarred water consumption. The results show that jarred water samples had total coliform levels ranging from 17 to 1600 MPN/1000 ml and fecal coliform levels from 11 to 240 MPN/100 ml, well exceeding the acceptable limit of zero according to BSTI and WHO guidelines. In contrast, bottled water samples had less than 1.8 MPN/100 ml for both total and faecal coliforms, indicating their absence and confirming the safety of bottled water for consumption (Table 6).

Table 6: Quantitative analysis of microbial counts in bottled and jarred drinking water.

Element	Brand bottled water (MPN/100 ml)	Jarred water (MPN/100 ml)	BDS standard (MPN/100 ml)
Coliform	<1.8	17-1600	0
Fecal coliform	<1.8	11-240	0

Total and fecal coliform counts are key indicators of drinking water contamination (Wen et al. 2020). Total coliforms indicate contamination from natural sources, as well as human or animal excretion (Edberg et al. 2012), while fecal coliforms specifically indicate contamination from intestinal discharges, which poses a higher health risk (Cabral 2010, Schmidt et al. 2013). Therefore, measuring both total and fecal coliform levels is essential to assessing the health risks associated with contaminated drinking water (Lapworth et al. 2017, Whitehead 2018). Pathogenic bacteria such as *E. coli*, Cryptosporidium, Salmonella, and Giardia, often associated with contaminated drinking water, pose major health risks in low- and middle-income countries (Kristanti et al. 2022, Nwadike et al. 2024). Coliform bacteria support the growth of these pathogens (Gerba and Pepper 2019). This study found that all jarred water samples were contaminated with total and fecal coliforms, highlighting a serious public health risk. Potential source of contamination include improper boiling, inadequate filtration, reuse of uncleaned filters, and contamination from improperly washed containers (Omarova et al. 2018, Malik et al. 2024).

The degree of contamination varied across samples, with high levels of total and fecal coliforms detected in samples from Elephant Road, Chalk Bazar, Basabo, Gulshan, and Banani. The highest contamination levels were observed in Sadar Ghat, where total coliform reached 1600 MPN/100 ml and fecal coliform 240 MPN/100 ml, indicating water unfit water for consumption. In contrast, no microbial contamination was found in any bottled water samples, which is consistent with reverse osmosis (RO) technology used in bottled water treatment (Matin et al. 2021, Rbeida and Eteer 2023). RO technology effectively removes bacteria and other contaminants (Belila et al. 2016, Labella et al. 2021). According to BDS and WHO standards, the presence of coliforms and fecal coliforms in drinking water is unacceptable. High levels of contamination in jarred water samples indicate significant health risks, while bottled water has been found to be free from microbial contamination and poses no such risks. To protect public health, strict monitoring and control measures are required at jarred water treatment facilities to eliminate microbial contamination and ensure safe drinking water.

Labeling practices for commercially available bottled and jarred water

The survey results reveal a worrying lack of compliance and transparency in the labeling practices among bottled and jarred water producers. Traders often prioritize commercial interests over consumer safety, withholding crucial information about the mineral composition and safety of their products (Shiquan and Deyi 2023). In the case of bottled water, labels often display mineral compositions that differ significantly from actual analytical results, misleading consumers. The situation with jarred water is even more concerning. Approximately 95% of jarred water producers provide no labeling, with no information on mineral content, and 100% of producers do not include any information on microbial safety. This lack of transparency, combined with the microbial contamination found in jarred water samples, exposes consumers to significant health risks (WHO 2022). As a result, many consumers unknowingly ingest poor quality or unsafe water, potentially leading to adverse health effects (Schwarzenbach et al. 2010, Singh et al. 2024).

pH analysis

Figure 3 shows the pH values of different samples compared to standard limits (6.0–8.0). Most samples were within the range, but SSML-002_1 and DMMD-003_7J exceeded the upper limit, suggesting possible contamination or changes in alkalinity. DGSTN-003_15J and DSGHT-003_19J were close to the upper limit but remained acceptable and required monitoring. SSHN-002_2, DLLA-003_5 and BAIFD-005_1 stayed well within limits, reflecting stable conditions and quality control.

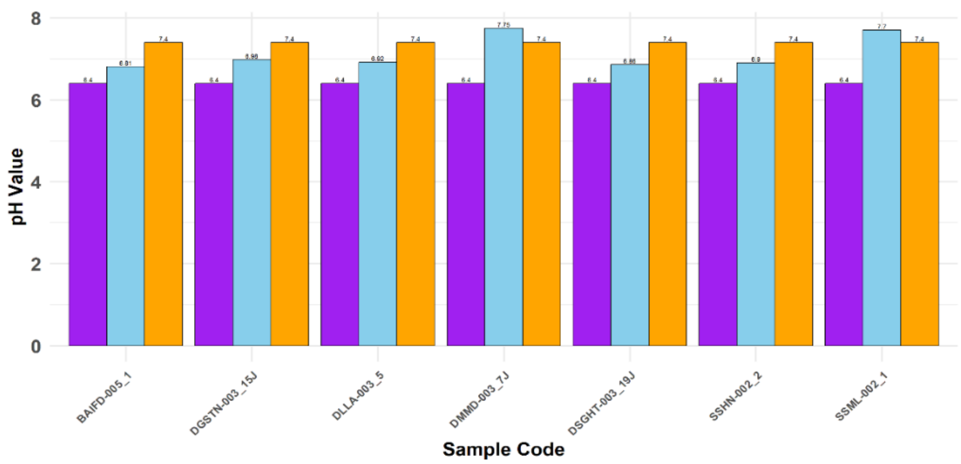

Fig. 3: Variation of test results of pH with label information of the producer.

TDS levels: Total dissolved solids (TDS) levels are an important indicator of drinking water quality, reflecting the concentration of dissolved ions and non-ionic substances that can affect the taste, palatability, and safety of the water (Kumar et al. 2023). According to the World Health Organization (WHO 2022), TDS concentrations below 500 mg/L are generally considered acceptable for drinking water, as higher levels can negatively impact both aesthetic quality and health. In this study, TDS concentrations varied across the samples, with most values well below the 500 mg/L standard, suggesting an overall high-water quality.

Fig. 4 shows TDS test results for different sample codes against the standard TDS threshold (500 mg/L). The highest TDS concentration was observed in sample DGSTH003_15J, which reached the standard limit (~500 mg/L). Sample DSGRT003_9J exhibited a moderately high TDS level (~330 mg/L). Other samples have significantly lower TDS concentrations. Overall, most samples remained below the standard threshold, except for DGSTH003_15J, which was at the limit. The optimal TDS range for the best-tasting drinking water with optimal taste is generally between 150.00 and 250.00 mg/L, as recommended for consumer preferences. A study by Islam et al. (2016) reported TDS levels in drinking mineral water samples from Bangladesh ranging from 9.44 to 335.00 mg/L. Maintaining TDS levels within acceptable limits is crucial not only for aesthetic reasons but also for public health. High concentration of TDS, if it contains harmful ions or compounds, can pose health risks (APHA 2017).

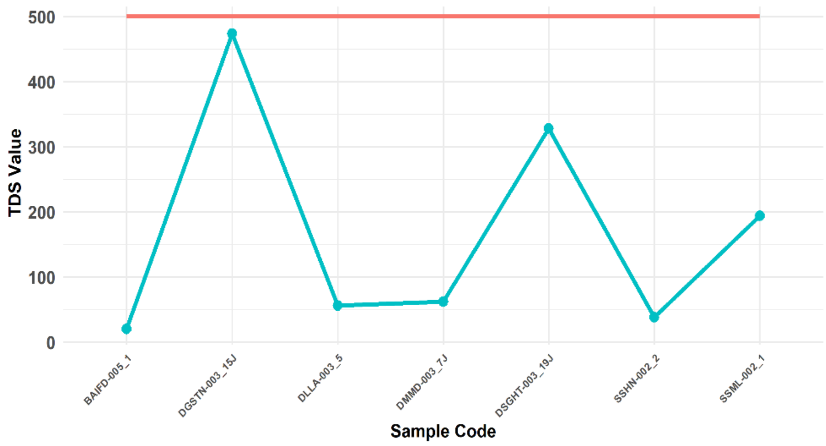

Fig. 4: Variation of TDS test results with producer label information.

Chloride concentrations

Fig. 5 illustrates the chloride concentrations in different samples relative to the standard chloride limit (250 mg/L). The results indicate that all the samples tested had chloride concentrations significantly lower than the standard limit. The highest recorded chloride concentration was observed in sample DGSTH003_15J (approximately 90 mg/L), while other samples, including DLLA003_S, DIMB003_7J, DSGRT003_9J, SSM-002_2, and SSM-002_1, had much lower chloride concentrations. The results confirm that chloride concentrations are within the standards in all cases, thus ensuring the usability and safety of these samples for the intended purposes. A study by the US Geological Survey (2019) found that only 1.4% of samples exceeded the secondary maximum contaminant level (SMCL) of 250 mg/L for chloride in drinking water. Research comparing global chloride standards shows that many countries, including China, have established similar thresholds for chloride in drinking water at 250 mg/L. However, some studies suggest lower recommended values based on species sensitivity distribution, indicating a need for adaptive management strategies to effectively address localized sources of contamination.

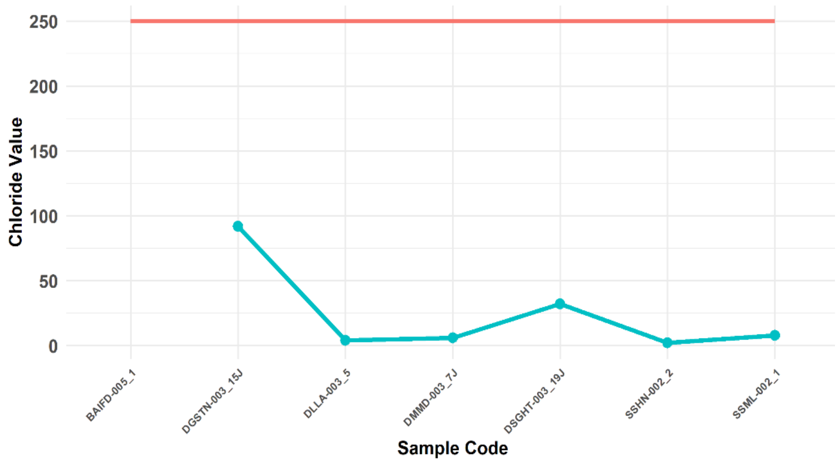

Fig. 5: Variation of test results of chloride with label information of the producer.

Other parameters

No samples tested positive for nitrite (NO_2), in accordance with the strict zero-tolerance policy of the Bangladesh drinking water standards (BDS). Nitrate (NO_3) was detected in four samples, but concentrations were well below the BDS limit of 4.5 mg/L, ranging from 0.17 to 0.21 mg/L. Furthermore, no detectable levels of arsenic (As), cadmium (Cd), iron (Fe), manganese (Mn), or lead (Pb) were found in any sample, ensuring compliance with the respective BDS standards for these trace metals (Table 4). In contrast, four samples (SSML-002_1, SSHN-002_2, DLLA-003_5, and BAIFD-005_1) showed negligible contamination by total coliform (<1.8 MPN/100 ml), thus meeting the strict BDS standard of 0 MPN/100 ml. In contrast, samples DMMD-003_7J (17 MPN/100 ml), DGSTN-003_15J (130 MPN/100 ml), and DSGHT-003_19J (1600 MPN/100 ml) displayed significantly increased total coliform levels, exceeding acceptable limits and indicating compromised water quality (Table 4). Five samples (SSML-002_1, SSHN-002_2, DLLA-003_5, BAIFD-005_1, and DMMD-003_7J) met the BDS standard for fecal coliforms, with levels below the detection limit (<1.8 MPN/100 ml). However, samples DGSTN-003_15J (79 MPN/100 ml) and DSGHT-003_19J (240 MPN/100 ml) showed high fecal coliform contamination, which poses serious health risks (Table 7).

Table 7: Variation of test results of particular parameters with producer label information.

Sample code	Evaluation summary	Nitrite (NO_2) mg/L	Nitrate (NO_3) mg/L	Arsenic (As) mg/L	Cadmium (Cd) mg/L	Iron (Fe) Mg/L	Manganese (Mn) mg/L	Lead (Pb) mg/L	Total coliform MPN/100 ml	Fecal coliform MPN/100 ml
SSML-002_1	BDS standard	Nil	4.5	0.01	0.003	0.3	0.5	0.01	0	0
	Test result	ND	0.19	ND	ND	ND	ND	ND	<1.8	<1.8
	Company label	-	<2 .5	-	<0.003	-	<0.1	<0.01	-	-
SSHN-002_2	BDS standard	Nil	4.5	0.01	0.003	0.3	0.5	0.01	0	0
	Test result	ND	0.19	ND	ND	ND	ND	ND	<1.8	<1.8
	Company label	Nil	4.5	0.01	0.003	-	-	0.01	-	-
DLLA-003_5	BDS standard	Nil	4.5	0.01	0.003	0.3	0.5	0.01	0	0
	Test result	ND	0.17	ND	ND	ND	ND	ND	<1.8	<1.8
	Company label	Nil	Nil	Nil	<0.03	-	Nil	<0.01	-	-
BAIFD-005_1	BDS standard	Nil	4.5	0.01	0.003	0.3	0.5	0.01	0	0
	Test result	ND	0.21	ND	ND	ND	ND	ND	<1.8	<1.8
	Company label	Nil	<4	Nil	<0.003	-	-	<0.01	-	-
DMMD-003_7J	BDS standard	Nil	4.5	0.01	0.003	0.3	0.5	0.01	0	0
	Test result	ND	ND	ND	ND	ND	ND	ND	17	<1.8
DGSTN-003_15J	BDS standard	Nil	4.5	0.01	0.003	0.3	0.5	0.01	0	0
	Test result	ND	ND	ND	ND	ND	ND	ND	130	79
DSGHT-003_19J	BDS standard	Nil	4.5	0.01	0.003	0.3	0.5	0.01	0	0
	Test result	ND	ND	ND	ND	ND	ND	ND	1600	240

ND: Not Detected; MPN/100 ml: Most probable number per 100 ml.

Study alignment with the SDGs

The following table summarizes how the identified water quality deficiencies align with specific Sustainable Development Goals (SDGs), highlighting the critical connections between water safety and the global sustainability goals (Table 8).

Table 8: Alignment of water quality issues with the sustainable development goals.

SDG goals	Target	Description
SDG 3: Good health and Well-being.	Substantially reduce deaths and illnesses from hazardous chemicals and contamination.	Highlights the need to minimize health risks caused by contaminated drinking water.
SDG 6: Clean water and Sanitation.	Achieve universal and equitable access to safe and affordable drinking water for all.	Stresses the importance of robust monitoring systems to ensure safe drinking water.
SDG 12: Responsible Consumption and Production.	Ensure people have relevant information for sustainable lifestyles.	Emphasizes accurate labelling to promote informed consumer choices and responsible production.
SDG 17: Partnerships for the Goals.	Enhance global partnerships for sustainable development.	Encourages collaboration to address water quality challenges and implement sustainable solutions.

Conclusion

This study evaluated the chemical, microbial, and labeling attributes of bottled and jarred drinking water in accordance with the Bangladesh Drinking Water Standards (BDS 1240: 2001) and World Health Organization (WHO) guidelines. The findings revealed significant differences in water quality between the two sources. Bottled water samples consistently met BDS and WHO guidelines, with negligible levels of contaminants. These attributes confirm that bottled water is a safer option for human consumption. In contrast, jarred water samples had higher levels of TDS and chloride, with a significant proportion containing elevated levels of total coliforms and fecal coliforms, exceeding acceptable limits. This study highlights critical public health risks associated with jarred water. It also identified labeling issues, bottled water has inaccurate mineral content, and jarred water lacks labels, misleading consumers, and hindering informed decision-making. Ensuring safe drinking water requires strict quality monitoring, improved jarred water practices, accurate labeling, and public awareness to mitigate health risks.

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