



RESEARCH PAPER

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Physical and chemical property analysis of tap water in Cantilan, Surigao Del Sur

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Abstract

Safe and potable water is crucial to ensure public health. This study evaluates the physical and chemical properties of tap water sources in Cantilan, Surigao del Sur, a town known as the "Cradle of All Towns." Water samples from multiple locations were analyzed to determine compliance with the Philippine National Standards for Drinking Water (PNSDW) 2017. The physical and chemical tests assessed parameters such as pH, turbidity, total dissolved solids, and heavy metal concentrations. Results showed that parameters such as pH, turbidity, total dissolved solids, and heavy metal concentrations consistently fell within acceptable limits, ensuring the safety and palatability of the water. While nitrate levels and total hardness remained within permissible thresholds, year-on-year fluctuations in certain parameters highlight the importance of continued surveillance to maintain water quality. Overall, the findings confirm that the water sources in Cantilan are safe but ongoing maintenance and periodic evaluations are recommended to ensure sustained compliance and public health protection.

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Introduction

In managing the collective water supply system, water quality of tap water in the distribution system should be monitored and the risk of losing its sanitary safety should be estimated (Domoń *et al.*, 2024).

Long term exposure to endocrine disrupting compound can potentially be risk to human health (Wee and Aris, 2019). Similarly, an assessment of freshwater systems in Mega Manila indicated that, although heavy metals and organic pollutants were undetected, high microbial activity was present in several samples, suggesting potential health risks (Obusan *et al.*, 2023).

Proper chlorination of the water system together with constant monitoring, proper disposal system to not contaminate the water source and sanitation education for the community should be prioritize by the concerned body to ensure water safety (Sitotaw *et al.*, 2021)

These findings underscore the necessity for regular monitoring and implementation of effective water treatment systems to ensure the provision of safe drinking water. The Philippine National Standards for Drinking Water (PNSDW) of 2017 provide guidelines for acceptable levels of various water quality parameters, emphasizing the importance of maintaining both microbiological standards to protect public health (Philippine National Standards for Drinking Water (PNSDW, 2017).

Materials and methods

The research was conducted in Cantilan, Surigao del Sur. A communication letter to the head of Cantilan water district to allow access to the physical and chemical parameters test results for two years. The inclusive years include 2022- 2023. There were four water sources that were tested, namely;

1. Lib-og Spring, Buntalid, Cantilan Surigao del Sur
2. Homoyat Pump Station, Buntalid, Cantilan Surigao del Sur
3. Calagdaan Pump Station, Calagdaan, Cantilan Surigao del Sur

4. Malitangtang Dug Well, Tigabong, Cantilan, Surigao del Sur

For the microbial analysis, testing is done monthly in different areas in Cantilan.

Results and discussion

Table 1 shows the physical and chemical test results of four tap water sources in 2023. The results reveal that all tested water sources had levels of arsenic, cadmium, and lead well below the acceptable limits. Specifically, the arsenic levels across all sources were below 0.005 mg/L, which is significantly lower than the PNSDW limit of 0.01 mg/L. The cadmium levels were similarly low (<0.001 mg/L), well within the standard of 0.003 mg/L. Lead levels in most sources were also below the PNSDW threshold of 0.01 mg/L, except for Homoyat Pump Station, which recorded 0.007 mg/L but is still within acceptable limits. Nitrate concentrations were low in all sources, ranging from 0.7 to 1.2 mg/L, far below the PNSDW's upper limit of 50 mg/L. The pH values ranged from 7.91 (Calagdaan) to 8.33 (Lib-og Spring), all within the ideal range of 6.5 to 8.5. Total dissolved solids (TDS), a measure of dissolved substances in water, ranged from 162 mg/L (Lib-og Spring) to 213 mg/L (Homoyat Pump Station), all well below the PNSDW limit of 600 mg/L. The turbidity, which indicates water clarity, varied from 0.73 NTU (Lib-og Spring) to 2.54 NTU (Homoyat), with all sources meeting the standard of less than 5 NTU.

For primary parameters, it showed good results. Barium levels were low across all sources, with Calagdaan Pump Station showing the lowest value of <0.005 mg/L, well below the PNSDW limit of 0.7 mg/L. Boron, chromium, manganese, nickel, and selenium were undetectable in all sources, which is desirable as their concentrations should remain low. Sulfate levels, a common component of water, were below the PNSDW limit of 250 mg/L in all sources, ranging from 1 to 2 mg/L.

In terms of secondary parameters, the water quality continued to meet standards. Aluminum concentrations were low across all sources, ranging from 0.007 mg/L (Calagdaan) to 0.02 mg/L (Lib-og Spring), which is well below the PNSDW limit of 0.2 mg/L.

Table 1. Physical and chemical test results of the four tap water sources in 2023

Parameters	PNSDW 2017	Calagdaan pump station	Homoyat pump station	Lib-og spring	Malitang-tang dug well
Mandatory					
Arsenic	0.01 mg/L	<0.005	<0.005	<0.005	<0.005
Cadmium	0.003 mg/L	<0.001	<0.001	<0.001	<0.001
Color, apparent	10 units	6	10	6	8
Lead	0.01 mg/L	<0.005	0.007	0.005	<0.005
Nitrate	50.00 mg/L	1.2	0.8	0.7	0.9
pH	6.5-8.5 (5.0-7.0 undergo R.O or distillation)	7.91	8.17	8.33	8.27
Total dissolved solids	600 mg/L (<10 mg/L undergo R.O. or distillation)	207	213	162	187
Turbidity	5 NTU	0.8	2.54	0.73	1.54
Primary					
Barium	0.70 mg/L	<0.005	0.022	0.02	0.01
Boron	2.00 mg/L	0.021	<0.005	<0.005	<0.005
Chromium	0.05 mg/L	<0.005	<0.005	<0.005	<0.005
Manganese	0.4 mg/L	<0.005	<0.005	<0.005	<0.005
Nickel	0.07 mg/L	<0.005	<0.005	<0.005	<0.005
Selenium	0.4 mg/L	<0.005	<0.005	<0.005	<0.005
Sulfate	250 mg/L	2	1	<1	2
Secondary					
Aluminum	0.2 mg/L	0.007	0.014	0.02	0.017
Copper	1.0 mg/L	<0.005	<0.005	<0.005	<0.005
Iron	1.0 mg/L	<0.005	<0.005	<0.005	<0.005
Zinc	5.0 mg/L	<0.005	<0.005	<0.005	<0.005
Chloride	250 mg/L	38	20	24	18
Total hardness	300 mg/L	220	224	170	188
Odor	Unobjectable	Unobjectable	Unobjectable	Unobjectable	Unobjectable
Other parameters					
Appearance	Clear	Not Clear	Not Clear	Not Clear	Not clear
Temperature		24.9	24.9	24.9	24.9
Specific Conductance		393	401	306	353
Salinity		0.2	0.2	0.2	0.2
Molybdenum		<0.005	<0.005	<0.005	<0.005
Beryllium		<0.005	<0.005	<0.005	<0.005
Cobalt		<0.005	<0.005	<0.005	<0.005
Silver		<0.005	<0.005	<0.005	<0.005

Copper, iron, and zinc were all undetectable (<0.005 mg/L) in all sources. Chloride levels ranged from 18 mg/L (Malitangtang Dug Well) to 38 mg/L (Calagdaan Pump Station), all within the acceptable range of up to 250 mg/L. Total hardness, which measures water's mineral content, ranged from 170 mg/L (Lib-og Spring) to 224 mg/L (Homoyat Pump Station), all within the acceptable limit of 300 mg/L. Importantly, there were no odors detected in any of the water sources, which is a positive indication of water quality.

The physical characteristics of the water were also assessed. Temperature readings were consistent across all sources at 24.9°C, indicating a stable water

temperature. Specific conductance, which indicates the water's ability to conduct electricity (and indirectly the level of dissolved salts), varied from 306 $\mu\text{S}/\text{cm}$ (Lib-og Spring) to 401 $\mu\text{S}/\text{cm}$ (Homoyat Pump Station). Salinity was consistent at 0.2%, which is typical for freshwater sources. Additionally, molybdenum, beryllium, cobalt, and silver were all undetectable in all sources, indicating that these potentially harmful substances are not present in detectable amounts.

One notable exception in the results was the appearance of the water. All sources, except for Calagdaan Pump Station, showed "Not Clear" water, which indicates some level of turbidity or particulate

matter in the water, even though the turbidity measurements were within acceptable limits. This could suggest the presence of fine particles that are not captured in turbidity tests or a natural occurrence in the water's environment.

In summary, the physical and chemical test results from these four tap water sources demonstrate that all parameters are within the limits set by the PNSDW, with the exception of water appearance, which may require further investigation. The consistently low levels of harmful chemicals and physical impurities across all sources indicate that the water is generally safe for consumption. However, the clarity of the water, particularly in three of the four

sources, warrants attention to ensure that aesthetic qualities, such as appearance, are also addressed, even though they do not necessarily affect the safety of the water.

Table 2 presents the physical and chemical properties of the waters in the same locations for the year 2022, highlighting some variations compared to the 2023 results. Nitrate levels in 2022 were higher compared to 2023, ranging from 0.7 mg/L to 5.10 mg/L. These values remain well below the maximum permissible limit of 50 mg/L, ensuring no significant risk of methemoglobinemia. However, the observed variation may be attributed to seasonal agricultural runoff or differences in water treatment efficacy.

Table 2. Physical and chemical test results of the four tap water sources in 2022

Parameter	PNSDW 2017	Calagda-an pump station	Homoyat pump station	Lib-og spring	Malitang-tang dug well
Mandatory					
Nitrate	50.00 mg/L	2.2	4.1	3.4	5.1
Color, apparent	10 units	7	6	7	6
Turbidity	5 NTU	0.39	1.5	0.36	1.3
pH	6.5-8.5 (5.0-7.0 undergo R.O or distillation)	7.98	7.83	7.68	6.68
Total dissolved solids	600 mg/L (<10 mg/L undergo R.O. or distillation)	211	214	214.7	169.7
Primary					
Sulfate	250 mg/L	2	8	2	<1
Secondary					
Iron	1.0 mg/L	0.01	0.07	0.02	0.08
Chloride	250 mg/L	43.96	45.38	44.67	12.76
Total hardness	300 mg/L	162	173	160	211
Odor	Unobjectable	Unobjectable	Unobjectable	Unobjectable	Unobjectable
Other parameters					
Temperature	°C	25	25	25	25
Specific conductance		436	442	442	352
Salinity		0.2	0.2	0.2	0.2
Flouride	1.5 mg/L	0.16	0.27	0.27	0.06
Sulfate	250 mg/L	2	8	2	<1
Nitrate	50 mg/L	2.2	4.1	3.4	5.1
Magnesium (as CaCO ₃)		115	115	110	110
Calcium (as CaCO ₃)		47	58	50	101

The pH levels in 2022 exhibited slight fluctuations, with the Homoyat Pump Station recording a value of 6.68, which is on the lower side of the acceptable range. A more acidic pH could potentially increase the corrosivity of the water, posing risks to the distribution system. Chloride levels were notably higher in 2022, which could contribute to a slightly

salty taste if the trend continues, although the concentrations remain well within safe limits.

The results further indicate that from 2022 to 2023, the physical and chemical properties of tap water from the four main sources in Cantilan remained within the national acceptable limits as prescribed by the Philippine

National Standard for Drinking Water of 2017. No major fluctuations in water quality parameters were observed during the two-year period. However, it is recommended that consistent monitoring and regulation of these parameters be maintained to ensure the compliance with safety standards.

Conclusion

The study on the physical and chemical properties of the water sources in Cantilan demonstrates that the quality of water from the analyzed sites generally meets the standards set by the Philippine National Standards for Drinking Water (PNSDW) 2017. Parameters such as pH, turbidity, total dissolved solids, and heavy metal concentrations consistently fell within acceptable limits, ensuring the safety and palatability of the water. While nitrate levels and total hardness remained within permissible thresholds, year-on-year fluctuations in certain parameters highlight the importance of continued surveillance to maintain water quality. Overall, the findings confirm that the water sources in Cantilan are safe but ongoing maintenance and periodic evaluations are recommended to ensure sustained compliance and public health protection.

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