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Microbial quality assessment of tap water in Cantilan, Surigao del Sur

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Abstract

Ensuring access to safe and potable water is a critical public health concern, particularly for communities relying on a single water source. This study evaluates the microbial quality of tap water in Cantilan, Surigao del Sur, a town known as the "Cradle of All Towns." Water samples were collected from multiple locations over a two-year period (January 2022 – December 2023) and analyzed for compliance with the Philippine National Standards for Drinking Water (PNSDW) 2017. Results indicate that, while the water supply generally met regulatory standards, minor seasonal variations in microbial counts were observed, particularly in May and June 2022, where slight traces of contamination were detected in some areas. However, these fluctuations remained within acceptable limits, suggesting that the water distribution system is well-maintained. The findings underscore the importance of continuous monitoring and improvements in water treatment strategies to ensure long-term water safety. This study provides essential insights into the current state of water quality in Cantilan, serving as a foundation for future water safety initiatives and policy recommendations.

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Introduction

Ensuring the safety and quality of drinking water is a critical public health concern, particularly in regions like the Philippines where access to clean water can be inconsistent.

Studies have assessed the physico-chemical and microbiological characteristics of domestic water supplies to determine their potability. For instance, research conducted in Bontoc, Mountain Province, revealed that while physico-chemical parameters generally met acceptable ranges, microbial contamination was prevalent, rendering the water unsafe for direct consumption (Magwilag *et al.*, 2023).

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).

Bacterial groups have been used as an indicator of water pollution, specifically the total coliform count. WHO (1971) stated that the allowable limit of coliform and E. coli should be 0/100 mL for drinking water and 126 CFU/100 mL for domestic and recreational water.

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, utilizing data sourced from Cantilan Water District. A comprehensive monthly microbial water analysis was performed across various locations within Cantilan. The analysis focused on quantifying total coliforms and fecal coliforms, using the Multiple Tube Fermentation (MTF) technique and Heterotrophic Plate Counts (HPC), where the pour plate method was implemented for enumeration. The temporal scope of this study spans from January 2022 to December 2023.

Results and discussion

The microbial analysis of waterworks in Cantilan for the year 2023 shows that the heterotrophic plate count (HPC), which measures the concentration of heterotrophic bacteria, was elevated in certain months, particularly September, where Brgy. Linintian recorded 485 CFU/mL. Although HPC does not directly correlate with health risks, higher counts suggest potential regrowth or biofilm formation within the distribution system. The WHO highlights that HPC should ideally remain below 500 CFU/mL to ensure acceptable water quality (Table 1).

Some *et al.* (2021) stated that one of the major problems concerning water quality is the microbial pollution. The presence of pathogenic bacteria, protozoa and viruses is a serious threat to humans as it could lead to enteric outbreaks.

Table 1. Water microbial analysis of water works in 2023

Month	Location	HPC[a/] CFU/mL Baterial count	Total coliforms MPN/100mL	Thermotolerant (Fecal) coliforms MPN/100mL	Remarks
14-Jan-23	Brgy. Buntalid	15 CFU/mL	<1.1	<1.1	Passed
	Brgy. Magasang	0 CFU/mL	<1.1	<1.1	Passed
	Brgy. Magosilom	0 CFU/mL	<1.1	<1.1	Passed
	Brgy. Linintian	0 CFU/mL	<1.1	<1.1	Passed
	Brgy. Tapi	0 CFU/mL	<1.1	<1.1	Passed
12-Feb-23	Brgy Buntalid	2 CFU/mL	<1.1	<1.1	Passed

	Bgry. Linintian	0 CFU/mL	<1.1	<1.1	Passed
	Brgy. Magasang	0 CFU/mL	<1.1	<1.1	Passed
	Brgy. Magosilom	0 CFU/mL	<1.1	<1.1	Passed
	Bgry. Pag-antayan	0 CFU/mL	<1.1	<1.1	Passed
	Bgry. Tapi	0 CFU/mL	<1.1	<1.1	Passed
18-Mar-23	Brgy. Buntalid	0 CFU/mL	<1.1	<1.1	Passed
	Bagsukan	11 CFU/mL	<1.1	<1.1	Passed
	Brgy. Linintian	2 CFU/mL	<1.1	<1.1	Passed
	Brgy. Magosilom	0 CFU/mL	<1.1	<1.1	Passed
	Brgy. Pag-antayan	0 CFU/mL	<1.1	<1.1	Passed
	Brgy. San Pedro	0 CFU/mL	<1.1	<1.1	Passed
8-Apr-23	Brgy Linintian	2 CFU/mL	<1.1	<1.1	Passed
	Brgy Buntalid	1 CFU/mL	<1.1	<1.1	Passed
	Brgy Magasang	1 CFU/mL	<1.1	<1.1	Passed
	Brgy Magosilom	1 CFU/mL	<1.1	<1.1	Passed
	Brgy. Pag-antayan	0 CFU/mL	<1.1	<1.1	Passed
	Brgy. Tapi	4 CFU/mL	<1.1	<1.1	Passed
5-May-23	Brgy. Busukan	3 CFU/mL	<1.1	<1.1	Passed
	Brgy. Consuelo	<1.0 CFU/mL	<1.1	<1.1	Passed
	Brgy. Magosilom	<1.0 CFU/mL	<1.1	<1.1	Passed
	Brgy. Linintian	<1.0 CFU/mL	<1.1	<1.1	Passed
	Brgy. Pag-antayan	1 CFU/mL	<1.1	<1.1	Passed
	Brgy. Parang	<1.0 CFU/mL	<1.1	<1.1	Passed
10-Jun-23	Brgy. Busukan	1.0 CFU/mL	<1.1	<1.1	Passed
	Brgy. Consuelo	<1.0 CFU/mL	<1.1	<1.1	Passed
	Brgy. Linintian	<1.0 CFU/mL	<1.1	<1.1	Passed
	Brgy. Magasang	1.0 CFU/mL	<1.1	<1.1	Passed
	Brgy. Magosilom	<1.0 CFU/mL	<1.1	<1.1	Passed
	Brgy. Parang	<1.0 CFU/mL	<1.1	<1.1	Passed
8-Jul-23	Brgy. Bugsukan	<1.0 CFU/mL	<1.1	<1.1	Passed
	Brgy. Buntalid	<1.0 CFU/mL	<1.1	<1.1	Passed
	Brgy. Calagda-an	<1.0 CFU/mL	<1.1	<1.1	Passed
	Brgy. Linintian	<1.0 CFU/mL	<1.1	<1.1	Passed
	Brgy. Pag-antayan	<1.0 CFU/mL	<1.1	<1.1	Passed
6-Aug-23	Brgy. Buntalid	<1.0 CFU/mL	<1.1	<1.1	Passed
	Brgy. Calagda-an	<1.0 CFU/mL	<1.1	<1.1	Passed
	Brgy. Linintian	<1.0 CFU/mL	<1.1	<1.1	Passed
	Brgy. Magosilom	<1.0 CFU/mL	<1.1	<1.1	Passed
	Brgy. Pag-antayan	<1.0 CFU/mL	<1.1	<1.1	Passed
	Brgy. San Pedro	<1.0 CFU/mL	<1.1	<1.1	Passed
9-Sep-23	Brgy. Linintian	485 CFU/mL	<1.1	<1.1	Passed
	Brgy. Magosilom	29 CFU/mL	<1.1	<1.1	Passed
	Brgy. Pag-antayan	101 CFU/mL	<1.1	<1.1	Passed
	Brgy. Parang	101 CFU/mL	<1.1	<1.1	Passed
	Brgy. Tigabong	1 CFU/mL	<1.1	<1.1	Passed
7-Oct-23	Brgy. Bugsukan	<1.0 CFU/mL	<1.1	<1.1	Passed
	Brgy. Buntalid	4 CFU/mL	<1.1	<1.1	Passed
	Brgy. Consuelo	<1.0 CFU/mL	<1.1	<1.1	Passed
	Brgy. Linintian	4 CFU/mL	<1.1	<1.1	Passed
	Brgy. Magosilom	2 CFU/mL	<1.1	<1.1	Passed
	Brgy. Parang	<1.0 CFU/mL	<1.1	<1.1	Passed
11-Nov-23	Brgy. Magasang	1 CFU/mL	<1.1	<1.1	Passed
	Brgy. San Pedro	<1.0 CFU/mL	<1.1	<1.1	Passed
	Brgy. Parang	<1.0 CFU/mL	<1.1	<1.1	Passed
	Brgy. Buntalid	<1.0 CFU/mL	<1.1	<1.1	Passed
	Brgy. Linintian	1 CFU/mL	<1.1	<1.1	Passed
	Brgy. Magosilom	1 CFU/mL	<1.1	<1.1	Passed
10-Dec-23	Brgy. Linintian	<1.0 CFU/mL	<1.1	<1.1	Passed
	Brgy. Magosilom	<1.0 CFU/mL	<1.1	<1.1	Passed
	Brgy. Pag-antayan	<1.0 CFU/mL	<1.1	<1.1	Passed
	Brgy. Calagda-an	<1.0 CFU/mL	<1.1	<1.1	Passed
	Brgy. Parang	1 CFU/mL	<1.1	<1.1	Passed
	Brgy. Buntalid	<1.0 CFU/mL	<1.1	<1.1	Passed

Table 2. Water microbial analysis of water works in 2022

Month	Location	HPC[a/] CFU/mL Baterial count	Total coliforms MPN/100mL	Thermotolerant (Fecal) coliforms MPN/100mL	Remarks
January 31,2022	Brgy. Magosilom	3800	<1.1	<1.1	Failed
	Brgy. Linintian	1	<1.1	<1.1	Passed
	Brgy. Buntalid	10	<1.1	<1.1	Passed
	Brgy. Parang	2	<1.1	<1.1	Passed
	Brgy. Magasang	20	<1.1	<1.1	Passed
	Brgy. Linintian	5	<1.1	<1.1	Passed
February 21,2022	Brgy. Linintian	<1	<1.1	<1.1	Passed
	Brgy. Buntalid	<1	<1.1	<1.1	Passed
	Brgy. Parang	<1	<1.1	<1.1	Passed
	Brgy.Pag-antayan	<1	<1.1	<1.1	Passed
	Brgy. Consuelo	<1	<1.1	<1.1	Passed
	Brgy. Magosilom	<1	<1.1	<1.1	Passed
March 22, 2022	Brgy. Linintian	23	0	0	Passed
	Brgy. Magosilom	190	0	0	Passed
	Brgy. Buntalid	35	0	0	Passed
	Brgy. Palasao	27	0	0	Passed
	Brgy. Magasang	25	0	0	Passed
	Brgy. Pag-antayan	36	0	0	Passed
April 19,2022	Brgy. Lininti-an	1	0	0	Passed
	Brgy. Pag-antayan	5	0	0	Passed
	Brgy. San Pedro	7	0	0	Passed
	Brgy. Buntalid	1	0	0	Passed
	Brgy. Parang	8	0	0	Passed
May 4, 2022	Brgy. Linintian	50	0	0	Passed
	Brgy. Buntalid	10	0	0	Passed
	Brgy. Parang	150	1.1	0	Passed
	Brgy. Pag-antayan	10	0	0	Passed
	Brgy. Magosilom	10	0	0	Passed
June 6, 2022	Brgy. Pag-antayan	0	0	0	Passed
	Brgy. Parang	0	0	0	Passed
	Brgy. Palasao	0	0	0	Passed
	Brgy. Tigabong	0	0	0	Passed
	Brgy. Pag-antayan	0	0	0	Passed
July 5, 2022	Brgy. Magosilom	0	0	0	Passed
	Brgy. Palasao	0	0	0	Passed
	Brgy. Buntalid	0	0	0	Passed
	Brgy. Magasang	0	0	0	Passed
	Brgy. Linintian	1	0	0	Passed
	Brgy. Magosilom	0	0	0	Passed
	Brgy. Calagda-an,	0	0	0	Passed
August 8, 2022	Brgy. Buntalid	8	0	0	Passed
	Brgy. Tigabong	25	0	0	Passed
	Brgy. Parang	32	0	0	Passed
	Brgy. Pag-antayan	21	0	0	Passed
	Brgy. Magosilom	17	0	0	Passed
	Brgy. Linintian	62	0	0	Passed
September 10, 2022	Brgy. Parang	0	<1.1	<1.1	Passed
	Brgy. Consuelo	1	<1.1	<1.1	Passed
	Brgy. San Pedro	1	<1.1	<1.1	Passed
	Brgy. Linintian	1	<1.1	<1.1	Passed
	Brgy. Bugsukan	0	<1.1	<1.1	Passed
	Brgy. Magosilom	1	<1.1	<1.1	Passed
October 08,2022	Brgy. Palasao	123	<1.1	<1.1	Passed
	Brgy. Magosilom	65	<1.1	<1.1	Passed
	Brgy. Linintian	39	<1.1	<1.1	Passed
November 13, 2022	Brgy. Magasang	0	<1.1	<1.1	Passed
	Brgy. Magosilom	0	<1.1	<1.1	Passed
	Brgy. Linintian	0	<1.1	<1.1	Passed

	Brgy. Buntalid	0	<1.1	<1.1	Passed
	Brgy. Pag-antayan	0	<1.1	<1.1	Passed
	Brgy. Parang	0	<1.1	<1.1	Passed
Decmber 11, 2022	Brgy.Pag-antayan	2	<1.1	<1.1	Passed
	Brgy. Magosilom	2	<1.1	<1.1	Passed
	Brgy. Linintian	0	<1.1	<1.1	Passed
	Brgy. San Pedro	10	<1.1	<1.1	Passed
	Brgy. Parang	5	<1.1	<1.1	Passed
	Brgy. Palasao	0	<1.1	<1.1	Passed

According to Luvhimbi *et al.* (2022), although water leaving the treatment plant met bacteriological standards, the detected coliform bacteria could be an indication of contaminated distribution networks.

Total and fecal coliforms were consistently below detection limits (<1.1 MPN/100mL) across all sampling locations, confirming the absence of fecal contamination and compliance with PNSDW standards. This suggests that the water is microbiologically safe for consumption and that treatment processes effectively address contamination risks. Seasonal variations in microbial counts, especially during the rainy season, may indicate increased organic matter inflow or reduced chlorination efficacy, necessitating regular monitoring and possible adjustments to treatment protocols.

The data in this Table 2 presents microbial water quality results from various locations in Cantilan, Surigao del Sur, between January and December 2022. The primary indicators for water contamination were Total Coliforms and Thermotolerant (Fecal) Coliforms, which are commonly used to assess the safety of water for consumption. These indicators are measured in Most Probable Number (MPN) per 100 milliliters and Colony Forming Units (CFU) per milliliter. High levels of these bacteria suggest contamination, often from fecal matter, and can pose health risks such as waterborne diseases.

The results reveal that, generally, the water sources in the tested locations meet the safety standards for drinking water, with most locations consistently showing low or undetectable levels of both Total Coliforms and Thermotolerant Coliforms. Notably, the water in sites such as Buntalid, Magosilom, and Linintian exhibited passing results throughout the year, indicating good water quality with minimal or no contamination. In particular, tests from February to December 2022 mostly reported either zero or less than 1 CFU/mL, demonstrating that the water sources in Cantilan were generally safe to consume.

However, an important exception was observed in January 2022, when Barangay Magosilom showed an alarmingly high Total Coliform count of 3800 CFU/mL. This value far exceeds acceptable limits and suggests significant contamination, likely from improper waste disposal or other local environmental factors. The failure in Barangay Magosilom calls for further investigation into potential causes of contamination, such as inadequate sanitation or pollution sources. The high level of contamination in this location is a critical finding, as it could pose a significant public health risk if not addressed.

Conclusion

The findings of this study indicate that the microbial quality of tap water in Cantilan, Surigao del Sur, remained relatively stable throughout the two-year monitoring period, with only minor variations observed across different locations. Notably, slight traces of microbial contamination were detected in some areas during May and June 2022. However, overall microbial levels remained within the acceptable limits set by the Philippine National Standards for Drinking Water (PNSDW) 2017, demonstrating that the water supply system is generally well-maintained. The absence of significant seasonal fluctuations suggests that existing water treatment and distribution practices are effective in ensuring water safety. Nevertheless, the occasional presence of microbial contaminants highlights the need for continuous monitoring and proactive management

strategies to maintain water quality and prevent potential health risks. Future research could explore factors influencing these variations and recommend further improvements in water treatment processes.

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