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Detection and Enumeration of Coliforms in Drinking Water Sources in the Selected Barangay in Santa Maria, Davao Occidental Philippines

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Authors' contributions

This work was carried out in collaboration among all authors. 'Author A' designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. 'Author B' and 'Author C' managed the analyses of the study. 'Author C' managed the literature searches. All authors read and approved the final manuscript.

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Short Research Article

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ABSTRACT

The study aimed to determine the presence of fecal and nonfecal coliforms in selected drinking water sources of Santa Maria, Davao Occidental. Three (3) barangays were purposively identified as sampling sites, namely: Barangay Pongpong, Barangay San Isidro, and Barangay San Roque, where spring water, Jetmatic, and manual water pump are the sources of drinking water.

The study was conducted at Sta Maria, Davao Occidental Philippines from August 2021 to December 2021.The water samples were collected aseptically from the identified reservoir in the drinking water of the selected barangay of Sta Maria, Davao Occidental. The collected samples were brought to the SPAMAST Microbiology Laboratory. One (1) mL of sample was plated aseptically in the coliform Petrifilm. The plated water samples were incubated at 35-37 degrees Celcius for 24 hours. Colonies in the Petrifilm were counted manually and recorded as colony-forming units (CFU).

Microbial analysis detected the presence of total coliforms on the drinking water reservoir from the spring water source from barangay Pongpong, manual water pump and spring water source from

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barangay San Isidro and the manual water pump from barangay San Roque. Meanwhile, noOccidental, Philippines. Generally, the drinking water sources of the three (3) barangays exceeded the national standard set by the Department of Environment and Natural Resources (DENR) and the World Health Organization (WHO). Periodic monitoring on the drinking water sources in the identified barangays is highly recommended.

Keywords: Drinking water; microbiology; coliform; public safety.

1. INTRODUCTION

An adequate, safe, and accessible water supply is highly essential to human life. Improving access to safe drinking water can provide health benefits. The importance of water, sanitation, and hygiene for health and development has been reflected in the outcomes of a series of international policy forums [1]. Water regulates the internal heat level and gives the premise to body liquids and digestion [2].

Many people struggle to obtain access to safe water. A clean and treated water supply to each house may be the norm in Europe and North America, but in developing countries, access to both clean water and sanitation is not the rule, and waterborne infections are common. Worldwide, waterborne diseases are the cause of the death, and suffering of millions of people, especially children, in developing countries [3].

In the Philippines, people living in rural areas are dependent on groundwater as their source of water. Water is widely utilized for various rural and urban domestic purposes such as drinking, cooking, washing, bathing, and in agriculture and industry. It is recorded that at present, 15.73 million Filipinos live in 212 waterless barangays in Metro Manila and in 432 waterless municipalities in the rest of the country without access to safe water supply [4].

The study of the quantitative determination of coliforms in selected drinking water sources of Sta Maria, Davao Occidental, Philippines is the first reported data in the province of Davao Occidental. Moreover, the microbial assessment utilizes the rapid test technique using the Petrifilm method. The water resources differ from province to province based on several factors, like population density, rainfall patterns, watershed quality, and the rate of groundwater recharge [5].

Flow rules suggest the utilization of Escherichia coli (EC) or thermotolerant ("fecal") coliforms (FC) as markers of fecal tainting in drinking water. Confirmation of E. coli in a water system indicates recent fecal contamination, which may pose an immediate health risk to anyone who consumes the water [6]. In Sta Maria, Davao Occidental, Philippines, there is no reported data regarding the monitoring and keeping of water sources for safe consumption. The identified water sources are water pumps, flowing, and spring water. This study focuses on the determination of coliforms in selected drinking water sources in Sta Maria, Davao Occidental, Philippines. This would benefit the residents of the said barangays as well as the whole municipality, for the people would be aware of the composition of their water sources.

The goal of the study was to accurately determine the bacteria within the drinking water sources of selected barangays in Sta Maria, Davao Occidental using the Petrifilm method. The research aimed to detect and quantify the presence of coliform count in the selected drinking water sources of Santa Maria, Davao Occidental Philippines.

Its specific goal was to determine the presence of the following indicator microorganisms in the three selected barangays in Sta Maria, Davao Occidental: Escherichia coli and total coliform; and compare the microbial analysis results to the national standards set by the Department of Environment and Natural Resources (DENR).

2. MATERIALS AND METHODS

The study was conducted at Sta Maria, Davao Occidental, Philippines. The three barangay of Sta. Maria, Davao Occidental (refer to Fig. 1) are chosen as the study sites. The distance between Barangay Pongpong and Barangay San Isidro is about 500 meters. Barangay San Isidro and Barangay San Roque is 1 kilometer, and Barangay Pongpong to Barangay San Roque is estimated to have a distance of 1.5 kilometer (Fig. 1). Barangay Pongpong has a population of 2,168 making up the 3.77% of the overall population of Sta. Maria Davao Occidental. Barangay San Isidro is a barangay

in Sta. Maria Davao Occidental has population of 2,955; they constitute the 5.14% of the total population of the municipality. Barangay San Roque holds 1,658 individuals based on the 2020 census and has a 2.29% growth rate.

2.1 Study Design

This study utilized an experimental research design. Experimental research aimed to determine the coliforms of drinking water in selected barangays in Sta Maria, Davao Occidental Philippines. The dependent variables were determined using the 3M Petrifilm method for microbiological analysis. The purposive sampling technique was the sampling technique employed in the study. Water samples from the various water sources of the three (3) barangays were collected and tested for coliforms. The scheme of the experimental set-up for the study of the determination of coliform in selected drinking water sources of Sta Maria, Davao Occidental, Philippines.

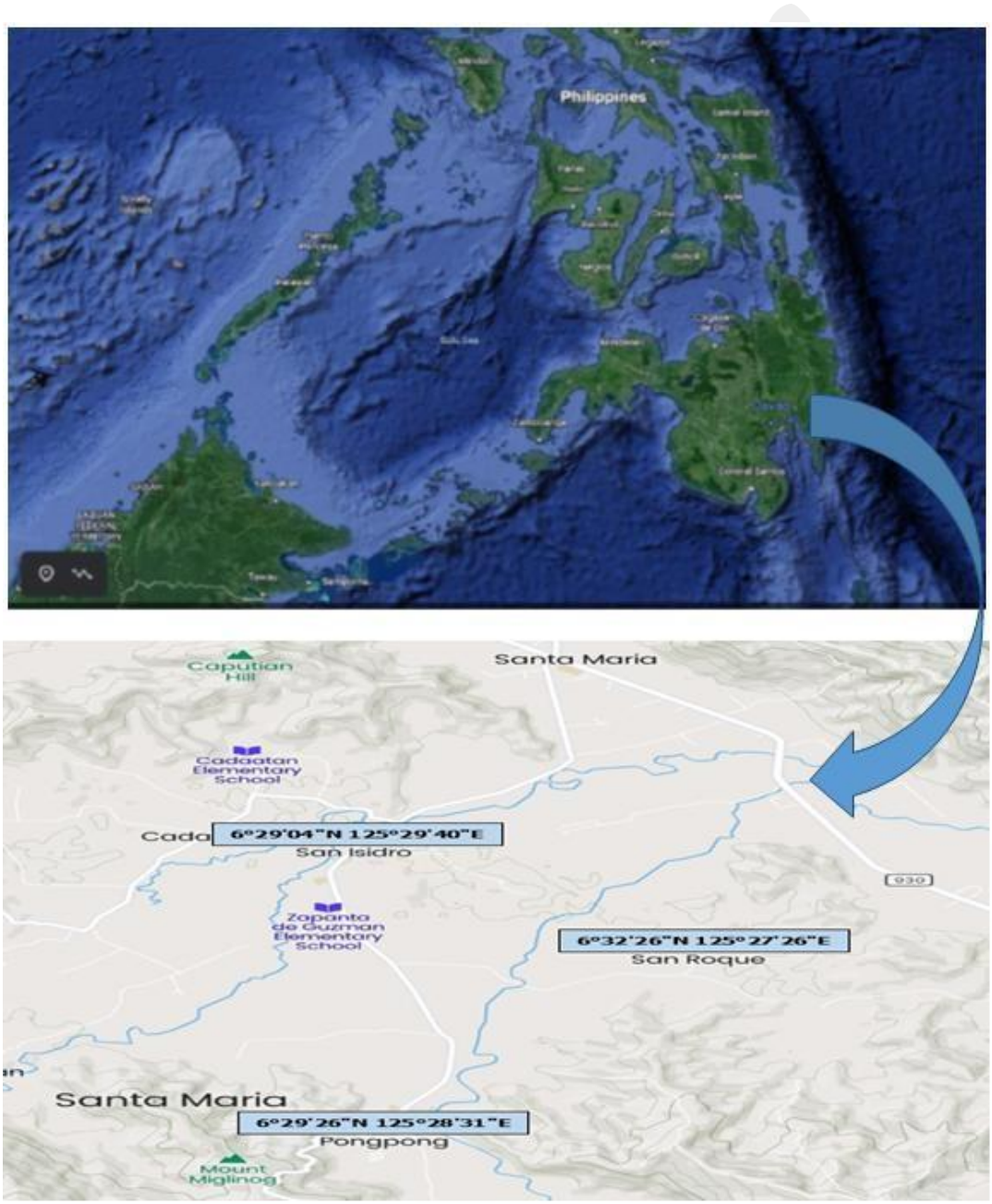

Fig. 1. Showing the Map of Sta. Maria Davao Occidental (https://earth.google.com)

The sites and types of water sources were determined in selected barangays in Sta. Maria, Davao Occidental, Philippines, Site one (1) was the barangay Pongpong, and the water sources are flowing water and manual Jetmatic. The second (2) location was barangay San Isidro, and water sources were flowing water and manual water pump. The site three (3) was in Barangay San Roque, and the water source is a manual water pump. There are three (3) samples collected in each source. Bottles are labeled (S1, S2, S3) to differentiate between the first, second, and third specimens collected.

The following equipment and instruments were used to measure the total coliforms and Escherichia coli present in the different water samples, namely laminar flow, autoclave, incubator with a temperature ranging from (30-35 degrees Celsius) and culture medium (Petrifilm). In the laminar flow. 1 mL of collected water samples were inoculated in the Petri plates aseptically. Lastly, the incubated Petri plates were counted manually for the number of colonies and were interpreted as Colony Forming Units (CFU). The drinking water samples were analyzed and interpreted based on the reference of the 3M coliform Petrifilm method by Bird et al. (2018) [7].

3. RESULTS AND DISCUSSION

The drinking water sources from the selected barangays of Sta Maria were analyzed for the presence of coliform using the 3M Petrifilm method. The utilization of the 3M Petrifilm method was previously used by Belote et al. (2002) in determining drinking water quality [8]. The Petrifilm method reported good correlation with the Most Probable Number (MPN) method. Moreover, the Petrifilm method was also used in the enumeration of waterborne *Escherichia coli* in environmental waters [9].

Furthermore, Petrifilm method was also used in the enumeration of total coliforms in groundwater sources [10]. In a comparative study on coliform method determination, it was reported to be the most consistent method [11]. The presence of coliform organisms in selected barangays of Sta Maria, Davao Occidental is shown in Table 1.

The analysis of samples in barangay Pongpong found in the spring water source had detected coliforms while *E. coli* was not present. At the same sampling site but on a different water source, manual, Jetmatic does not have the presence of organisms, both *E. coli* and coliform. In barangay San Isidro spring water source, the first sample was the only specimen that had no organisms found, while the other two had detected coliforms. At the same sampling site, the manual water pump is detected coliforms in three samples collected. In barangay San Roque, all the samples had coliforms detected and there was no *E. coli* determined.

In the Philippines, approximately 91% of the country's population has access to at least basic water services; but access is highly discriminatory across the country, with regional basic water service access ranging from 62% to 100%. It was reported that 99% of the one-fifth wealthiest households are more likely to have access to basic water services, while only 80% of the poorest percentiles do [12].

The presence of organisms in a selected barangay of Sta Maria, Davao Occidental, Philippines, is shown in Table 1. The presence of coliforms was quantified in terms of colony forming units (CFU), which are used to estimate the number of viable bacteria in a sample. The analysis of samples in Barangay Pongpong found in the spring water source had detected coliforms while *E. coli* was not present. A TNTC, or Too Numerous to Count, was also observed at the flowing/spring sample from barangay Pongpong. A TNTC is declared when colony counts are above 250 and it is impossible to tell whether colonies are separated. On the same sampling site but on a different water source, the manual Jetmatic did not have the presence of *E. coli*, nor coliform. In barangay San Isidro spring water source, the first sample was the only specimen that had no presence of coliforms, while the other two sources had detected with coliforms. At the same sampling site, the manual water pump was detected with coliforms in three samples collected. Furthermore, in barangay San Roque, all the samples were detected with coliforms but there was no presence of *E. coli* enumerated.

Moreover, Table 1 shows the comparison of the results with the Department of Environment and Natural Resources (DENR). According to the national standards set by DENR, drinking water must have 0 CFU/mL. The results revealed that only the manual jetmatic water sources of Barangay Pongpong are compliant with drinking water quality national standards, while the other water samples were detected with the occurrence of various coliforms.

Table 1. Results of Coliform analysis in drinking water sources of Selected Barangay of Santa Maria, Davao Occidental

Water Sources	Treatments	Coliform (CFU/mL)	Remarks	*E. coli* (CFU/mL)	Remarks
Flowing/Spring water	Pongpong S1	3	Non-compliant	0	Compliant
	Pongpong S1	TNTC	Non-compliant	0	Compliant
	Pongpong S1	4	Non-compliant	0	Compliant
Manual/Jetmatic	Pongpong S2	0	Compliant	0	Compliant
	Pongpong S2	0	Compliant	0	Compliant
	Pongpong S2	0	Compliant	0	Compliant
Flowing/Spring water	San Isidro S1	12	Non-compliant	0	Compliant
	San Isidro S1	48	Non-compliant	0	Compliant
	San Isidro S1	39	Non-compliant	0	Compliant
Manual/Water Pump	San Isidro S2	0	Compliant	0	Compliant
	San Isidro S2	1	Non-compliant	0	Compliant
	San Isidro S2	TNTC	Non-compliant	0	Compliant
Manual/Water Pump	San Roque S1	8	Non-compliant	0	Compliant
	San Roque S1	91	Non-compliant	0	Compliant
	San Roque S1	6	Non-compliant	0	Compliant

Note: DENR Standard: 0 CFU/ml

According to DENR standards for water quality, a zero/100mL count of coliforms must be found in any water source for safe drinking water consumption. Furthermore, all surface waters in the country must be free of human-carcinogenic, mutagenic, or teratogenic substances that pose a serious danger to public health, safety or welfare [13]. Drinking water contamination was also reported in the nearby region. Enguito et al. (2013) reported the presence of fecal coliform in Ozamiz City, Philippines. The presence of fecal coliforms was attributed to the high discharge of organic waste from toilets, kitchens, piggeries, and commercial establishments associated with the presence of dense populations [14]. Ground water was also reported to be above the maximum presence of coliforms in the drinking water of Mati, Davao Oriental, Philippines [15]. Furthermore, drinking water in upland and coastal communities in Misamis Oriental, Philippines, was reported to be contaminated with fecal coliform [16]. Lastly, surface waters in Marawi [17] and Dugwells water sources in Zamboanga, Philippines [18,19] were also detected with coliforms.

4. CONCLUSIONS

Based on the results of the study, the following conclusions were formulated; The results of coliform analysis using the 3M Petrifilm method in drinking water sources of selected barangays in Sta Maria are hereby reported.

The Jetmatic water sources of barangay Pongpong were not detected with coliforms. However, water samples from spring water and manual water pumps were detected with coliform microorganisms. The different water sources, namely spring water and manual water pumps, did not meet the water quality standards set by DENR for water consumption. Moreover, only the manual jetmatic water source conformed to the DENR water quality standards. Furthermore, the researchers strongly recommend the end user to source alternative sources of drinking water and implement immediate cleaning in place of the currently utilized drinking water sources. The findings of the study were presented to the local officials of the barangays and encouraged them to have regular monitoring of the water quality in coordination with the local officials.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. World Health Organization (WHO). Guidelines for Drinking Water Quality: Fourth Edition Incorporating the First Addendum. Geneva: Preface; 2017. Available:https://ssrn.com/abstract=1672306
2. Staci G. The Potential Importance of Conservation, Restoration and Altered Management Practices for Water Quality in the Wabash River Watershed. 2013December 09-13, 2013. Available:https://cfpub.epa.gov/si/si_public_comments.cfm
3. Schafer A. Sustainable Water for the Future: Water Recycling Versus Desalination; 2010. Available:https://www.elsevier.com/books/sustainable- water-for -the-future/escobar/978-0-444-53115-5
4. Asian Development Bank. Water Supply and Sanitation Sector Assessment, Strategy, and Road Map; 2013. Retrieved last May 13 2022. Available:https://www.adb.org/sites/default/files/institutional-document/33810/files/philippines-water-supply-sector-assessment.pdf
5. Senate Economic Planning. Turning the tide: Improving water resource management in the Philippines (PB-11-03); 2011. Available:http://www.senate.gov.ph/publications/PB%20201108%20%20Turning%20the%20Tide.pdf.
6. Department of Health. Coliform bacteria and drinking water. Department of Health, United States; 2016. Available:https://www.doh.wa.gov/Portals/1/Documents/Pubs/331-181.pdf.
7. Bird P, Bastin B, Klass N, Crowley E, Agin J, Goins D, Bakken H, Lingle C, Schumacher A, & Collaborators. Evaluation of the 3M™ Petrifilm™ Rapid *E. coli*/Coliform Count Plate for the Enumeration of E. coli and Coliforms: Collaborative Study, First Action: 2018.13. Journal of AOAC International. 2020; 103(2):513–522. Available:https://doi.org/10.1093/jaocint/qsz013
8. Beloti, Vanerli, Souza, Juliana Aparecida de, Barros, Márcia de Aguiar Ferreira, Nero, Luís Augusto, Mattos, Marcos Rodrigues de, Gusmão, Viviane Vieira, & Moraes, Luciane Bilia de. Evaluation of Petrifilm™ EC and HS for total coliforms and Escherichia coli enumeration in water. Brazilian Journal of Microbiology 2003;34(4):301-304. Available: https://doi.org/10.1590/S1517-83822003000400002
9. Vail JH, Morgan RM, Merino CR, Gonzales FS, Miller R, Ram JL. Enumeration of waterborne Escherichia coli with Petrifilm plates: comparison to standard methods. Journal of Environmental Quality. 2003;32(1):368-73.
10. Pearson AL, Roberts MC, Soge OO, Ivanova IC, Mayer JD, & Meschke JS. Utility of EC 3 MTM Petrifilm TM and sanitary surveys for source water assessment in Nyabushozi County, south- western Uganda; 2008.
11. Wohlsen T, Bates J, Vesey G, Robinson WA, & Katouli M. Evaluation of the methods for enumerating coliform bacteria from water samples using precise reference standards. Letters in Applied Microbiology. 2006;42(4):350–356. Available: https://doi.org/10.1111/j.1472-765X.2006.01854.x
12. Chowdhury Z, Francia M. UNICEF Philippines. Two billion people lack safe drinking water, more than twice lack safe sanitation; 2017.Retrieved last May 2022. Available:https://www.unicef.org/philippine s/press-releases/two-billion-people-lack- safe-drinking-water-more-twice-lack-safe- sanitation
13. Department of Environment and Natural Resources. DENR Administrative order no. 2016-08. Retrieved last May 13, 2022. Available: https://emb.gov.ph/wp-content/uploads/2019/04/DAO-2016-08_WATER-QUALITY-GUIDELINES-AND-GENERAL-EFFLUENT-STANDARDS.pdf
14. Enguito MR, Matunog VE, Bala JJ, Villantes YL. “Water Quality Assessment of Carangan Estero in Ozamiz City, Philippines.”; 2013.
15. Tayone JC. “Biological and Chemical Characteristics of Groundwater in a Rural Settlement Area of Davao Oriental.” American Scientific Research Journal for Engineering, Technology, and Sciences. 2015;14:94-99.
16. Besagas RL, Asoy AY, Ceniza MS, Leopoldo GD, Dael NT, and Del Rosario

RM. “Upland and Coastal Freshwater Sources in Misamis Oriental, Philippines: A Comparison of Water Quality.” Mindanao Journal of Science and Technology. 2015:13:1 Available:http://ejournals.ph/form/cite.php?id=12568 (accessed September 11, 2018)

17. Tonog MN, Poblete MM. "Drinking Water Quality Assessment in Selected Barangays in Laoang, Northern Samar, Philippines," International Journal of Environmental Science and Development. 2015;6(1):29-33, 2015.
18. Satar SS, Dagoc RJ, Dagoc KM, Valdez SA, Veloso KR, Mag-aso AV. Microbial Water Quality Assessment in Lake Lanao Along Marawi City, Lanao Del Sur, Mindanao, Philippines. Int. J. Biosci. 2020;16(2):12-18.
19. Dabalos E, Diamante CC. Water Quality Assessment in Barangay Santo Niño Sibuco, Zamboanga Del Norte, Mindanao, Philippines. Ciência. 2020;39(1):111–118. Available:www.wmsu.edu.ph/research_journal

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