INNSPUB

Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 22, No. 6, p. 122-126, 2023
http://www.innspub.net

RESEARCH PAPER

OPEN ACCESS

Evaluating the water quality of key freshwater source in Alubijid, Misamis Oriental, Philippines

Ronnie L. Besagas*, Romeo M. Del Rosario, Girlie D. Leopoldo, Noel T. Dael, Antonio Y. Asoy

University of Science and Technology of Southern Philippines, Cagayan de Oro City, Philippines

Article published on June 11, 2023

Key words: Water quality, Heavy metals, Total coliform, *E. coli,* Physico-chemical characteristics

Abstract

This study aimed to assess the water quality of a major freshwater source in Alubijid, Philippines, with the objective of ensuring safe and reliable freshwater resources for human consumption. The rationale behind this research was the critical importance of accessible and uncontaminated water for sustaining human health and well-being. To achieve this, the study employed a comprehensive approach, analyzing various parameters including physico-chemical characteristics, heavy metals, and microbial indicators. The results of the analysis indicated that the majority of physico-chemical parameters fell within the established standards, ensuring compliance with water quality guidelines. However, the total hardness levels approached the maximum limit defined by the Philippine National Standards for Drinking Water (PNSDW), suggesting that the water could be classified as hard. The levels of heavy metals and other metals remained within safe ranges, with the exception of some uncertainty surrounding antimony due to the detection limit of the employed method. Regarding microbial quality, although one out of four samples tested positive for E. coli, indicating a slight concern, the overall microbial status was relatively acceptable. The presence of total coliforms was noted in all samples but at low levels, signifying a manageable risk. Additionally, it was highlighted that the water underwent chlorine treatment prior to distribution, enhancing its suitability for drinking purposes.

***Corresponding Author:** Ronnie L. Besagas ✉ rlbesagas@ustp.edu.ph

Introduction

Water is an indispensable resource for all forms of life on Earth, as its presence is vital for survival. With approximately 71% of the planet's surface covered by water, equivalent to a staggering 1,386,000,000 cubic kilometers worldwide, it is abundantly available. However, 97% of this water exists in oceans, seas, and bays, rendering it excessively saline for human consumption, agriculture, or industry, except for cooling purposes. Another 2% is locked in frozen glaciers and polar ice caps, leaving less than 1% of the Earth's water as accessible freshwater, found in the form of lakes, rivers, reservoirs, and aquifers. This scarcity of freshwater resources magnifies its tremendous value as a precious commodity, given its limited availability (USGS, 2014; Soh *et al.*, 2007; Wetzel, 2001; Miller, 2000).

Freshwater holds a critical and ever-changing role in the natural environment. It is indispensable to humans for various essential activities like drinking, washing, bathing, as well as for crucial sectors such as agriculture and industry. As humans rely on water consumption, ensuring its quality becomes of paramount importance. The water we consume must be devoid of substances or contaminants that could lead to illness. Water quality encompasses more than just microbial safety, such as meeting the standards for indicator organisms like total coliform/E. coli. It is equally crucial to pay close attention to reducing individuals' exposure to chemical and physical hazards that can be present in contaminated drinking water and may be ingested.

Freshwater remains a scarce commodity in numerous regions worldwide. As reported by the WHO (2000), a staggering 1.1 billion individuals lack access to fundamental safe drinking water supplies, while 2.4 billion people lack basic sanitation services. The situation is bound to worsen with the rising demand for freshwater resulting from population growth, rapid industrialization, and economic development if not effectively addressed. Unfortunately, these growth and development processes generate substantial amounts of anthropogenic and industrial waste, contributing to the degradation of our water systems. Moreover, two major environmental challenges confronting humanity today, namely climate change and ozone depletion, pose additional threats to the quality, quantity, and treatability of this invaluable resource (Soh *et al.*, 2007). Based on the aforementioned factors, it is crucial to conduct a comprehensive examination of the levels of specific physico-chemical, heavy metal, and microbial characteristics in the major freshwater sources of Alubijid, Misamis Oriental, Philippines. The city has undergone various significant transformations, both as a result of human activities and natural phenomena, which may have impacted the quality of its freshwater resources. Obtaining the findings of this study will provide valuable insights for making informed decisions regarding the management of water resources intended for human consumption.

Materials and methods

Sampling

Water samples were carefully collected using clean polyethylene bottles. To ensure the absence of any contaminants, the bottles underwent thorough acid-washing and subsequent rinsing with high-quality distilled water. For microbial testing purposes, separate sterile bottles were dedicated solely for water sample collection. Strict adherence to aseptic technique was observed throughout the process of collecting samples for microbiological analysis. To maintain the integrity of the samples, they were promptly placed in a polystyrene foam box containing ice and securely kept inside during transportation to the laboratory.

Physico-chemical analysis

The analysis included assessing several parameters, namely pH, temperature, turbidity, conductivity, total dissolved solids (TDS), salinity, chlorides, total hardness, and total organic carbon (TOC). The conductivity, TDS, and salinity measurements were conducted using the HACH sension5 Conductivity Meter. The chloride content was calculated based on the salinity using the appropriate formula.

$$Chloride\left(\frac{mg}{L}\right) = \frac{Salinity\ (in\ ppt)}{1.80655} \times 1000$$

On-site measurement of turbidity was conducted using the HACH 2100Q turbidimeter. The total hardness was determined through the standard EDTA titration method (PCARRD, 1991).

The total organic carbon (TOC) was assessed using the spectrophotometric method outlined in Hach—Method 10129 (Direct Method). This particular method is suitable for measuring TOC within the low range of 0.3 to 20.0mg/L. It relies on detecting the color change of an indicator caused by the change in pH resulting from the CO2 released during the oxidation of organic carbon by persulfate in a specialized reagent-containing vial. Absorbance readings were obtained at 598 nm and 430 nm utilizing the HACH DR 5000 UV-Vis spectrophotometer.

Analysis of heavy metals and other metals

The research encompassed nine metals: arsenic, cadmium, copper, mercury, lead, aluminum, zinc, iron, and antimony. To determine the contents of zinc, copper, iron, lead, and cadmium in the samples, flame atomic absorption spectroscopy was utilized. Mercury analysis was carried out using cold vapor spectrometry. The analysis of antimony was conducted using inductively coupled plasma-optical emission spectroscopy. For arsenic analysis, silver diethyldithiocarbamate was employed, while eriochrome cyanine R was used to analyze aluminum. To preserve water samples that couldn't be analyzed within 24 hours of sampling, their pH was adjusted to 2.0 using concentrated nitric acid.

Microbiological test (total coliform and Escherichia coli)

The membrane filtration method was employed for the microbial testing of all samples. The total coliform count was determined by counting the number of colonies, while the presence or absence of E. coli was determined based on the appearance of E. coli colonies.

Results and discussion

Three tables are provided to present the water quality data for the primary freshwater source in Alubijid, which is the deepwell located in Barangay Tipolanan. Table 1 displays the physico-chemical characteristics, Table 2 shows the levels of selected heavy metals and other metals, while Table 3 inidcates the results of the microbial tests.

Table 1. Physico-Chemical Analysis of Freshwater in Alubijid.

Sampling	Parameter									
	Conductivity (µS/cm)	pH	TOC (mg/L C)	Appearance	Turbidity (NTU)	Temp (°C)	TDS (mg/L)	Salinity (ppt)	Chlorides (mg/L)	Total Hardness (mg/L $CaCO_3$)
First	873.0	7.42	21.0	colorless-clear	0.15	27.8	427.0	0.4	221	309.0
Second	830.1	7.38	19.8	colorless-clear	0.12	27.5	404.0	0.4	221	267.2
Third	836.8	7.29	12.6	colorless-clear	0.17	27.6	410.0	0.4	221	241.7
Fourth	830.5	7.19	5.25	colorless-clear	0.27	28.7	405.0	0.4	221	262.1
PNSDW Std[1]		6.5-8.5			5		500		250	300
USA Std[2]		6.5-8.5			5		500		250	
EU Std[3]	2,500	6.5-9.5	No abnormal change	Acceptable, no abnormal change	Acceptable, no abnormal change				250	
WHO Std[4]										

[1]Philippine National Standards for Drinking Water (2007). [3]Drinking Water Directive – European Union (1998)

[2]Drinking Water Standards and Health Advisories – USEPA (2012). [4]Guidelines for Drinking Water Quality – WHO (2011)

Table 2. Freshwater Quality in Alubijid: Heavy Metal and Other Metal Content

Sampling	Parameter								
	Pb (mg/L)	Cd (mg/L)	Al (mg/L)	As (mg/L)	Hg (mg/L)	Sb (mg/L)	Zn (mg/L)	Cu (mg/L)	Fe (mg/L)
First	<0.003**	<0.002**	<0.02*	<0.005*	<0.001*	<0.01*	0.012	<0.002*	0.053
Second	<0.003**	<0.002**	<0.02*	<0.005*	<0.001*	<0.01*	<0.002*	<0.002*	<0.005*
Third	0.005	<0.002**	<0.02*	<0.005*	<0.001*	<0.01*	<0.002*	<0.002*	<0.005*
PNSDWStd[1]	0.01	0.003	0.02	0.05	0.001	0.02	5.0	1.0	1.0
USA Std[2]	0.015 (at tap)	0.005	0.05-0.2	0.010	0.002	0.006	5.0	1.3 (at tap)	0.3
EU Std[3]	0.010	0.005	0.200	0.010	0.0010	0.005		2.0	0.200
WHO Std[4]	0.01	0.003		0.01	0.006	0.02		2.0	

*Method Detection Limit
**Reporting Unit

[1]Philippine National Standards for Drinking Water (2007)
[2]Drinking Water Standards and Health Advisories – USEPA (2012)
[3]Drinking Water Directive – European Union (1998)
[4]Guidelines for Drinking Water Quality – WHO (2011)

Table 3. Microbiological Characteristics of Freshwater in Alubijid.

Sampling	Parameter	
	Total Coliform (colonies/100mL)	*E. coli*
First	25.7	Absent
Second	14.0	Absent
Third	5.0	Absent
Fourth	11.5	Present
PNSDW Std[1]	<1; not more than 5% of samples positive in a month	Absent
USA Std[2]	Not more than 5% of samples positive in a month	Absent
EU Std[3]	0	Absent
WHO Std[4]		Absent

[1]Philippine National Standards for Drinking Water (2007)
[2]Drinking Water Standards and Health Advisories – USEPA (2012)
[3]Drinking Water Directive – European Union (1998)
[4]Guidelines for Drinking Water Quality – WHO (2011)

The analysis of physico-chemical parameters indicates that there is no significant cause for concern, as the results of most parameters fall within the established standards. However, the total hardness of the water is very close to the maximum level specified by the Philippine National Standards for Drinking Water (PNSDW), suggesting that the water can be classified as hard.

Regarding the levels of heavy metals and other metals examined in this study, they are within safe limits. However, there is some uncertainty regarding antimony (Sb) due to the detection limit of the employed method (0.01mg/L), which is higher than the imposed standards set by the Philippines and the World Health Organization (WHO) of less than 0.02mg/L. Consequently, it is difficult to determine if the concentration is below the maximum levels of 0.006mg/L (USA) or 0.005mg/L (EU).

In terms of microbiological quality, the water does not pose significant concerns. While one out of the four samples tested positive for E. coli, it does not represent a widespread failure, accounting for only 10% of the samples. Moreover, although total coliforms are consistently present, their levels are relatively low. To establish the acceptability of the microbial quality, a larger number of samples should be collected. It is worth noting that Alubijid treats its water with chlorine prior to distribution, making it suitable for drinking purposes in terms of microbiological quality.

Conclusions

Based on the analysis of the data and discussions presented, the overall water quality of the freshwater source in Alubijid appears satisfactory. The physico-chemical parameters largely meet the established standards, except for the total hardness, which indicates that the water can be classified as hard. The levels of heavy metals and other metals are within safe limits, although there is uncertainty regarding antimony due to the detection limit of the method used. The microbial quality of the water, while not perfect, is relatively acceptable, with only one out of four samples testing positive for E. coli.

Recommendations

Given the proximity of the total hardness to the maximum level specified by the PNSDW, it would be prudent to continue monitoring this parameter regularly to ensure it does not exceed the recommended threshold. To obtain a more comprehensive understanding of the microbial quality, it is recommended to increase the number of samples collected and tested. This will provide a clearer assessment of the presence and levels of total coliforms and E. coli in the freshwater source. Regular monitoring of the water quality, including physico-chemical parameters, heavy metals, and microbial indicators, should be implemented. Additionally, effective management strategies should be in place to address any changes or challenges that may arise in maintaining the water quality standards over time.

References

Miller GT. 2000. Living in the Environment, Brooks/Cole, Cengage Learning, 20 Davis Drive, Belmont CA 94002-3098, USA.

PCARRD. 1991. Standard Methods of Analysis for Soil, Plant Tissue, Water and Fertilizer. Los Baños, Laguna, Philippines.

Soh Y, Roddick F, Leeuwen J. 2008. The future of water in Australia: The potential effects of climate change and ozone depletion on Australian water quality, quantity and treatability, from http://www.search.proquest.com/pqcentral/docview/22171507/A18A3C21F87D4ODAPQ/3?accountid

USGS. 2014. How much water is there on, in, and above the earth? From http://water.usgs.gov/edu/earthhowmuch.html.

Wetzel RG. 2001. Limnology - Lake and River Ecosystems 3rd Ed. San Diego. Academic Press.