

Determination of Calcium (Ca) Levels in Refilled Drinking Water in Baubau City

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ARTICLE INFORMATION

Received: 5 June 2026
Revised : 7 July 2026
Accepted: 10 August 2026
DOI:

KEYWORDS

Baubau, Calcium, Complexometric, Refilled
Drinking Water

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A B S T R A C T

Background: Water is indispensable for sustaining human life, serving not only as a basic biological requirement but also as a determinant of overall well-being. Among the minerals naturally present in water, calcium (Ca) is particularly significant due to its essential role in supporting growth as well as maintaining the strength of bones and teeth. Insufficient calcium intake may result in developmental problems, osteoporosis, and other related health issues, while an excessive amount can adversely affect kidney function. **Objective:** of this research is to measure the concentration of calcium (Ca) in refilled drinking water available in Baubau City and to assess whether it aligns with recognized water quality standards. **Method:** The study was conducted using the complexometric titration method. Water samples were collected from three areas with different topographical characteristics: coastal, lowland, and highland regions. **Results:** The analysis revealed that calcium levels in coastal areas were 5.48% or 54.8 mg/L, in lowland areas 4.96% or 49.6 mg/L, and in highland areas 1.86% or 18.60 mg/L. Based on comparisons with the standards established by SNI 01-0220-1987, the Indonesian Ministry of Health, and the World Health Organization (WHO), the calcium concentration in refilled drinking water across all surveyed areas remains below the recommended threshold of 75 mg/L. **Conclusion:** Refilled drinking water in Baubau City contains calcium levels within the safe range, making it suitable for community consumption without posing health risks related to excessive calcium intake.

INTRODUCTION

Health is defined as a state of complete physical, mental, and social well-being, and not merely the absence of disease or infirmity (Julismin & Hidayat, 2013). One of the essential factors influencing health is the availability of clean water, since contaminated water can serve as a medium for disease transmission (Getas *et al.*, 2015). Water is a chemical molecule formed through a covalent bond between oxygen and hydrogen, which is highly soluble and therefore easily contaminated (Revansyah *et al.*, 2023). Drinking water refers to water that, whether treated or untreated, meets health standards and can be consumed directly (Ministry of Health, 2023). Given its vital role in daily life, drinking water quality must comply with the provisions of the Indonesian Ministry of Health Regulation No. 32 of 2017, which requires it to be clear, odorless, and tasteless (Sari & Huljana, 2019).

Minerals are naturally occurring inorganic compounds with distinctive physicochemical properties and an orderly crystal structure. They may form compact or fragmented rocks and play an important role in supporting physiological processes in the body (Gautama *et al.*, 2021). Minerals include heavy metals, which are divided into two categories: essential (Cu, Fe, Co, Mn), required in small amounts but toxic in excess, and non-essential (Pb, Cd, Hg), which have no biological function and are toxic (Teheni *et al.*, 2016). One of the most important essential minerals is calcium (Ca), which plays a crucial role in bone and tooth formation, cell metabolism, as well as muscle and heart function (Shinta & Sulistiyani, 2010). Calcium deficiency may lead to osteoporosis, while excessive intake can cause kidney disorders and constipation (Almatsier, 2010). Therefore, calcium levels, as well as heavy metal content in drinking water, must be closely monitored to ensure compliance with health standards.

The permissible limits of calcium in drinking water differ among national and international institutions. According to SNI 01-0220-1987, the recommended calcium (Ca) concentration in drinking water is 75 mg/L (PT. Konsultan Legal Indo, 2024). The Indonesian Ministry of Health sets

the safe range of Ca and Mg in drinking water between 75–200 mg/L to prevent adverse health effects (Sehol *et al.*, 2020). Meanwhile, WHO establishes the standard calcium concentration at 150 mg/L (15 mg/100 mL) (Agustina *et al.*, 2016). These variations reflect differences in regulatory references, highlighting the need for research to ensure that refilled drinking water complies with applicable standards.

Baubau City, as a developing urban area, has a large number of refilled drinking water providers. Moreover, variations in geographical conditions-ranging from coastal areas to lowlands and highlands are suspected to influence the mineral content, including calcium, in groundwater. Therefore, this study is essential to determine the quality of refilled drinking water consumed by the community, particularly with regard to calcium levels.

METHODOLOGY

Type of Research

This study is classified as quantitative research employing the complexometric method to measure the calcium (Ca) content in refilled drinking water. This method was chosen due to its high accuracy in determining metal ion concentrations, particularly calcium, through the formation of complexes with EDTA solution as the titrant.

Time and Place of Research

The study was conducted at the Pharmacy Laboratory of Baubau Polytechnic on May 20, 2025. The laboratory was selected due to its adequate facilities for performing complexometric titration analysis.

Sample

The samples used in this study were refilled drinking water collected from three different depots in Baubau City, each representing coastal, lowland, and highland areas. The selection of these locations aimed to provide a more comprehensive overview of calcium level variations in refilled drinking water based on geographical differences in Baubau City.

Instruments and Materials

The instruments utilized in this research included a 100 mL beaker glass, a 50 mL burette, a glass funnel, 250 mL and 50 mL Erlenmeyer flasks, a 100 mL measuring cylinder, a dropper pipette, a volumetric pipette, as well as a stand and clamp. The materials used consisted of refilled drinking water samples, distilled water, 0.01 M CaCO_3 solution, EDTA solution, Eriochrome Black T (EBT) indicator, murexide indicator, pH 10 buffer solution, and sodium hydroxide (NaOH) solution.

Procedure

Sampling of refilled drinking water was carried out by collecting 250 mL from each of the three depots. The samples were stored in prepared glass bottles and labeled according to their respective locations: P for coastal depot, DR for lowland depot, and DT for highland depot.

The next step was the standardization of the EDTA solution. A total of 10 mL of 0.01 M calcium carbonate (CaCO_3) standard solution was placed into a 250 mL Erlenmeyer flask, followed by the addition of 10 mL buffer solution at pH 10 to maintain stable conditions during titration. A small amount of Eriochrome Black T (EBT) indicator (tip of a spatula) was then added, and titration was performed with 0.01 M EDTA solution until the color changed from purple-red to blue. The volume of EDTA consumed was recorded and used as a reference for determining the concentration of the standard solution.

The determination of calcium levels was performed by pipetting 25 mL of the water sample into a 250 mL Erlenmeyer flask. Subsequently, 2 mL of 1 N NaOH solution was added to create alkaline conditions, followed by a small amount of murexide indicator (tip of a spatula). Titration was then carried out using 0.01 M standard EDTA solution until the solution color changed from pink to purple. The volume of EDTA used was recorded, and the titration was repeated three times to improve accuracy. The average EDTA volume from the three titrations was used as the basis for calculating the calcium concentration in the samples.

RESULTS & DISCUSSION

The determination of calcium concentration was carried out using the **complexometric titration method**. Each sample was titrated three times (**triplicate measurements**) to ensure accuracy. The titration results for calcium concentration are presented in the following table:

Table 1. Percentage of Calcium Content in (%)

No.	Sample	Volume (mL)	EDTA Volume (mL)				Calcium Concentration
			I	II	III	Average	
1.	P	25	1,5	3,3	5,5	3,43	5,48%
2.	DR	25	1,5	3	3,45	3,1	4,96%
3.	DT	25	0,5	1	2	1,16	1,86%

Source: Primary Data (2025)

Notes:

P : Refilled drinking water located in the coastal area.

DR : Refilled drinking water located in the lowland area.

DT : Refilled drinking water located in the highland area.

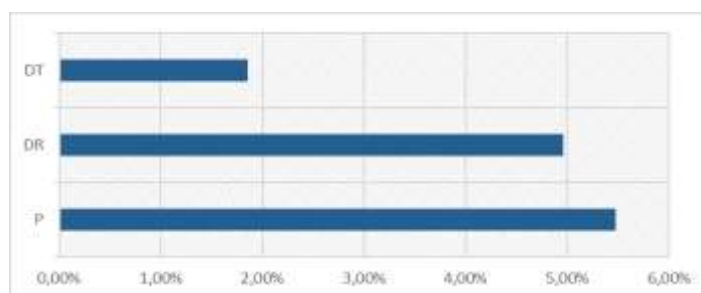


Figure 1. Percentage of Calcium Concentration (%)

Table 2. Percentage of Calcium Content in mg/L

No.	Sample	Volume (mL)	EDTA Volume (mL)				Calcium Concentration
			I	II	III	Average	
1.	P	25	1,5	3,3	5,5	3,43	54,8
2.	DR	25	1,5	3	3,45	3,1	49,6
3.	DT	25	0,5	1	2	1,16	18,60

Source: Primary Data (2025)

Notes:

P : Refilled drinking water located in the coastal area.

DR : Refilled drinking water located in the lowland area.

DT : Refilled drinking water located in the highland area.

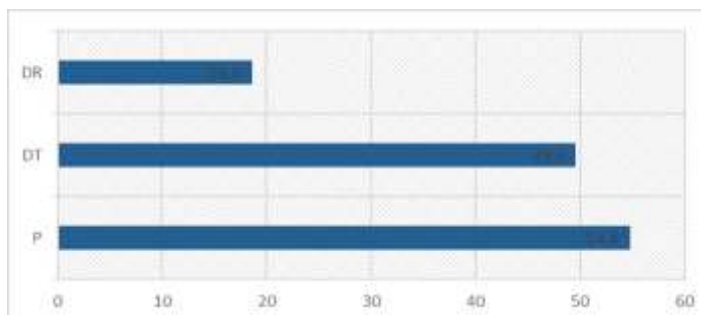


Figure 2. Percentage of Calcium Concentration mg/L

Based on Tables 1 and 2, the findings revealed variations in calcium concentrations in refilled drinking water across three regions of Baubau City: coastal (P), lowland (DR), and highland (DT). The coastal sample exhibited the highest calcium concentration at 5.48% or 54.8 mg/L, while the lowland sample showed a moderate level at 4.96% or 49.6 mg/L. In contrast, the highland sample recorded the lowest concentration, 1.86% or 18.6 mg/L.

The differences in calcium concentrations among these regions can be explained by geological, hydrological, and geochemical factors influencing local aquifers. In coastal areas, the elevated calcium levels are closely associated with the Submarine Groundwater Discharge (SGD) mechanism. According to Kiro (2025), SGD occurs due to density differences between seawater and freshwater, which drive seawater intrusion into coastal aquifers. This process induces cation exchange, in which Na^+ and K^+ ions from seawater are replaced by Ca^{2+} and Sr^{2+} ions derived from sediments or rocks. Additionally, prolonged contact between seawater and carbonate rocks enhances the dissolution of calcite (CaCO_3) and dolomite ($\text{CaMg}(\text{CO}_3)_2$), thereby increasing calcium concentrations in groundwater. This phenomenon aligns with the geological conditions of Baubau City, which are predominantly composed of coral limestone, conglomerates, and Pleistocene sandstones (Sikumbang *et al.*, 1995). The combination of SGD and local carbonate lithology explains the elevated calcium content in coastal refilled drinking water.

In contrast, the lowland region exhibited slightly lower calcium concentrations. This may be attributed to the influence of carbonate rocks being less pronounced than in the coastal zone. Groundwater in lowland areas typically originates from rainfall infiltration and local recharge, meaning its ionic composition is more strongly influenced by local lithology and the duration of water–rock interaction. Appelo & Postman (2005) noted that Ca^{2+} concentrations in groundwater are largely affected by the extent of carbonate mineral dissolution, pH, and the presence of competing ions such as Mg^{2+} and Na^+ .

Meanwhile, the highland region showed the lowest calcium concentrations, a result of its geology being dominated by igneous rocks (e.g., granite) and metamorphic rocks (gneiss, schist), which are poor in carbonate minerals. These rock types exhibit low solubility, thus contributing minimal Ca^{2+} ions to groundwater. Arifah *et al* (2014), in their study in Kendal Regency, also reported that low Ca concentrations in highland groundwater were due to limited carbonate mineral content in soils, coupled with hydrological conditions that restrict Ca^{2+} supply. These factors explain why calcium concentrations in Baubau's highland refilled drinking water samples reached only 18.6 mg/L.

When compared to regulatory standards, the results remain within safe limits. According to SNI 01-0220-1987, the recommended calcium concentration in drinking water is 75 mg/L (PT. Konsultan Legal Indo, 2024). The Indonesian Ministry of Health specifies a safe range of 75–200 mg/L for Ca and Mg to prevent adverse effects (Sehol *et al.*, 2020). Meanwhile, the World Health Organization (WHO) sets the standard calcium concentration at 150 mg/L (15 mg/100 mL) mL (Agustina *et al.*, 2016). All samples from the three regions were found to be below the maximum allowable limits. This indicates that refilled drinking water in Baubau City is still safe for consumption with respect to calcium content. Thus, although there are regional variations, the differences in calcium levels do not pose significant health risks as they remain within both national and international safety thresholds.

It is also important to note that the presence of calcium in drinking water provides physiological benefits. According to Shinta & Sulistiyan (2010), calcium is an essential mineral that plays a critical role in bone and tooth formation, nerve function, and muscle contraction. Calcium in drinking water may contribute to daily calcium intake, although it is not the primary source. Therefore, despite being below the recommended threshold of 75 mg/L, the calcium content in Baubau's refilled drinking water can still provide beneficial mineral intake for the community.

In conclusion, this study confirms that variations in calcium concentrations in refilled drinking water across Baubau City are influenced by local geological and hydrological factors, particularly SGD in coastal areas and the dominant rock types in lowland and highland regions. Comparisons with national and international standards indicate that the detected calcium concentrations remain within safe limits, thus confirming that refilled drinking water in Baubau City is suitable and safe for consumption.

CONCLUSION

This study demonstrates that calcium concentrations in refilled drinking water in Baubau City vary across regions, with 54.8 mg/L in coastal areas, 49.6 mg/L in lowland areas, and 18.6 mg/L in

highland areas. All values remain below the maximum limit of 75 mg/L as stipulated by both the Indonesian National Standard (SNI) and the Ministry of Health. Therefore, refilled drinking water in Baubau City can be categorized as meeting quality standards, safe, and suitable for consumption.

ACKNOWLEDGMENT

The author would like to express profound gratitude to beloved parents, Mr. La Ode Muharam and Mrs. Nilawati, for their unwavering prayers, love, and continuous support. Sincere appreciation is also extended to Mrs. Apt. Wa Ode Syafriah, S.Farm., M.Si., as the First Supervisor, and Mr. Muhammad Tasjiddin Teheni, S.Si., M.Si., as the Second Supervisor, for their invaluable guidance and constructive advice throughout the course of this research.

REFERENCES

- Agustina, A., Nurhaini, R., & Wulandari, W. (2016). Determination of calcium levels in dug well water in Sampang Gedangsari, Gunung Kidul Village using atomic absorption spectrophotometry. *Journal of Applied Pharmacy and Health Sciences*, 1(5), 1–23. <https://medium.com/@arifwicaksanaa/pengertian-use-case-a7e576e1b6bf>
- Appelo, C. A. J., & Postma, D. (2005). *Geochemistry, groundwater and pollution (2nd ed.)*. CRC Press.
- Arifah, N., Achmadi, J., & Purnomoadi, A. (2014). Calcium (Ca) and phosphorus (P) mineral status of local goats in highland and lowland areas of Kendal Regency. *Journal of Food Technology Applications*, 2(4), 89–97.
- Gautama, A., Novianto, D., & Suhardono, A. (2021). Resources, reserves, and mineral and rock production in East Java Province, 2018. *Qua Teknika Journal*, 11(1), 52–66.
- Getas, I. W., Pauzi, I., & Danuyanti, I. G. A. N. (2015). Analysis of calcium (Ca) and iron (Fe) levels in refilled drinking water (Amiu) sourced from dug wells in Mataram City. *Journal of Medical Laboratory and Bioscience Analysis (JAMBS)*, 2(1), 60–66. <https://doi.org/10.2307/3615019>
- Julismin, & Hidayat, N. (2013). Overview of health services and health behavior in Indonesia. *Journal of Geography*, 5(1), 123–134.
- Kiro, Y. (2025). Coastal aquifers: Key contributors to ocean chemistry through solute fluxes. *Nature Communications*, 16(1), 1–10. <https://doi.org/10.1038/s41467-025-62411-8>
- Ministry of Health of the Republic of Indonesia. (2023). *Minister of Health Regulation No. 2 of 2023*. Jakarta: MoH RI.
- PT. Konsultan Legal Indo. (2024). *Indonesian National Standard for Drinking Water*.
- Revansyah, M. A., Men, L. K., Setianto, S., F, F., Safriani, L., & Aprilia, A. (2023). Analysis of TDS, pH, and COD to assess water quality in Cilayung Village. *Indonesian Journal of Materials and Energy*, 12(2), 43.
- Sari, M., & Huljana, M. (2019). Analysis of odor, color, TDS, pH, and salinity of dug well water at a landfill site. *Alkimia: Journal of Chemistry and Applied Sciences*, 3(1), 1–5. <https://doi.org/10.19109/alkimia.v3i1.3135>
- Sehol, M., Mangesa, R., Loilatu, S. H., Studi, P., & Biologi, P. (2020). Testing the quality of drinking water in a refilled drinking water depot in Lala Village, Buru Regency (2019). *Uniqbu Journal of Exact Sciences*, 1, 73–81.
- Shinta, A. D. P., & Sulistiyani. 2010. *The effect of calcium on the growth and development of children's teeth*. *Journal of Dentistry, University of Jember (JKG Unej)*, 7(3), 40–44.

- Sikumbang, N., Sanyoto, P., Supandjono, R. J., and Gafoer, S. (1995). *Geological map of the Buton sheet, Southeast Sulawesi, scale 1:250,000*. Bandung: Geological Research and Development Center.
- Teheni, M. T., La Nafie, N., & Dali, S. (2016). Analysis of heavy metal Cd in *Eucheuma cottoni* algae in the waters of Bantaeng Regency. *Indonesian Journal of Chemical Research*, 4(1), 348–351. <https://doi.org/10.30598/ijcr.2016.4-the>