

Comparison of Calcium Levels (Ca^{2+}) in Mountainous Wells and Coastal Well Water with the Crimsontry Method

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A B S T R A C T

Background: Calcium is one of the essential minerals contained in water, and its levels can vary depending on the water source and geographic location. Well water in mountainous and coastal areas shows quite different characteristics, both in terms of clarity, taste, and mineral content. One of the essential mineral elements contained in water is calcium (Ca^{2+}). **Objective:** This study was to determine and compare calcium (Ca^{2+}) levels in mountain well water and coastal well water using complex methods. **Methods:** Complexometry The analysis was performed with the mureksid indicator and Na_2EDTA pentiter solution, which had previously been standardized three times (triplo) to ensure the accuracy of the concentration. The complexometry method was chosen because EDTA is able to form a stable complex with metal ions, making it very effective in quantitative analysis. **Results:** In water samples from mountainous areas (P), calcium levels decreased from 58,700 mg/L to 33,040 mg/L after cooking, while in samples from coastal areas (K), calcium levels from 69,960 mg/L to 38,960 mg/L showed a difference in calcium levels in the two water sources, which was suspected to be influenced by geographical, environmental, and environmental factors. and soil conditions. **Conclusion:** Thus, it can be concluded that calcium levels in coastal well water are higher compared to mountain well water which can be caused by several factors influenced by geology and environmental influences such as rainfall, temperature, and human activities.

INTRODUCTION

The balance of minerals in the body is very important because it plays a role in regulating enzyme activity as well as maintaining muscle and nerve sensitivity to stimuli. Minerals themselves are divided into two groups, namely macro minerals and micro minerals. Macro minerals are minerals that the body needs in amounts of more than 100 mg per day, examples are calcium, phosphorus, potassium, sulfur, magnesium, sodium, and chloride. Meanwhile, microminerals are minerals that require less, i.e. less than 100 mg per day, such as cobalt, manganese, and zinc (Almatsier S, Soetardjo S, 2010).

Mineral deficiency in the body can cause various health problems. Minerals are micronutrients that play an important role in maintaining body functions, starting from bone formation, fluid regulation, muscle contraction, to supporting the immune system. If the body does not get enough mineral intake, the balance of physiological functions can be disturbed (Bakhtra et al., 2015).

Minerals are essential nutrients that the body needs in certain amounts to maintain health and survival. Although the amount required is relatively small compared to macronutrients such as carbohydrates, proteins, and fats, the role of minerals is no less important. Minerals work at various levels, from cells, tissues, organs, to the body's system as a whole (Bakhtra et al., 2015).

Calcium (Ca^{2+}) is a mineral that is very important for the human body, especially in the formation and maintenance of bones and teeth, muscle contraction, transmission of nerve impulses, and blood clotting processes. However, excessive exposure to calcium from the work environment, such as in the cement industry that uses limestone as a raw material, can pose health risks. Workers who are directly exposed to calcium dust in the long term have the potential to experience serious disorders such as heart attack due to electrolyte balance disorders, kidney damage due to increased filtration load, as well as anemia triggered by impaired metabolism of the body (Amran, 2018). Not only production workers, administrative employees can also have high levels of calcium in the body. This can be caused by exposure to calcium dust particles that are spread in the work environment, even if they are not in direct contact with the production process. In addition, lifestyles such as consuming foods high in

calcium without being balanced with adequate physical activity or hydration can worsen the condition. Therefore, controlling dust exposure in the workplace, regular health check-ups, and implementing a healthy lifestyle are important steps to maintain the body's calcium levels in balance and prevent the onset of diseases due to excess calcium.

Based on this background, the formulation of the problem in this study is what is the level of calcium (Ca^{2+}) in mountain well water and coastal well water, and whether there is a significant difference between calcium (Ca^{2+}) levels in the two water sources.

METHOD

Types of Research

The research used in this study is Laboratory Experimental research. The samples used were mountain well water and coastal well water with a complex method.

Research Time and Place

This research was conducted from June to July 2025. Baubau Polytechnic Pharmacy Laboratory.

Tools and Materials:

The tools used in the study include a 100 mL glass beaker, a 50 mL burette, a glass funnel, a 250 mL and 50 mL erlenmeyer, a 100 mL measuring cup, a volume pipette, a drip pipette, as well as a tripod and clamp.

The materials used include samples of mountain and coastal well water, aquadest, CaCO_3 0.01 M, EDTA, NRE indicators, mureksid indicators, pH 10 buffer solutions, and sodium hydroxide (NaOH).

Working Procedure

Taking well water as a sample

25 mL of water samples were taken from both wells according to the criteria, namely mountain well water and coastal well water. Put water in a glass bottle that has been prepared. Labeled for glass bottles as markers, namely P (wells located in mountainous areas), K (wells located in coastal areas)

Na₂ EDTA Standardization

10 mL of standard CaCO_3 solution 0.01 M was inserted into the 250 mL Erlenmeyer. Added 40 mL of aquadest and 10 mL of Ph 10 ammonium chloride buffer solution. Added an NRE indicator spatula tip. It is titrated with a solution of Na_2EDTA of 0.01 M until there is a change from purplish red to blue. Recorded the volume of Na_2EDTA used.

Determination of Calcium (Ca^{2+})

Prepared tools and materials used 25 mL is taken, each of mountain well water and coastal well water, put into a 250 mL Erlenmeyer flask. Add 2 mL of NaOH 1 N solution. Add the mureksid indicator to the tip of the spatula. Titration with a standard solution of Na_2EDTA 0.01 M until there is a change in pink to purple. Record the volume of Na_2EDTA raw solution used. Repeat the titration 3 times, then average the volume of Na_2EDTA used.

Data Analysis

Calcium Levels Calculation

The calculation of calcium levels in samples in mountain well water and coastal well water using the complexometric method can be calculated with the formula:

$$\% \text{Ca} = \times 100\% \frac{(M \times V) \text{Na}_2\text{EDTA} \times \text{BA}}{D}$$

Information:

%Ca = Calcium content (%)

M = Molarity of Na_2EDTA Raw Solution (M)

V = Volume of Na_2EDTA Raw Solution (mL)

BA = Atomic Weight of Calcium 40.08

D = Test Solution Volume

RESULTS & DISCUSSION

RESULT

Table 1. Presentation of Calcium Levels in the Form of mg/L

No.	Sample	Volume (mL)	Na ₂ EDTA Volume (mL)				Calcium Level (mg/L)
			I	II	III	Average	
1.	Mountain Water	25	2	3,7	5,3	3,66	58,700mg/L
2.	Coastal Water	25	2,3	4,5	6,8	4,36	69,960mg/L

4.	Mountain Water (Cook)	25	1,5	1,9	2,8	2,06	33,040mg/L
5.	Coastal Water (Cook)	25	1,7	2,1	3,5	2,43	38,960mg/L

Source: Data processed, 2025

Information:

PM: Mountain well water is then cooked

KM: Coastal well water is then cooked

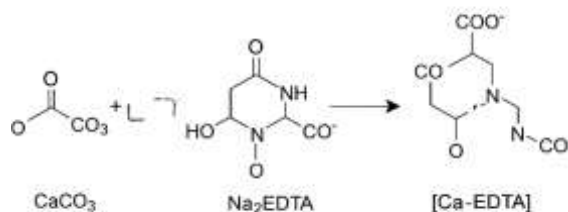


Figure 4. Reaction between CaCO_3 and Na_2EDTA

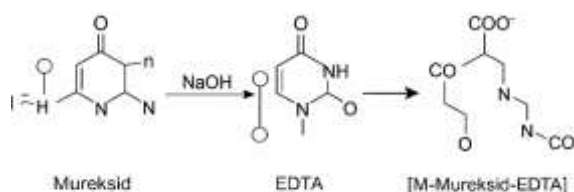


Figure 5. Complex Ion Formation Reactions

DISCUSSION

Water sampling was carried out at two locations with different geographical characteristics. The first location is in Dongkala Village/Village, Pasar Wajo District, Buton Regency, which is included in the coastal area. This region has a flat height varying between 12 meters above sea level (masl) to 50 meters above sea level. The water sources of this area generally come from shallow wells that are affected by the abundant marine deposits and carbonate rocks around the coastal area. The second location is in Jaya Bakti Village, South Mambulu neighborhood, Sampolawa District, South Buton Regency, is a mountainous area with an altitude of about 200 meters above sea level. The water source in this area comes from wells located in the highlands, which usually come from aquifers of granite rocks and other metamorphic rocks that tend to have a relatively low mineral content.

This grouping of areas based on altitude and geological characteristics is important because it theoretically affects the mineral content in the water, including calcium. Coastal areas tend to have higher mineral content due to the influence of carbonate rocks and marine deposits, while mountainous areas tend to have lower mineral content.

Calcium content testing is performed by the EDTA titration complexometry method, which is one of the most common and accurate chemical analysis techniques in determining calcium ions in water samples. This method is based on the ability of EDTA (Ethylene Diamin Tetra Acid) to form a stable complex with calcium ions, so that the number of calcium ions can be quantitatively calculated through titration.

The testing procedure begins with sterile water sampling and preliminary treatment to ensure the absence of contamination. The sample was then tested with an eriochrome black T indicator and EDTA solution until a discoloration occurred marking the titration endpoint. Repetitions are performed at least three times to get consistent and accurate results. The advantages of this method include its high level of sensitivity and its ability to detect calcium ions in low to medium concentrations. The accuracy of the results depends on the calibration of the tool, the accuracy of the measurements, as well as the test procedures that are carefully performed.

The results of calcium level testing from the two locations showed significant differences, according to the geographical and geological characteristics of the region. In water samples from coastal areas, the average calcium level value was 69.88 mg/L, while in samples from mountainous areas, the average calcium level was 58.68 mg/L. This data shows that the calcium mineral content in coastal areas is relatively higher compared to mountainous areas. This difference is quite consistent with geological theories and previous research results that carbonate rocks such as limestone and limestone abundant in coastal areas are the main source of calcium minerals in water (Irzon, 2022). On the other hand, mountainous areas dominated by granite and metamorphic rocks have a lower mineral content due to the nature of these rocks which are less soluble in water (Lesmana et al., 2021). In addition, the mineral dissolution process is also influenced by climatic factors, water pH, and human activities. Coastal areas closer to the sea and carbonate deposits naturally increase calcium content in groundwater and wells. In contrast, more isolated mountainous regions tend to have purer water and less soluble minerals.

The WHO suggests calcium levels in drinking water should ideally range from 15 to 100 mg/L for health benefits and stability of the distribution system. The calcium levels of both samples were within that range. Samples from coastal (69.88 mg/L) and mountainous (58.68 mg/L) areas showed that the water taken from both locations met WHO standards and was relatively safe to consume in terms of mineral content. This calcium content contributes to the body's good mineral needs, helping to maintain healthy bones and teeth. However, levels that are too high (more than 100 mg/L) can cause mineral deposits on pipes and household appliances, as well as an unpleasant taste. Therefore, although calcium levels at both locations are still within safe limits, water quality management is still necessary to prevent long-term problems.

The cooking process carried out on water samples from both locations showed a small change in calcium levels. In water samples from mountainous areas (PM), calcium levels decreased from 58,700 mg/L to 33,040 mg/L after the cooking process, while in samples from coastal areas (KM), calcium levels decreased from 69,960 mg/L to 38,960 mg/L. Therefore, in accordance with drinking water quality standards according to SNI 01-0220-1987-1 concerning Drinking Water Quality, the maximum recommended requirement is 75 mg/L. The phenomenon of decreasing calcium levels during the cooking process can be caused by mineral deposition due to increased temperature and pH change of the water. Calcium minerals, especially in the form of calcium carbonate, tend to settle when water is heated, so their content in the water decreases (Kesuma, 2019). In addition, the evaporation of water during the cooking process is also able to increase the concentration of minerals in smaller volumes of water, causing minerals to settle and decrease the content in the remaining water. It should be noted that the cooking process does not significantly reduce the overall calcium content, but it can lead to deposits that settle at the bottom of the cooking container. Therefore, the cooking process can affect the physical quality of the water and the distribution system, but it does not drastically reduce the mineral content.

The results of this study are in line with the literature that states that the mineral content in groundwater is greatly influenced by geological factors and the climate of the water source area. (Irzon, 2022) states that carbonate rocks such as limestone and limestone are the main sources of calcium minerals in groundwater and wells in coastal areas. They also added that water from areas with such rocks tends to have higher levels of minerals, which can provide health benefits but also potentially lead to sedimentation. (Lesmana et al., 2021) confirms that granite and metamorphic rocks common in mountainous areas have less soluble properties and produce fewer minerals in groundwater. Therefore, water from this area generally has a lower mineral content, including calcium.

COVER

This study shows that the complexometry method with the murexide and Na₂EDTA pentiter indicators is effectively used to determine calcium (Ca²⁺) levels in mountain and coastal well water samples. The results of the study prove that there is a difference in calcium levels between the two water sources, which is influenced by the geographical and environmental conditions of each region. The standardization of Na₂EDTA solutions is carried out in a triple manner to ensure the consistency and accuracy of the data, so that the results obtained can be trusted. Overall, this study confirms that the complexometry method is a simple, economical, but capable of providing valid results for the analysis of metal ions in water. However, this determination and comparison still has limitations in the complex mode analysis method used in this study may have limitations in detecting very low or very high calcium levels.

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