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# Total Hardness Test on Dug Well Water in Alak Village, Kupang City

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**Abstract:** Total hardness is the content of Ca2+, Mg 2+ and other 2-valent ions in clean water and drinking water. The hardness level of dug well water in Alak Village is high. The purpose of this study was to determine the total hardness content of dug well water in Alak Village, Kupang City. The research method is pre-experimental with a research design that is cross-sectional study. The results showed that the results of the Total Hardness measurement of the 20 dug wells, the largest was 548 mg/L and the lowest was 384 mg/L. The average result of Total Hardness measurement is 466.20 mg/L. It is suggested for the health center in Alak Village to be able to provide education about the negative impact of Total Hardness which reaches above 500 mg/L.

**Keywords:** Dug Water; Total Hardness.

## Introduction

Clean water is a basic need for every living creature (Dharminder et al., 2019; Sihombing, 2020). If the basic needs are not fulfilled then humans and other living things will suffer. The need for clean water must be fulfilled both in terms of quality and quantity (Akhtar et al., 2021; Van Vliet et al., 2021). Therefore, the government has made clean water facilities through PDAM (Regional Water Supply Company) so that people can get clean water to use according to their needs. For areas that have not yet received clean water services from the PDAM, they usually use ground water (dug and drilled wells), river water and rain water and others.

The Province of East Nusa Tenggara (NTT), especially the City of Kupang, is an area that generally has calcareous soil (Ngongo et al., 2022). Calcareous soil is soil that has high Calcium (Ca) and Magnesium (Mg) (Taalab et al., 2019). This will have an impact on clean water, especially water originating from groundwater (dug wells) which will have a fairly high Total Hardness content. Calcium and Magnesium levels in clean water and drinking water are needed by the body (Rachmat, 2021). One of them is for bone formation. However, if the Total Hardness content exceeds the threshold, it will be bad for health and the environment.

Water hardness is divided into 2 groups, namely permanent hardness and temporary hardness (Kaho, 2019). Permanent hardness is caused by chloride (Cl-) and sulfate (SO42-) anions, while temporary hardness is caused by carbonate (CO32-) and bicarbonate (HCO3-) anions.

Temporary hardness can be reduced by heating (Ningrum, 2020; Yunitasari, 2022). During the heating process, precipitation will occur in the boiler where the water is heated to temperatures above 100 $^0$C for several minutes. This white precipitated substance is called temporary hardness. Temporary hardness consists of substances CaCO3, MgCO3, Ca(HCO3)2 and Mg(HCO3)2. While hardness remains composed of CaCl2, MgCl2, CaSO4 and MgSO4 compounds. Fixed hardness can be reduced by adding certain chemicals, one of which is the processing of down-flow and up-flow filtration systems (Asmaningrum & Pasaribu, 2016; Sulistyani et al., 2012).

Total hardness is measured by titration using the complexometric method (Nielsen & Nielsen, 2017;

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Sumalapao et al., 2017), also known as the calorimetric titration method (Boppana et al., 2023; de Almeida et al., 2021; Duong et al., 2023). This method is known as the reaction of forming neutral molecules which dissociate in solution (Syafiq, 2021). The condition that must be met in this method is the formation of complex compounds with a high level of solubility. The groups attached to the central ion, called ligands, are dissolved in water.

The Total Hardness Standard according to Permenkes number 492/MENKES/PER/IV/2010 concerning drinking water quality is 500 mg/L. Water whose hardness exceeds this threshold value can cause several diseases (Latuconsina & de Lima, 2020; Nawan et al., 2023). Diseases that can arise include urolithiasis (kidney stones), cardiovascular disease (blockage of the heart arteries) and high levels of Ca and Mg can interfere with digestion and absorption of nutrients. Besides that, it will remove the foam in the soap, so you need more soap when bathing or washing clothes (Nyoman et al., 2018). As for the environment, the impact of high hardness is that it can cause corrosion on household furniture.

The purpose of this study was to determine the total hardness level of dug well water in Alak Village, Alak District, Kupang City. Based on the description above, it is necessary to test the Total Hardness of Well Water in Alak Village, Alak District, Kupang City.

## Method

This type of research is pre-experimental research with a cross-sectional study design. The method used in this study is the complexometric method (Styawan et al., 2020) with the titrant being Etiten Diamin Tetra Acetic Acid (EDTA) using a Buffer Phosphate solution and the indicator being Eriochrome Black T (EBT). The time for the research is in November 2022. The research location is at the Testing Laboratory of the Kupang Health Polytechnic.

The sample in this study were 20 dug wells in the Alak Subdistrict, Alak District, Kupang City. The sampling technique is simple random. Sampling of well water is carried out as follows: 1 liter of water samples are taken using clean and closed plastic bottles. All samples that have been taken are then brought to the laboratory to be tested for total hardness.

The total hardness test is as follows: Standardization of Na2EDTA solution by taking 20 mL of 0.01 M CaCO3 solution, and placing it in a 250 m Erlenmeyer flask. Then 1 mL of buffer solution pH 10 ± 0.1 was added and 30 mg of EBT indicator was added. Titrate with Na2EDTA solution until a change from red to purple occurs. Then determine Total Hardness in the following way: take 25 mL of dug well water sample, put it into a 250 mL Erlenmeyer flask. Then 25 mL of distilled water was added, then homogenized and added 1 mL to 2 mL of buffer solution pH 10 ± 0.1. Then 30 mg of EBT indicator was added to the tip of the spatula. Titrate slowly with 0.01 M Na2EDTA standard solution until the color changes from purplish red to blue. The results obtained are entered into the calculation formula. The formula for calculating Total Hardness uses equation 1.

$$\text{Total hardness} = \frac{1000}{\text{V sample test}} \text{xV EDTAxM EDTAx100} \quad (1)$$

## Result and Discussion

This research was conducted in the Alak Sub-District, Kupang City in April 2023. The samples for this study came from 20 dug wells in the Kelurahan. Total hardness was tested using the complexometric method with a titrant, namely EDTA (Ethylene Diamine Tetra Acetic Acid) which is an amino acid compound used for the determination of polyvalent metal content such as Ca2+ and Mg2+. The results obtained from the Total Hardness test are as follows as shown in Figure

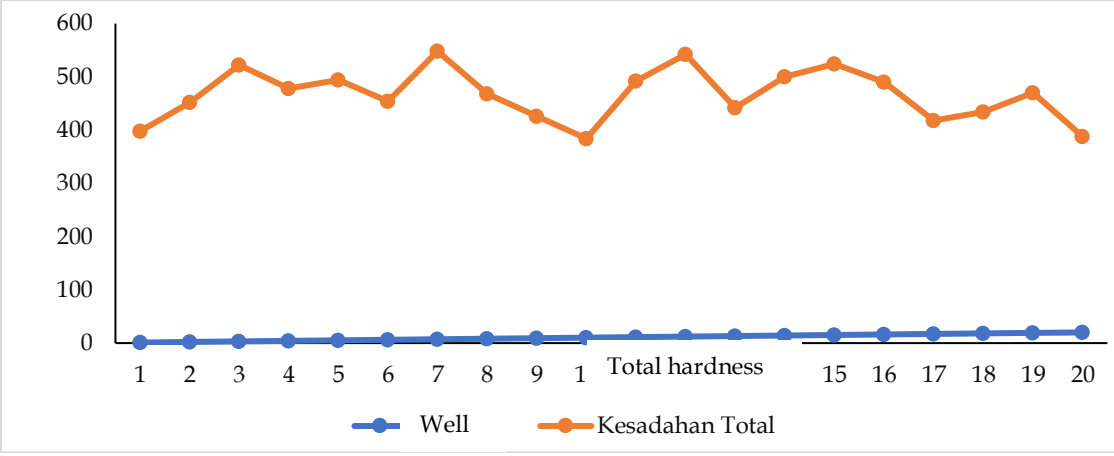



**Figure 1.** Total Hardness in Dug Well Water in Alak Village

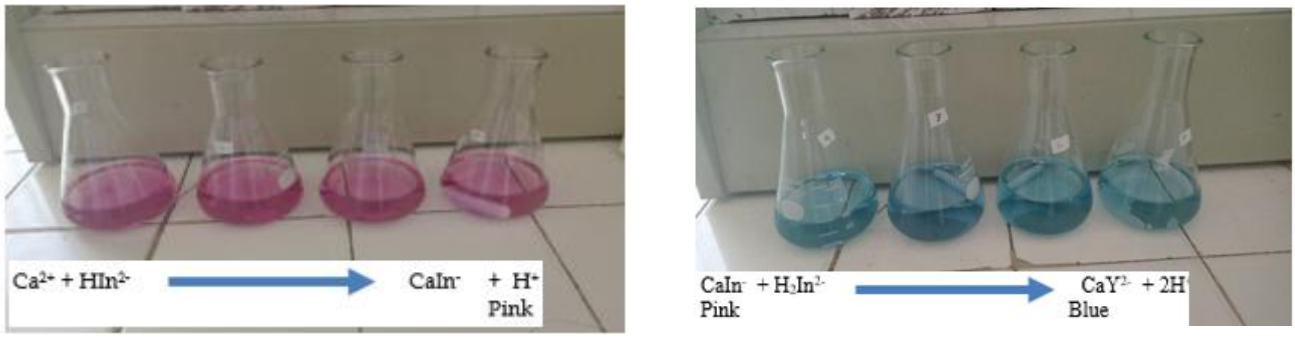
The highest Total Hardness test results were dug well number 7 with 548 mg/L and the lowest Total Hardness was dug well number 10 with 384 mg/L. Furthermore, the results obtained were tested using SPSS 22. Data processing using SPSS 22 is shown in Table 1.

**Table 1.** Processing of Total Hardness Numbers Using SPSS 22

| | | |
|---|---|---|
| N | Valid | 20 |
| | Missing | 0 |
| Mean | | 466.20 |
| Std. Error of Mean | | 10.958 |
| Std. Deviation | | 49.007 |
| Variance | | 2401.642 |
| Range | | 164 |
| Minimum | | 384 |
| Maximum | | 548 |

Table 1 shows that the average Total Hardness test is 466.20 mg/L with a standard deviation of 49.007. Total hardness is the mineral content of Calcium, Magnesium and other 2-valent ions. Calcium is the main substance found in water containing hardness followed by Magnesium and a few ions of Manganese ($Mn^{2+}$), Iron ($Fe^{2+}$) and others (Mogashane et al., 2023). Soil in Kupang City is a type of soil that contains lime. Soil containing lime will be affected by groundwater. Groundwater contains $Ca(HCO_3)_2$, $Mg(HCO_3)_2$, $CaCO_3$ dan $MgCO_3$.

If in the body there are $Ca^{2+}$ ions, $Mg^{2+}$, $Mn^{2+}$ and other ions in an amount that does not exceed the threshold, these ions will be beneficial for human life. Calcium and Magnesium can function in the formation of bones, and make the bones less porous (Ciosek et al., 2021; Venkatraman & Swamiappan, 2020). However, if Calcium and Magnesium and other 2-valent ions are present in amounts that exceed the threshold, it will have a negative impact on the body. These hazards, among others, can cause cardiovascular disease (blockage of the heart arteries) and urolithiasis (kidney stones). Besides that, it can also cause other damage to the environment, namely the formation of scale on metal equipment. Another thing that can happen is clogging of metal pipes due to calcium carbonate (CaCO3) deposits. The reaction that occurs during the titration process as seen in Figure 2.




(a) (b)

**Figure 2.** Total Hardness Test: (a) before equivalence point; (b) after equivalence point

Based on the data obtained from the 20 samples tested, there were 5 samples that had Total Hardness values above 500 mg/L. This has exceeded the threshold for the Total Hardness value required by Permenkes number 907 of 2002 which states that the quality standard for clean water and drinking water for the Total Hardness parameter is 500 mg/L or 500 ppm. This value will have a negative impact on the people living in the area if they consume water directly without processing it first.

Water that is hard enough can be treated by boiling it first (Labhasetwar & Yadav, 2023; Wutich et al., 2020). The heating process can temporarily reduce hardness by forming a white precipitate at the bottom of the container used for the heating process (Ghina, 2023; Marlina, 2023). So the process of heating water up to 100 $^0$C has uses, one of which is to reduce the hardness of the water. Reducing hardness can still be carried out according to research from Ngere et al. (2023) where the hardness is reduced by adding 60 mesh of zeolite with a residence time of 45 minutes. Total hardness before treatment was 80 mg/L and after adding zeolite with a residence time of 45 minutes it decreased to 20 mg/L. Activated charcoal can also reduce total hardness in water samples according to research from Sejati in 2021. The research results from Sejati showed that the decrease in total hardness could be affected by the large amount of rice husk charcoal added to the sample. The more rice husk charcoal added to the sample, the lower the total

hardness decreases and the water hardness drops below the threshold.

## Conclusion

The conclusion of this study is that the total hardness rate of well water in Alak Village is from 384 mg/L to 548 mg/L with an average value of 466.20 mg/L. This indicates that the hardness level decreases below the threshold.

**Author Contributions**

This article was prepared by two authors, namely C.A.K.E and B.W. The authors completed this article together at each stage.

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**Conflicts of Interest**

The authors declare no conflict of interest.

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