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Comparison to the Iron Level on the well water and PDAM water sample using ICP-OES Spectrophotometer

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ABSTRACT

Iron (Fe) is one of the elements that can be found in almost every place on earth, in all geological levels, and in all water bodies. In general, the iron in the water can be dissolved. The content of *Fe* ions in drilled well water can range between 5-7 mg/L. ICP-OES spectrophotometry is a type of ICP that utilizes plasma as a source of atomization and excitation. The purpose of this research is to determine the difference in *Fe* content between well water samples and PDAM water samples in the Pemulutan sub-district using the ICP-OES spectrophotometer. The type of research used was cross-sectional. The population in this study was well-watered and PDAM-watered in Pemulutan District. The sampling technique in this study was simply random. The place of this research was in the Palembang Health Laboratory Center. The results showed that the average difference in the examination of *Fe* levels in well water samples and PDAM water using the sda was 0.13198 mg/L for well water and 0.00445 mg/L for PDAM water. The conclusions were that PDAM water is safer to use for sanitation activities or consumption purposes than well water. The iron (Fe) content in well water is higher than the iron (Fe) content in PDAM water.

Keywords: water, iron (Fe), ICP-OES spectrophotometry

INTRODUCTION

One of the most important needs in human life is water. Humans use clean water for a variety of daily activities, including drinking, bathing, cooking, washing, and other needs. One of the reasons for the decline in water quality is the increase in unwise human activities. Water as an environmental component will be influenced by other components, so it is important to maintain the quality of clean water (Alamsyah dkk, 2022).

There are many types of water sources, one of which is well water and PDAM water (Arrahma Wijayanti, 2020). Well, water is a source of clean water that comes from groundwater. Groundwater comes from rainwater runoff, which infiltrates into the ground through several layers of soil and collects into groundwater. This causes groundwater to contain minerals such as calcium, magnesium, and iron. Water with high hardness causes soap to be unable to foam and will produce scale (Db dan Saptomo, 2019). PDAM water (from the Regional Water Supply Company) is sourced from surface water or river water. PDAM water treatment goes through chemical, physical, and bacteriological processes. Therefore, drinking water is cooked first to reduce chemical content such as metal levels in the water (Faisal dan Atmaja, 2019a).

The content of Fe ions in drilled well water can range between 5-7 mg/L. Meanwhile, the quality standard for iron content in clean water is based on the Regulation of the Minister of Health of the Republic of Indonesia Number 32 of 2017, a maximum of 1 mg/L of iron (Fe) contained in well water, if consumed continuously can cause respiratory

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problems (weakness, coughing, shortness of breath). breathing, and cyanosis). The high or low content of iron (Fe) is influenced by the condition of the soil structure. Factors that cause high levels of iron (Fe) in waters are contamination from waste resulting from human activities, such as household waste, industrial activity waste, and chemical liquid waste that is not managed properly. According to the regulation of the Minister of Health of the Republic of Indonesia (2017) water quality examination includes physical and chemical parameters. The physical parameters of water are turbidity, color, taste, and odor. While the chemical parameters of water are the content of inorganic and organic substances that have a pH between 6.5 and 8.5 (Pirdaus dkk, 2018).

There are several ways to measure the levels of metal in the environment. The method that has been is used Atomic Absorption spectroscopy (AAS). Advances in atomic spectroscopic techniques and the discovery of a new excitation source in the form of plasma have led to an alternative analytical technique for determining heavy metal levels using Inductively Coupled Plasma (ICP). The source of excitation in the ICP is plasma generated from radiofrequency electromagnetic waves through an induction coil. This excitation source produces a high-temperature flame, which is higher than AAS, thereby minimizing the possibility of chemical interference and increasing the sensitivity of the method. This technique could measure analytes simultaneously, has high sensitivity, has a low analyte detection limit of up to ppb units, and can be carried out easily and quickly (Sanitasi dkk, 2021). Some of the advantages of using the ICP method are also explained by Concern, namely the ability to identify and measure all elements that are analyzed together (Siahaan, 2019).

Siahaan carried out an analysis of iron (Fe) levels in dug-well water in one of the complexes in Medan City In 2019. The results showed that dug well water was unfit for consumption because the iron (Fe) content was above the normal iron (Fe) level regulated by the Regulation of the Minister of Health of the Republic of Indonesia No. 416/MENKES/PER/IX/1990, namely a maximum of 0.3 mg/day. L (Prihatin dkk, 2017). Research by Silviana E, et al (2020) about analysis of the content of iron (Fe) contained in PDAM water in Pidie Jaya Regency showed ~~that~~ the content of iron (Fe) tends to be still within the specified requirements, so it is safe for consumption.

Based on the previous research and given the importance of checking water quality, the researchers considered it to examine the iron (Fe) content of well water and PDAM water in Pemulutan District, Ogan Ilir Regency, South Sumatra Province, Indonesia because many people in the area still use well water, even though PDAM water has been obtained.

MATERIAL AND METHOD

The type of research used is *cross-sectional.* Cross-sectional research is research that measures variables only once at a time. The materials used in this research were concentrated HCL, *Nitric Acid* (HNO_3), Aquadest, 20% amino hydrohydroxyl solution, ammonium acetate buffer pH 4, and standard iron solution. while the tools used are the ICP-OES spectrophotometry, measuring pipette, measuring flask, suction ball, beaker, and heating device. It is generally indicated to look for a relationship between the independent variable (risk factor) and the dependent variable (effect) by taking a momentary measurement (Sutriyawan, 2021). The parameters used in this research were to see the iron (Fe) content in well water

and PDAM water samples using the ICP-OES spectrophotometry tool (Thermo Icap 7000 series). Figure 1 shows the flow of research carried out.

Time And Place of Research

Sampling was carried out in Pemulutan District, Ogan Ilir Regency, South Sumatra Province, Indonesia. Meanwhile, data collection was carried out at the Health Laboratory Center (BBLK) on January 15–20, 2023.

Figure 1. The map of Pemulutan district OKI

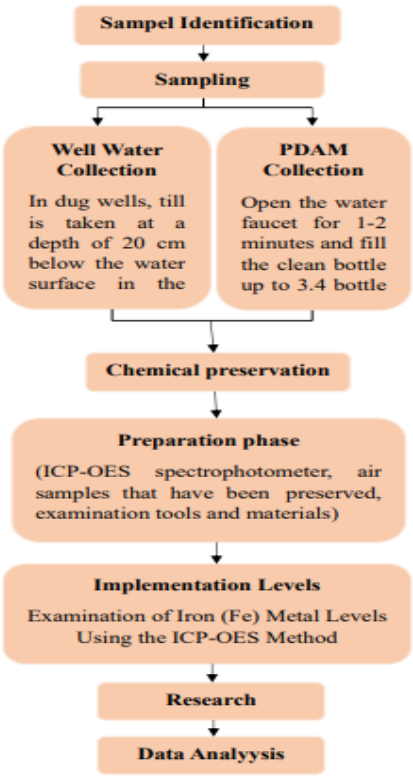

Figure 2. Research Flowchart

Well water collection

In dug wells, till is taken at a depth of 20 cm below the water surface in the morning. The stages of sampling for excavated samples according to SNI for this purpose are (1) prepare a sampling tool that is appropriate to the condition of the air source, (2) rinse the tool with the sample to be taken three times, (3) take samples according to requirements.

Sampling at the water tap

The steps for taking samples are as follows (1) prepare a clean iron-free bottle, (2) open the tap for 1-2 minutes, (3) open the bottle cap and fill the sample to ¾ v of the bottle volume and (4) preserve it chemically

Chemical preservation

According to SNI, chemical preservation is carried out by adding concentrated nitric acid to the sample with a pH < 2. This is followed by qualitative analysis and determination of the maximum wavelength, making a standard solution, and determining the Fe content.

Preparation phase

Prepare tools and materials consisting of personal protective equipment to be used. Then, prepare the tools to be used, consisting of ICP-OES Spectrophotometry (Figure 2). Fe cathode hollow lamps, beakers, measuring pipettes, glass funnels, measuring flasks, Erlenmeyer glass funnels, watch glass, a set of vacuum filter tools, membrane filters with a pore size of 0.45 m, an analytical balance with an accuracy of 0.0001 g, and a spray flask. Then prepare the materials to be used, namely samples of well water, PDAM water, nitric acid (HNO_3), aqua dest, 1000 ppm iron (Fe) standard solution, acetylene gas (C_2H_2), 7) HNO diluent solution 3 0.05 M, and 8) HNO washing solution 3 5% (v/v).

The procedure for making liquor is to Prepare a 100 mg Fe/L ferrous metal mother solution. Weigh ± 0.100 g of iron metal, put it into a 1000.0 mL volumetric flask, add a mixture of 10 mL HCl (1+1) and 3 mL HNO_3 concentrated until dissolved (≈ 100 mg Fe/L), adding 5 mL HNO_3 concentrated, and then dilute with mineral-free water up to the tera mark. Make a standard solution of ferrous metal (10 mg Fe/L). Pipette 10.0 mL of 100 mg Fe/L ferrous mother liquor, then put it into a 100.0 mL volumetric flask; adjust the diluent solution up to the mark; and homogenize.

Create a calibration curve. Setting up the spectrophotometer (ICP-OES) tool. Prepare a blank solution and a working solution. Carry out tests on the blank solution and the working solution by the established test method. Print a calibration curve, which is the relationship between the blank and the level of working solution, the response of the instrument, and the equation of the regression line from the tool. After the calibration curve is formed to meet the acceptance limit where the linear regression coefficient (r) is 0.995, before the sample is measured, the calibration curve is checked by measuring the median working solution again. Sampling was carried out by taking 100 ml of water from each well and putting it in a clean container.

Implementation Level

Sample Total Iron Test The tools used are measuring pipettes, cups, watch glasses, Erlenmeyer funnels, measuring flasks, and hot plates. the materials used are samples of well water, PDAM water, Nitric Acid (HNO_3) concentrated water, and mineral-free water. SDA total iron test. Homogenize the test sample and pipette 50.0 mL of the test sample into a 100-mL beaker or 250-mL Erlenmeyer flask. Add 5 mL of concentrated Nitric Acid (HNO_3). If using a beaker, cover it with a watch glass, and if using Erlenmeyer, use a funnel as a cover. Heat slowly until the remaining volume is 15–20 mL. If the digestion is not complete (not clear), then add another 5 mL of concentrated HNO_3, cover the beaker with a watch glass or cover the Erlenmeyer with a funnel, and heat again (do not boil).

Do this process repeatedly until all the metal is dissolved; rinse the shiny glass and put the rinse water into the beaker; transfer the sample for each test into a 50 volumetric flask (filter if necessary); and add mineral-free air until the mark is precise and homogeneous; then the test sample is ready to measure its absorption. Measure the absorption using :

1) Calculation

$$Fe\ \left(\frac{mg}{L}\right) = C\ x\ fp \qquad (1)$$

Fe is Ferrous metal levels (mg/L), C is Levels obtained by measurement results (mg/L), and Fp is the Dilution Factor.

2) Interpretation of Result

The normal value of Iron (Fe) content is 0.3 mg/L.

RESULT AND DISCUSSION

Analysis of Iron (Fe) Content in Well Water

The results of the iron (Fe) test on 10 samples of well water using the ICP-OES spectrophotometry method can be seen in Table 1:

Table 1. Test results for iron (Fe) content in well water samples

NO	SAMPLE CODE	RESULTS (mg/L)
1	S1	0,0769
2	S2	0,0348
3	S3	0,0026
4	S4	0,0026
5	S5	0,3826
6	S6	0,0441

7	S7	0,0202
8	S8	0,1071
9	S9	0,3190
10	S10	0,3299
	Average	0,13198

Based on Table 1, the ICP-OES spectrophotometry was used to test 10 samples of well water for iron (Fe) levels. The highest level was 0.3826 mg/L, and the lowest was 0.0026 mg/L. The water content is lower than the maximum level set by the Republic of Indonesia Minister of Health Regulation (2017) so that this water meets quality standards and is safe for consumption. There are 3 samples in the well water sample that exceed the normal value of iron (Fe) that has been set.

Analysis of Iron (Fe) Content in PDAM Water

The results of the iron (Fe) test on 10 samples of well water using the ICP-OES spectrophotometry method can be seen in Table 2

Table 2. Test Results for Iron (Fe) Content in PDAM Water Samples

NO	SAMPLE CODE	RESULTS (mg/L)
1	P1	0,0038
2	P2	0,0006
3	P3	0,0032
4	P4	0,0087
5	P5	0,0033
6	P6	0,0003
7	P7	0,0123
8	P8	0,0006
9	P9	0,0107
10	P10	0,0020
	Average	0,0045

Table 2 shows the results of the test for iron (Fe) content in 10 PDAM water samples; the highest level was 0.0123 mg/L, while the lowest level was 0.0006 mg/L. The water content is lower than the maximum level set by the Republic of Indonesia Minister of Health Regulation (2017) so that this water meets quality standards and is safe for consumption.

Comparison of Iron (Fe) Content in Well Water and PDAM

The results of iron (Fe) content in the well water and the PDAM water sample were quite different iron (Fe) levels using the ICP-OES spectrophotometry can be seen in Figure 3.

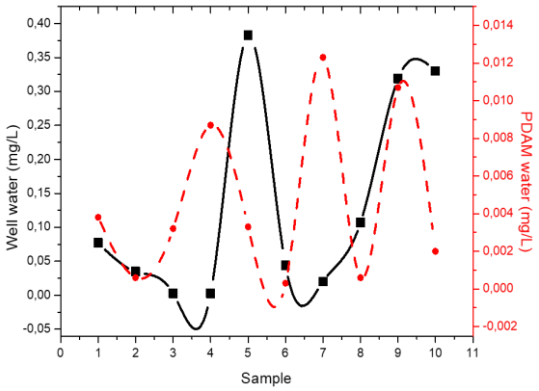

Figure 3. Content of iron (Fe) in the well water and PDAM water samples

Figure 3 shows that three samples in the well water sample that exceed the normal value of iron (Fe) which has been determined to exceed the normal limit of the quality standard caused by yellow and dirty water. Meanwhile, in PDAM water samples, none of the samples showed high levels of iron (Fe). In three samples in the air well sample the water content is lower than the maximum level set by the Republic of Indonesia Minister of Health Regulation (2017), so this water has quality standards and is safe for consumption. Well, water are 3 samples in the well water sample that exceed the normal value of iron (Fe) that has been set. Meanwhile, samples from PDAM water in Pemulutan are good for consumption. It was concluded that the iron (Fe) content in well water is higher than the iron (Fe) content in PDAM water.

CONCLUSION

Differences in the iron (Fe) content of well water samples and PDAM water samples using the ICP-OES spectrophotometry can be concluded :

a. The highest Iron (Fe) content in the well water sample was 0.3826 mg/L, while the lowest iron (Fe) content in the well water sample was 0.0026 mg/L. Three well water samples obtained high Fe values due to the yellowish color of the well water, which caused it to exceed the established standard standards.
b. The highest iron (Fe) content obtained in the PDAM water sample was 0.0123 mg/L, while the lowest iron content in the PDAM water sample was 0.0003 mg/L. The water content is lower than the maximum level set by the Republic of Indonesia Minister of Health Regulation (2017) so that this water meets quality standards and is safe for consumption.
c. The results of the examination of iron (Fe) levels in well water samples obtained an average of 0.13198 mg/L, while measurements of iron (Fe) levels in PDAM water samples obtained an average of 0.00445 mg/L, so this study found the differences to be very meaningful.

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