Sainmatika: Jurnal Ilmiah Matematika dan Ilmu Pengetahuan Alam
Volume 20 No. 1, Juni 2023 DOI 10.31851/sainmatika.v20i1.10077
https://jurnal.univpgri-palembang.ac.id/index.php/sainmatika

Analysis of Iron and Lead Levels in Groundwater in Sub-Urban Areas of Palembang

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ABSTRACT

Access to clean water in Indonesia is one of the biggest problems. The main problem faced by the community is due to limited water resources and the problem of limited water quantity. Hence, they are unable to meet the increasing needs of the community. The decline in water quality is due to domestic and industrial waste entering water bodies. The influence of human activities so that pollutants entering the environment's surface, water, and groundwater increases yearly. Toxic and dangerous substances cause many problems to the environment and health. One of the harmful poisonous substances is heavy metals. This observational research is descriptive-analytic by testing the levels of metal iron (Fe), Lead (Pb), and pH of residents' well water. The research sample was collected using a sample grabber for the well water residents of Talang Betutu, Palembang. Samples were examined in the laboratory on the same day. The sample in this study amounted to 7 samples of residents' well water, which is still used for daily activities such as bathing and washing. Examination of heavy metals using a Uv Vis Spectrophotometer. The results showed that all residents' samples contained Fe and Pb at levels that did not exceed the quality standards. The chronic impact of consuming water containing heavy metals must be a concern because it lasts for a specific time.

Keywords: Heavy metals, Groundwater, Lead, Iron

INTRODUCTION

Water is an irreplaceable, essential element in life for all living things (Udhayakumar *et al*., 2016; Aprilia, 2014). The need for water can be in the form of surface water such as lakes, ponds, and rivers and groundwater such as well water. Well water stores and produces water for daily activities (Albertsson, 2014). Well water comes from underground springs dug and given round walls at the edges. Well water is susceptible to contamination from multiple sources, such as domestic waste, animal and human waste, pesticide residues, and other chemicals (Dantje, 2015).

Urban activities contribute to causing high environmental pollution. The uncontrolled increase in population has resulted in ecological pollution rates that exceed the rate of natural needs. Causes of water pollution due to urban waste include wastewater, household waste, gas waste, antibiotics, and garbage (Bahagia *et al*., 2018; Kurniawan and Mariadi, 2019; Mariadi and Kurniawan, 2020). The source of water that is still used as a source of water for household purposes is groundwater. Groundwater is

p-ISSN 1829 586X
e-ISSN 2581-0170

vulnerable to pesticide, fertilizer, and waste pollution (Ignatius *et al*., 2018).

Heavy metals such as cadmium and lead are heavy metals that are very dangerous to health. Both metals occur naturally in the environment, but their amounts can increase due to the disposal and use of batteries, industrial activities, ceramics, phosphate fertilizers, coal, fuel, and dye industries (Andjelkovic *et al*., 2019). Examination and prevention of exposure to heavy metals such as lead and cadmium is a significant issue for the wider community, even though the levels of exposure are low in the body due to their high toxicity effects. (Jarup and Akesson, 2009).

The results showed that urban surface water at a depth of 0.37 – 1.20 m contained contaminants such as Fe, Mn, Cd, Cu, and Zn, which could harm health if consumed for a long time. The presence of Cd, Cu, and Zn contaminants in surface water originates from anthropogenic activities. Metal contaminants such as iron and manganese affect the color of the water (*Awoyemi et al*., 2021). Cd content was found in the blood of residents on the coast of the Musi River (Mariadi *et al*., 2021). Ferrous metal also contaminates surface water in the foundry industry, where 4 out of 14 research sample locations found that the iron content was almost twice the permissible threshold value of 0.3 mg/L. (Susanto, 2005).

Cadmium metal can accumulate and be stored in various organs in the body, such as the kidneys and liver (Jarup and Akesson, 2009). It can cause multiple health problems, including a high risk of cancer, kidney dysfunction/acute kidney disease, respiratory tract, and heart disease (Hecht *et al*., 2016; Madrigal *et al*., 2019; Wang *et al*., 2021). Groundwater can be polluted with metals such as Fe and Mn, which cause discoloration of groundwater, and heavy metals such as Pb and Cd (Moumita *et al*., 2021). Heavy metals such as cadmium and metals such as Fe were found to contaminate waters (Muhammad *et al*., 2020), and the Fe content caused a decrease in the function of the electrolyzer membrane device. (Na Li *et al*., 2019).

Due to the negative impacts it is creating globally, heavy metal environmental contamination is a growing issue and a source of significant concern. The rapidly expanding agricultural and metal industries, inappropriate waste disposal, fertilizers, and pesticides are all responsible for the discharge of these inorganic pollutants into our rivers, soils, and environment (Briffa *et al*., 2020). Contamination of the water from metals accumulate in one or more different organs causing many serious diseases such as cancer (Masindi *et al*., 2018). Palembang, one of the development centers and urban areas in the province of South Sumatra and is actively developing, commercial, industrial, mall, and residential activities are increasing, triggering the disposal of excess waste into the environment. This is a problem for residents who still use groundwater as a companion besides using PDAM (Local Water Company) water. The regulation of the Minister of Health of the Republic of Indonesian 416/MENKES/PER/IX/1990 explains that water is drinking water, clean water, swimming pool water, and public bathing water. Furthermore, drinking water is water whose quality meets health requirements and can be drunk directly. While clean water is water that can be used for daily needs, whose quality meets health requirements, and can be drunk when it has been cooked.

Water quality is the condition measured and or tested based on specific parameters and specific methods based on the applicable laws and regulations Article 1 Decree of the Minister of State for the Environment Number 115 of

2003). Water quality can be expressed by water quality parameters. These parameters include physical, chemical, and microbiological parameters. Physical Parameters state the condition of the water that can be observed visually. Physical parameters are turbidity, particle or solid content, color, taste, odor, and temperature. Chemical parameters state the range of chemical elements or compounds in water, such as oxygen content, organic matter (BOD and COD), minerals, metals, degree of acidity, hardness, etc. Microbiological parameters state the range of microorganisms in water, such as bacteria, viruses, and other pathogenic microbes. (Masduqi in Yulli Nurraini, 2011). This study only used pH, Fe, and Pb to see the condition of groundwater quality. The pH level determines the acidity of the water which affects health and the level of oxygen solubility.

Population density, increasing commercial activities, the opening of malls, and rising domestic waste have triggered the decline in groundwater quality in Palembang. Several previous studies used Palembang well water samples to detect TSS and Turbidity (Mariadi and Kurniawan, 2020) and Pb content (Nora *et al*., 2022). This previous study used well water samples in areas close to landfills. Several areas in Palembang still use groundwater as a companion to water sources other than PDAM, which the Palembang City Government has prepared. Particulate contaminants often found are excess Fe levels in the water, causing well water to turn brown. The increase in Fe levels was accompanied by changes in the pH of the water, which tended to become more acidic. Therefore this research aims to investigate the condition of chemical quality, especially the levels of Fe, Pb, and pH of groundwater, which are still used by residents in several places in Palembang.

MATERIALS AND METHODS

This study used analytic observational with a cross-sectional design which was carried out from January to March 2021. The population in this study were all dug wells in Maskrebet, Sukarame District, Palembang. The sampling method was carried out using the purposive sampling method. Purposive sampling mean determine the location of wells in sampling that meet the criteria, such as dug wells and conventional wells. The provisions of the wells used for clean water, namely wells used for domestic household needs such as bathing, brushing teeth, washing clothes, washing cutlery, cooking, etc. The groundwater sampling method is carried out directly using the grab sampling method, which is a momentary sampling method that shows the characteristics of the water only at that time by using a water sampler following Standard National Indonesia (SNI) 6989.59:2008. Before analysis in the laboratory, preservation is carried out so that no physical or chemical changes occur. Parameters analyzed include Fe and Pb.

Sampling and Chemical Analysis

Physico chemical Examination According to SNI 6989.58.2008. Water is sampled using glass bottles and collected from polyethylene (PE) / polypropylene (PP) / Teflon / glass plastic, which can be closed firmly and tightly, cleanly, and is not quickly broken. The chemicals used were HNO_3 1:1 volume of 100 ml (50 ml concentrated HNO_3 and 50 ml distilled water). Sample containers for testing are prepared by washing glass or plastic bottles and caps with detergent and then rinsing them with clean water. Furthermore, the container was rinsed with nitric acid (HNO_3) 1:1, then rinsed again with analyte-free water three times and allowed to dry. After drying, close

p-ISSN 1829 586X
e-ISSN 2581-0170

the bottle tightly. Sampling begins by lowering the sampling tool into the well to a depth of the well 20 cm above the water level. Then, the filled sample taker is removed and transferred to the sample container

Pb and Fe Determination

Determination of lead, cadmium, and iron metals was carried out by acidifying the sample by adding a nitric acid solution to the sample, then filtering it with 0.45-micron filter paper and taking readings using an atomic absorption spectroscopy. Lead, cadmium, and iron concentration values in mg/L units are indicated on the instrument.

RESULTS AND DISCUSSION

The location of this research is Talang Betutu Village, Palembang, which is the center of the home industry for processing clay for bricks. This area has abundant clay resources around people's homes. Residents of this area already enjoy clean water from the regional drinking water company (PDAM) but only distribute it at certain hours, so residents still use the well water for daily activities. RT 38 is the center of the brick-making industry because this area is rich in raw materials, namely clay.

The type of regional soil the source of this research is clay, which has low porosity but high permeability, so it is flexible and difficult for water to penetrate. This soil type is the main ingredient for the ceramic and pottery industry. Soil is a solid component that produces all food ingredients in the environment that can potentially receive pollutants from various sources due to human activities that can flow with the soil flow. The path of entry of these pollutants can occur directly through water and air (Notodarmojo, 2005).

This study measured the metal levels of Fe, Pb, and the pH of the residents' well water, which is still used for daily activities. Checking the pH using the SNI 6989.11.2019 inspection method, Pb containing using the SNI 6989.8.2019 method, and Fe checking using SNI 6989.4.2019. The results of the examination are shown in Fig. 1, Fig. 2 and Fig. 3. The results of the study showed that all samples of residents' well water had Fe levels that still met the quality standards according to Minister of Health Regulation No. 32 of 2017 concerning environmental health quality standards and water requirements for hygiene and sanitation purposes where no Fe levels exceeded 1 mg/L. Physically, water samples in this area showed high clarity, and it was found that there were two residents' wells with a slightly brownish color. Based on the observations, the residents' slightly brown wells are adjacent to household sewer lines and septic tanks. Fig. 2 number well representation this cases with high level Fe better than the others well.

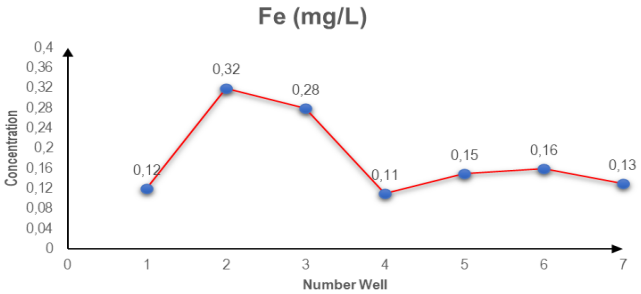

Fig 1 Results of water sample measurements for Fe

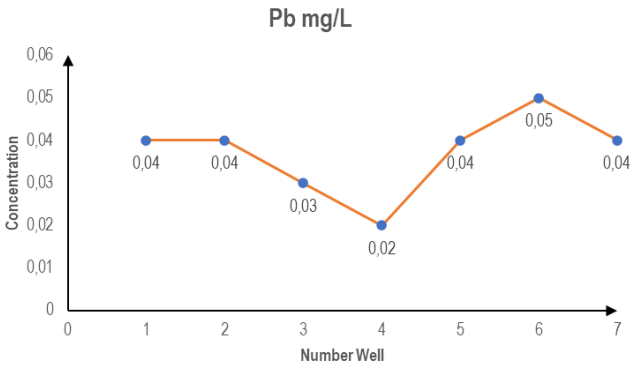

Fig. 2 Results of water sample measurements for Pb

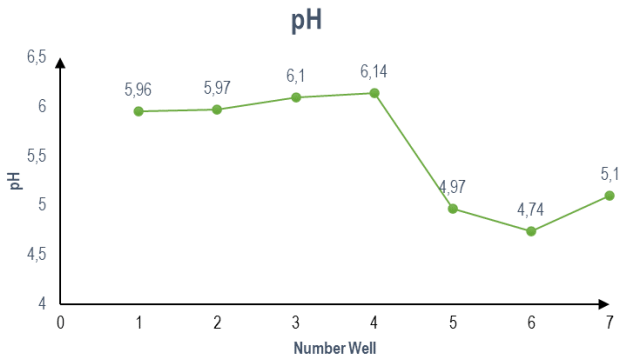

Fig. 3 Results of water sample measurements for pH

The residents' well water pH shows conditions outside the water book standard and is acidic (pH <7). Good water should have a neutral pH, according to Palar (1994), which states that a body of water with a neutral pH (range 7-8) will cause the solubility of metals in it to tend to be stable. The higher the pH of the water, the lower the solubility of metal compounds in water. Testing for Pb metal in water uses a spectrophotometer Uv - Vis. Atomic absorption spectrophotometry was used for determining the concentration of a metal element contained in the solution with very small concentration. SSA method used because of its high accuracy,fast and relatively easy (Gandjar and Rohman, 2009). Although this method has been validated, but the availability of the instrument is still limited.

Another method that can be used to measure lead levels is by using Spectrophotometry Uv-Vis because has a good accuracy for validation methods. Where this method is a fully automatic method, with a high level of accuracy and a low limit of detection. (Maese *et al*., 2020). The research results show that all residents' well water meets the threshold value (maximum level) of Pb in water. However, this remains a concern because five of them had lead levels that almost touched the threshold value, and if lead enters the body, it will accumulate and cause health problems. The entry route for these metals can be through the absorption of the skin, breathing, and food and drink routes.

Sources of lead pollution in an environment can be caused by vehicles (vehicle fuel, oil, tires, and incubation discs), the use of iron and steel, the coating industry, the energy industry, and the chemical industry (Guerreiro *et al*., 2018), the paint industry and the use battery stones (Ghorbani *et al*., 2018) and have polluted seawater (Rahmadani *et al*., 2015). Lead contamination in the environment must be a concern because of its highly toxic nature to nerves, especially for adolescents, and exposure, even at small levels, can increase the potential for cardiovascular disease in the United States (Lanphear *et al*., 2018). Other research shows this metal can inhibit the activity of enzymes in the process of forming hemoglobin in the blood. Most of these metals accumulate in organs such as the kidneys, liver, nails, adipose tissue, and hair and are slightly excreted through urine and feces (Widowati *et al*., 2008).

Several studies have shown a relationship between lead levels in blood, urine, and water, even at low levels (Ravenscroft *et al*., 2018). Blood lead content is negatively correlated with height but unrelated to body mass index. This was found in children of the same age in Greece (Kafourou *et al*., 1997) with an average content of 12.3 µg/dL. The moderate blood lead content in adolescents in Pakistan is 16.1 µg/dL (Rahman *et al*., 2002) and 2.4 µg/dL in Korea (Min *et al*., 2008. The fact found is that the level of exposure is directly related to the growth rate (Zhou *et al*., 2020), reduces head circumference (Choi *et al*., 2017; Kafourou *et al*., 1997), and reduces limb length (Kerr *et al*., 2019; Signes-Pastor *et al*., 2020) and correlates with cases of Autism (Aljumaili *et al*., 2021). An increase in the amount of lead

p-ISSN 1829 586X
e-ISSN 2581-0170

in the blood correlates with a decrease in the amount of iron in the body. It increases the risk of anemia (Slota et al., 2022) and cognitive impairment in children, even at low Pb levels in the blood (Maidooumi *et al*., 2022).

Various efforts have been made to eliminate sources of lead contamination in the environment. The initial steps used are identifying sources of contamination, using materials containing Pb, potentially polluted environments, and periodic assessment of Pb contamination (Lytle *et al*., 2019). Various technologies have been developed to reduce heavy metal pollution in the environment, both in water and on land, such as the use of metal-absorbing plants such as fire trees (Amriani, 2011), ion exchange technology (Carolin *et al*., 2017), solvent extraction (Fomina and Gadd, 2014), and chemical deposition (Carolin *et al*., 2017; Zhang *et al*., 2019). However, this technology and strategy is considered less economical and cannot be applied to low levels of metal contamination, which reach 1 – 100 mg/L (Carolin *et al*., 2017). This strategy adds more secondary waste to the environment (Abdel-Halim *et al*., 2003; Fomina and Gadd, 2014). Environmentally friendly and inexpensive technology must be able to degrade metal contamination even at a trim level. Various technologies have been developed, including organic sol-gel adsorbents and inorganic nanocomposites, which are environmentally friendly (Bidhendi *et al*. 2019).

CONCLUSION

Heavy metal content was found in residents' well water with varying levels. The average Fe in residents' well water is 0.18 mg/L and is still below the maximum threshold of 1 mg/L. The average pH in community well water is 5.56, below the threshold for the average water pH range, namely 6.5 – 8. The average Pb in community well water is 0.37 mg/L below the maximum 0.5 mg/L threshold. Although the levels of Pb and Fe in well water are still within the permissible range, it is necessary to be aware of the chronic effects of heavy metals if they are continuously exposed and consumed by humans. It is recommended that further research be carried out to test the levels of other contaminants, such as Cd metal and Pb metal testing in residents' blood.

ACKNOWLEDGEMENTS

The author is grateful to Universitas Katolik Musi Charitas for fully funding this research and to the Faculty of Engineering, Palembang PGRI University for facilitating the publication.

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p-ISSN 1829 586X
e-ISSN 2581-0170