Indonesian Journal of Chemistry and Environment
Vol. 6, No. 1, June 2023, pp. 1 ~ 8
e-ISSN: 2599-3186

Determination of Selenium, Lead, and Zinc Levels in Well Water Using the AAS Method

Khoirul Ngibad*
* Department of Medical Laboratory Technology, Universitas Maarif Hasyim Latif

Article Info

Article history:

Received March 10th, 2023
Revised May 17th, 2023
Accepted Jun 2nd, 202x

Corresponding Author:
Khoirul Ngibad
Dep. of Medical Laboratory Technology
Universitas Maarif Hasyim Latif
Email:
khoirul_ngibad@dosen.umaha.ac.id

ABSTRACT

Metal selenium (Se) has long been identified as a toxic element. In addition, the presence of lead metal (Pb) in waters is harmful both directly to the life of organisms and its effects indirectly on human health. Further, Zn metal can cause system dysfunction resulting in decreased growth and reproduction. This study aims to analyze Se, Pb, and Zan on well water around the Taman District, Sidoarjo Regency. The method used in this study is the AAS method at 196 nm for measuring Se levels, 283.3 nm for measuring Pb levels, and 213.9 nm for measuring Zn levels<. <0.013; and <0.002mg/L (well water A) and <0.002; <0.013; and 0.002 mg/L (well water B). The Se, Pb, and Zn levels still meet the quality standards (maximum content) of chemical parameters.

Keywords: AAS, Pb, Se, Zn, Well Water

1. INTRODUCTION

Water is a basic need to carry out human activities in their daily lives. Other living things also really need water to *survive* in living life. One type of water is clean water (Jannah et al., 2021) (Ngibad & Herawati, 2019) (Triarini et al., 2021). In meeting daily water needs, 2 types of clean water are used, namely: PDAM water and well water. Taman Subdistrict is located in Sidoarjo Regency. At least, the Taman subdistrict is fed by 2 rivers, namely the Pelayaran river and the X river. At certain times, the appearance of the 2 rivers is dirty so there are fears of pollution that can reduce the quality of the well water used by residents. The taste of well water in the Taman Subdistrict was found salty. The tendency to decrease water quality is caused by an increase in water pollution from both domestic and industrial waste (Kusumayanti & Hariyanto, 2019). Some of the aspects used to determine water quality include chemical aspects, physical aspects, and biological aspects (Kementerian Kesehatan RI, 2017). Selenium (Se), Lead (Pb), and Zinc (Zn) metals are additional chemical parameters so they need to be monitored in water for sanitary hygiene purposes, such as: well water (Kementerian Kesehatan RI, 2017).

Metal Se is necessary for normal growth and physiological functioning in living organisms. However, its distribution in the environment is not uniform and has long been identified as a toxic element (El-Sawy et al., 2023). Se poisoning is characterized by the presence of decay and discoloration of teeth, disorders of the gastrointestinal tract, skin lesions, and loss of hair and nails. In some cases, the skin on the tips of the fingers and toes peels off constantly. The target organs of Se exposure are the respiratory tract, liver, kidneys, blood, skin, and eyes (Gad & Pham, 2014).

The presence of lead metal (Pb) in waters is harmful both directly to the life of organisms and its effect indirectly to human health. Pb is a heavy metal that has high toxicity (toxicity) (Retyoadhi et al., 2005). The toxicity properties of heavy metals can be grouped into 3 groups, namely high toxicity consisting of elements Hg, Cd, Pb, Cu, and Zn. Pb metal can cause damage to the central nervous system and peripheral nerves such as tremors, headaches, stiff neck, fever, decreased intelligence, seizures, accumulation of cerebrospinal fluid in the brain, and blindness due to nerve atrophy of vision (Putri et al., 2019). A further impact of Pb poisoning is that it can cause hypertension and is one of the contributing factors to liver disease. When this element binds strongly to several amino acid molecules, hemoglobin, enzymes, RNA, and DNA; Then it will interfere with the metabolic channels in the body. Pb can also result in impaired blood synthesis, hypertension, hyperactivity, and brain damage (Dewa, 2015).

Zn heavy metal is one of the essential heavy metals needed by almost all organisms in small quantities. However, if the amount of Zn metal in the waters exceeds the specified threshold, it will be dangerous for the life of the organism itself and be toxic (Supriyantini et al., 2016) and can cause system dysfunction resulting in decreased growth and reproduction (Susilowati, 2021). A dose of Zn consumption of 2 gr or more can cause vomiting, diarrhea, fever, extreme fatigue, anemia, and reproductive disorders. Zn supplements can cause poisoning, as well as foods that are acidic and stored in cans coated with Zn (Zulfiah et al., 2017).

Measurement of Se levels is carried out using the atomic absorption and atomic fluorescence spectroscopy method (Pettine et al., 2015). Measurement of Pb levels in many aquatic samples using atomic absorption spectrophotometry (SSA) methods (Handriyani et al., 2020) (Putri et al., 2019) (Dewa, 2015). In addition, the measurement of Zn levels in aquatic samples also uses the atomic absorption spectrophotometry (SSA) method. (Khaira, 2016) (Blesstinov et al., 2017) (Irawan et al., 2015). Given the dangers of Se, Pb, and Zn metals in waters, it is necessary to research Se, Pb, and Zn levels in well water in Taman District, Sidoarjo Regency. According to the Indonesian Minister of Health Regulation No. 32 of 2017, the maximum allowable level for Se, Pb, and Zn metals is 0.01; 0,05; and 15 mg/L, successively (Kementerian Kesehatan RI, 2017).

2. RESEARCH METHOD

Tool

Glass funnel, erlenmeyer, goblet, measuring cup, watch glass, spray flask, measuring flask, zinc hollow cathode lamp, lead hollow cathode lamp, electric heater, measuring pipette, micropipette, membrane sieve, a set of vacuum filter devices, Atomic Absorption Spectrophotometer (SSA), test tube, and analytical scales.

Material

Aquadest, C2H2HP, HNO_3 0.05 M, HNO_3 5% (v/v), concentrated HNO_3, selenium solution, calcium solution, lead metal (Pb), Zn metal, membrane sieve, and compressed air.

Measurement of Selenium (Se) Levels

Variations in the concentration of the Se raw solution used include 0, 10, 20, 30, and 50 mg / L. Furthermore, each Se raw solution is taken and its absorption is measured using SSA-flame at 196 nm. Then, a series of Se level analysis procedures are based on SNI about Water, Selenium content testing method with carbon furnace atomic absorption spectrophotometer tool. Furthermore, the well water sample is treated the same as the standard solution Se (BSN, 1991).

Measurement of Lead (Pb) Levels

Variations in the concentration of the Pb raw solution used include 0; 2,5; 5; 7,5; 10; 15; 20; and 40 mg/L. Furthermore, each raw solution of Pb was taken and its absorption was measured using SSA-flame at 283.3 nm. Then, a series of Pb level analysis procedures are based on SNI on water and wastewater – Part 8: How to test lead (Pb) by Atomic Absorption Spectrophotometry (SSA) – flame. Furthermore, the well water sample is treated the same as the standard Pb solution (BSN, 2009b).

Measurement of Zinc (Zn) Levels

Variations in the concentration of the Zn raw solution used include 0; 0,05; 0,1; 0,2; 1; 1,5; and 2 mg/L. Furthermore, each Zn raw solution was taken and its uptake was measured using SSA-flame at 213.9 nm. Then, a series of Zn level analysis procedures are based on SNI on Water and wastewater – Part 7: How to test zinc (Zn) by Atomic Absorption Spectrophotometry (SSA) – flame. Next, the well water sample is treated the same as the standard Zn solution (BSN, 2009a).

3. RESULTS AND ANALYSIS

In this study, measurements of Se, Pb, and Zn levels were carried out using the AAS method. The principle of analysis is that the analyt of metal Se, Pb, and Zn in an air-acetylene flame is converted into its atomic form, absorbing the energy of electromagnetic radiation coming from the cathode lamp and the magnitude of absorption is directly proportional to the analyte content(BSN, 1991) (BSN, 2009a) (BSN, 2009b). In determining the levels of Se, Pb, and Zn using the SSA method, before measuring the concentration of Se, Pb, and Zn in the well water sample, a calibration curve must be made first.

Table 1 presents data on the Se standard series solution used for the manufacture of calibration curves measured at concentrations of 0, 10, 20, 30, and 50 mg/L. Se levels and signal responses have a linear relationship (Figure 1). The principle of measurement using the SSA method is based on Lambert-Beert's Law where the number of rays absorbed and the concentration of substances are directly proportional (Fahruddin, 2018). The calibration curve obtained is $y = 0.0016x + 0.0055$ and $r = 0.998$. A value of $r > 0.99$ indicates that the calibration curve has an excellent level of linearity (Ngibad, 2019). The calibration curve obtained is $y = 0.0016x + 0.0055$ and $r = 0.998$. A value of $r > 0.99$ indicates that the calibration curve has an excellent level of linearity

Table 1. Table 2. Signal measurement results in making Se calibration curves

Se concentration (mg/L)	Signal
0	0.0038
10	0.0232
20	0.0372
30	0.0516
50	0.0835

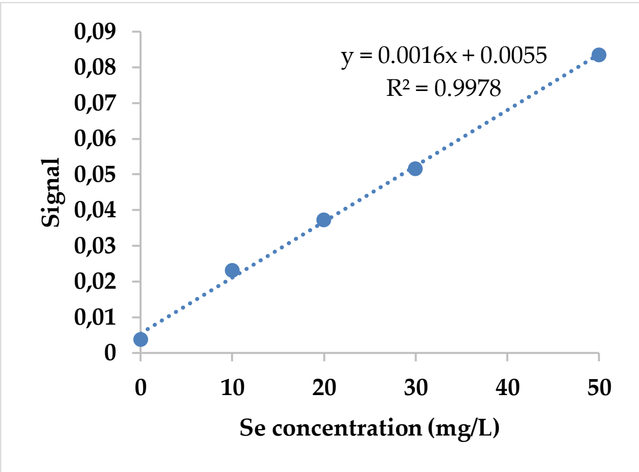

Figure 1. Calibration curve of Se standard

Table 2 presents the Pb standard series solution data used for the manufacture of calibration curves measured at a concentration of 0; 2.5; 5; 7.5; 10; 15; 20; and 40 mg/L. Pb levels and signal response have a linear relationship (Figure 2). The principle of measurement using the SSA method is based on Lambert-Beert's Law where the number of rays absorbed and the concentration of substances are directly proportional (Fahruddin, 2018). The calibration curve obtained is y = 0.0027x - 0.0006 and r = 0.998. A value of r > 0.99 indicates that the calibration curve has an excellent level of linearity (Ngibad, 2019). The procedure in SNI also requires a linear regression correlation value (r) ≥ 0.995.

Table 2. Results of signal measurement in making Pb calibration curves

Pb concentration (mg/L)	Signal
0	0.0027
2.5	0.0073
5	0.0113
7.5	0.0164
10	0.0259
15	0.0397
20	0.0555
40	0.1086

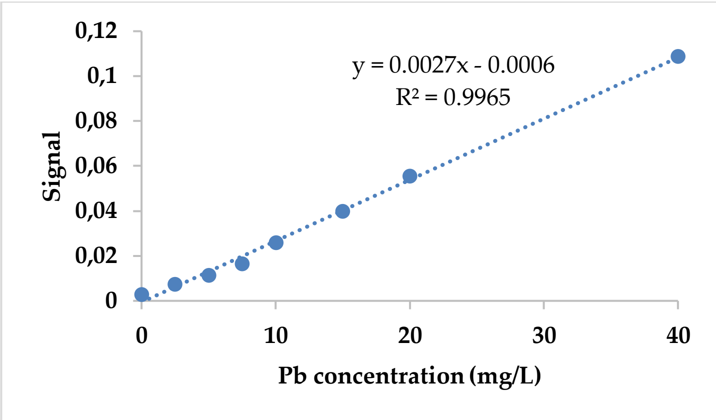

Figure 2. Calibration curve of Pb standard

Table 3 presents the Zn standard series solution data used for the manufacture of calibration curves measured at a concentration of 0; 2.5; 5; 7.5; 10; 15; 20; and 40 mg/L. Zn levels and signal responses have a linear relationship (Figure 2). The principle of measurement using the SSA method is based on Lambert-Beert's Law where the number of rays absorbed and the concentration of substances are directly proportional (Fahruddin, 2018). The calibration curve obtained is y = 0.2426x + 0.0061 and r = 0.997. A value of r > 0.99 indicates that the calibration curve has an excellent level of linearity (Ngibad, 2019). The procedure in SNI also requires a linear regression correlation value (r) ≥ 0.995.

Table 3. Results of signal measurement in making Zn calibration curves

Zn concentration (mg/L)	**Signal**
0	-0.002
0.05	0.013
0.1	0.0289
0.2	0.0553
1	0.2726
1.5	0.379
2	0.473

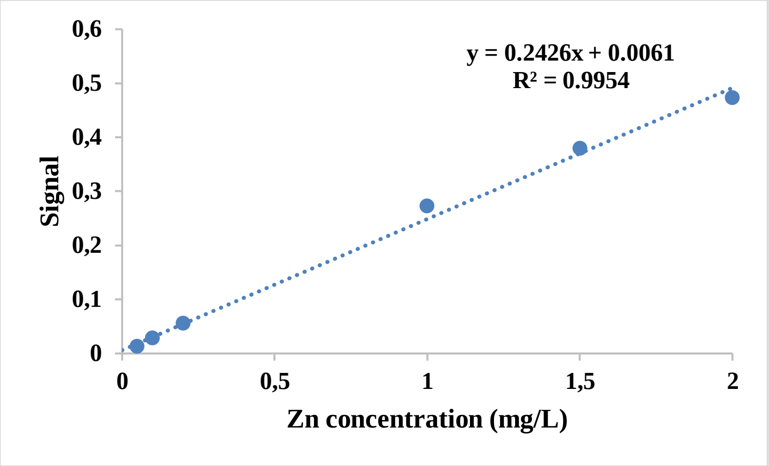

Figure 3. Calibration curve of Zn standard

After making calibration curves for Se, Pb, and Zn measurements, the signal response from the sample can be measured using AAS at the appropriate wavelength at the time of calibration curve manufacturing. The samples used in this study were sample A taken from the well water of the residents of Taman District around the shipping river and sample B taken from the well water of the residents of Taman District around river X.

Table 4. Results of measuring Se, Pb, and Zn levels in well water

Sample	Concentration (mg/L)		
	Se	Zn	Pb
Well Water Sample A	<0,002	<0,013	<0,002
Well Water Sample A	<0,002	<0,013	0,002

Table 4 shows that the levels of Se, Pb, and Zn in well water sample A are <0.002 each; <0.013; and <0.002mg/L while the levels of Se, Pb, and Zn levels in well B water samples were <0.002 each; <0.013; and 0.002 mg/L. These results provide scientific evidence that for the chemical parameters of Se, Pb, and Zn, both well water samples A and B still meet the quality standards for water media for sanitary hygiene purposes.

The methods that are widely developed by researchers as an effort to reduce Pb levels in aquatic samples include the use of water plants (*Ipomoea aquatica)* (Hapsari et al., 2018) and water jasmine plants (*Echinodorus palaefolius*) (Caroline & Moa, 2015) as phytoremediation Pb as well as adsorbent genjer plant (*Limnocharis flava* (L.)Buch.) (Haryati et al., 2012), activated charcoal adsorbent from banana peel, aquatic plants, rice husk charcoal, biomass (Rahmi & Sajidah, 2018) and quail eggshell adsorbent (Moelyaningrum, 2020). On the other hand, methods that are widely developed by researchers to reduce Zn levels in aquatic samples include the use of silver chitosan adsorbents (Agusnar & Hannani, 2018), CuO composite adsorbent (Khairuni et al., 2017), and banana peel waste biosorbents (*Musa acuminate*) (Fatmi & Putra, 2018).

4. CONCLUSION

Well water around Taman District, Sidoarjo Regency has Se, Pb, and Zn levels in the sample of <0.002 each; <0.013; and <0.002mg/L (well water A) and <0.002; <0.013; and 0.002 mg/L (well water B). The Se, Pb, and Zn levels still meet the quality standards (maximum content) of chemical parameters.

REFERENCES

Agusnar, H., & Hannani, N. (2018). PEMBUATAN KITOSAN PERAK SEBAGAI ADSORBEN UNTUK MENURUNKAN KADAR LOGAM BESI (Fe) DAN ZINK (Zn) PADA AIR SUNGAI DESA KOPAS KECAMATAN SIMPANG EMPAT KABUPATEN ASAHAN. *ABDIMAS TALENTA: Jurnal Pengabdian Kepada Masyarakat*, *3*(2), 383–392.

Blesstinov, A. G., Maddusa, S. S., & Joseph, W. B. S. (2017). Analisis kandungan seng (zn) dalam air, sedimen kerang dan ikan di sungai tondano tahun 2017. *KESMAS: Jurnal Kesehatan Masyarakat Universitas Sam Ratulangi*, *6*(3).

BSN. (1991). *SNI 06-2475-1991 tentang Air, Metode pengujian kadar selenium dengan alat spektrofotometer serapan atom tungku karbon*.

BSN. (2009a). *SNI 6989.7:2009 tentang Air dan air limbah – Bagian 7: Cara uji seng (Zn) secara Spektrofotometri Serapan Atom (SSA) – nyala*.

BSN. (2009b). *SNI 6989.8:2009 tentang Air dan air limbah – Bagian 8: Cara uji timbal (Pb) secara Spektrofotometri Serapan Atom (SSA) – nyala*.

Caroline, J., & Moa, G. A. (2015). Fitoremediasi logam timbal (Pb) menggunakan tanaman melati air (Echinodorus palaefolius) pada limbah industri peleburan tembaga dan kuningan. *Seminar Nasional Sains Dan Teknologi Terapan III*, 733–744.

Dewa, R. P. (2015). Analisa Kandungan Timbal (Pb) dan Kadmium (Cd) Pada Air Minum Dalam Kemasan Di Kota Ambon. *Majalah Biam*, *11*(2), 76–82.

El-Sawy, M. A., Mohamedein, L. I., & El-Moselhy, K. M. (2023). Evaluation of arsenic, selenium, tin, and mercury in water and sediments of Bitter Lakes, Suez Canal, Egypt. *The Egyptian Journal of Aquatic Research*. https://doi.org/https://doi.org/10.1016/j.ejar.2023.02.002

Fatmi, D., & Putra, B. H. (2018). Studi efektifitas limbah kulit pisang (Musa acuminate) sebagai biosorben logam berat seng (Zn). *Menara Ilmu*, *12*(9).

Gad, S. C., & Pham, T. (2014). *Selenium* (P. B. T.-E. of T. (Third E. Wexler (ed.); pp. 232–235). Academic Press. https://doi.org/https://doi.org/10.1016/B978-0-12-386454-3.00926-X

Handriyani, K. A. T. S., Habibah, N., & Dhyanaputri, I. G. A. S. (2020). Analisis Kadar Timbal (Pb) Pada Air Sumur Gali Di Kawasan Tempat Pembuangan Akhir Sampah Banjar Suwung Batan Kendal Denpasar Selatan. *JST (Jurnal Sains Dan Teknologi)*, *9*(1), 68–75.

Hapsari, J. E., Amri, C., & Suyanto, A. (2018). Efektivitas kangkung air (Ipomoea aquatica) sebagai fitoremediasi dalam menurunkan kadar timbal (Pb) air limbah batik. *Sanitasi: Jurnal Kesehatan Lingkungan*, *9*(4), 172–177.

Haryati, M., Purnomo, T., & Kuntjoro, S. (2012). Kemampuan tanaman genjer (Limnocharis Flava (L.) Buch.) menyerap logam berat timbal (Pb) limbah cair kertas pada biomassa dan waktu pemaparan yang berbeda. *Lateral Bio*, *1*(3).

Irawan, B., Amin, B., & Thamrin, T. (2015). Analisis Kandungan Logam berat Cu, Pb dan Zn pada Air, Sedimen dan Bivalvia di perairan Pantai Utara Pulau Bengkalis. *Dinamika Lingkungan Indonesia*, *2*(1), 40–51.

Jannah, Z. N., Herawati, D., & Ngibad, K. (2021). REVIEW: Analisis Konsentrasi Ion Sulfat dalam Air Menggunakan Spektrofotometri. *Jurnal Pijar Mipa*, *16*(2), 203–206. https://doi.org/10.29303/jpm.v16i2.1907

Kementerian Kesehatan RI. (2017). *PERATURAN MENTERI KESEHATAN REPUBLIK INDONESIA*

NOMOR 32 TAHUN 2017 TENTANG Standar Baku Mutu Kesehatan Lingkungan dan Persyaratan Kesehatan Air Untuk Keperluan Higiene Sanitasi, Kolam Renang, Solus Per Aqua, dan Pemandian Umum.

Khaira, K. (2016). Analisis kadar Tembaga (Cu) dan Seng (Zn) dalam air minum isi ulang kemasan galon di kecamatan Lima Kaum kabupaten Tanah Datar. *Sainstek: Jurnal Sains Dan Teknologi*, *6*(2), 116–123.

Khairuni, M., Alfian, Z., & Agusnar, H. (2017). Studi Penggunaan Kitosan Komposit CuO Sebagai Adsorben Untuk Menyerap Logam Besi (Fe) Mangan (Mn) Dan Seng (Zn) Pada Air Sungai Belawan. *Jurnal Kimia Mulawarman*, *14*(2), 115–119.

Kusumayanti, S., & Hariyanto, B. (2019). Studi Kimia Air Tanah Dangkal Di Kelurahan Taman Kecamatan Taman Kabupaten Sidoarjo. *Swara Bhumi*, *1*(3).

Moelyaningrum, A. D. (2020). Pemanfaatan Cangkang Telur Puyuh Sebagai Pengikat Logam Berat Timbal (Pb) dalam Air. *Jurnal Kesehatan*, *13*(2), 96–101.

Ngibad, K., & Herawati, D. (2019). ANALISIS KADAR KLORIDA DALAM AIR SUMUR DAN PDAM DI DESA NGELOM SIDOARJO. *JKPK (JURNAL KIMIA DAN PENDIDIKAN KIMIA*, *4*(1), 1–6.

Pettine, M., McDonald, T. J., Sohn, M., Anquandah, G. A. K., Zboril, R., & Sharma, V. K. (2015). A critical review of selenium analysis in natural water samples. *Trends in Environmental Analytical Chemistry*, *5*, 1–7. https://doi.org/https://doi.org/10.1016/j.teac.2015.01.001

Putri, Y. P., Fitriyanti, R., & Emilia, I. (2019). Analisis Kandungan Logam Berat Timbal (Pb) di Perairan Sungsang Kabupaten Banyuasin Provinsi Sumatera Selatan. *Prosiding Seminar Nasional Peran Sektor Industri Dalam Percepatan Dan Pemulihan Ekonomi Nasional*, *2*(2), 1–6.

Rahmi, R., & Sajidah, S. (2018). Pemanfaatan Adsorben Alami (Biosorben) Untuk Mengurangi Kadar Timbal (Pb) Dalam Limbah Cair. *Prosiding Seminar Nasional Biotik*, *5*(1).

Retyoadhi, A. Y., Susanto, T., & Martati, E. (2005). KAJIAN CEMARAN LOGAM TIMBAL (PB), TOTAL MIKROBIA DAN E. Coli PADA KERANG DARAH (Anadara granosa Linn) SEGAR DI KABUPATEN SIDOARJO. *Jurnal Teknologi Pertanian*, *6*(3).

Supriyantini, E., Sedjati, S., & Nurfadhli, Z. (2016). Akumulasi logam berat Zn (seng) pada lamun Enhalus acoroides dan Thalassia hemprichii di Perairan Pantai Kartini Jepara. *Buletin Oseanografi Marina*, *5*(1), 14–20.

Susilowati, P. E. (2021). Studi Bioakumulasi Logam Crom (Cr), Seng (Zn) dan Nikel (Ni) pada Tanaman Obat Binahong (Anredera cordifolia (Ten) Steenis.). *Akta Kimia Indonesia*, *6*(1), 12–27.

Triarini, L. J., Amalia, L. R., Damayanti, N. K., & Ngibad, K. (2021). Analisis Kadar COD Pada Air Sumur Desa Ngelom Sepanjang Menggunakan Metode Titrimetri. *Universitas Maarif Hasyim Latif*, *7*, 914–918.

Zulfiah, A., Seniwati, S., & Sukmawati, S. (2017). Analisis Kadar Timbal (Pb), Seng (Zn) Dan Tembaga (Cu) Pada Ikan Bandeng (Chanos Chanos Forsk.) Yang Berasal Dari Labbakkang Kab. Pangkep Secara Spektrofotometri Serapan Atom (SSA). *As-Syifaa Jurnal Farmasi*, *9*(1), 85–91.