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Analysis Of Cadmium (Cd) And Lead (Pb) Levels In Water Samples By Atomic Absorption Spectrophotometry (AAS) At The Lampung Health Laboratory Center

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Abstract:
Background. For sanitary hygiene, water is used for maintaining personal hygiene, such as bathing and brushing, as well as for food washing, dishwashing, and laundry in daily life, so its quality differs from that of drinking water. This study focuses on heavy metal pollution, particularly lead (Pb) and cadmium (Cd), which are known toxic substances harmful to living organisms.
Aims. Its purpose is to determine the levels of cadmium and lead in water samples by atomic absorption spectrophotometry at the Lampung Health Laboratory Center, conducted in December 2024-January 2025. T
Methods. The method refers to SNI No. 6989.84 of 2019 for 78 samples of sanitary hygiene water by Atomic Absorption Spectrophotometry (SSA). Cadmium (Cd) analysis of 37 samples: 21 were positive for Cd, but none exceeded the threshold limit value of 0.003 mg/L.
Conclusion. Meanwhile, the results of the lead (Pb) analysis showed that 1 of 37 samples did not exceed the threshold limit value of 0.01 mg/L, as stipulated in the Indonesian Minister of Health Regulation No. 2 of 2023.

Keywords: atomic absorption spectrophotometry, cadmium, heavy metals, lead, sanitary hygiene

INTRODUCTION

As the human population grows and activity increases, not all communities have access to clean water in their daily lives. People in rural areas use groundwater and river water for drinking and household use, even though the water is not necessarily suitable for consumption (Rohmawati & Kustomo, 2020). Clean water can be used in a variety of daily activities. The availability of high-quality, clean water can help meet people's needs, especially in maintaining health and improving welfare (Kaihena *et al*., 2024).

Atomic Absorption Spectrometry (AAS) or *Atomic Absorption Spectroscopy* (AAS) is an instrument used to measure the concentration of metal elements, based on absorption by free atoms. The basic principles of Atomic Absorption Spectrophotometry are the interaction between electromagnetic radiation and samples. Atomic Absorption Spectrophotometry operates by evaporating the sample solution, thereby converting the contained metals into free atoms. Atoms absorb radiation from light sources emitted by cathode lamps (Hollow Cathode Lamp) that contain elements and can be measured (Sugito, 2022)

Lead (Pb) is a type of heavy metal that has a relatively low melting point, is easy to form, and is widely used as a metal coating to protect against rusting. Lead and other heavy metals are class B metal ions with significant toxic potential. The toxic effects of lead metal can interfere with the formation of hemoglobin, damage the nervous, urinary, reproductive, and cardiovascular systems, and cause kidney damage (Saputri & Lidia, 2024).

Cadmium (Cd) is a dangerous type of heavy metal that is toxic even in low levels and is *non-degradable* or insoluble by living organisms. This heavy metal can also contaminate groundwater and water, via drinking water through the penetration of industrial wastewater containing cadmium into the water distribution (Pulungan & Wahyuni, 2021). Cadmium is used in a variety of industrial applications, including electrolysis, paint pigments, enamels, and plastics. Based on its physical properties, cadmium metal is soft and malleable, but it loses its luster when exposed to humid or wet air (Benavides *et al*., 2021).

Research on heavy metal pollution of Cd and Pb in water has been widely conducted because these two metals are toxic, bioaccumulative, and have a profound impact on human health. Previous studies in Indonesia have generally focused on:

1. Analysis of Cd and Pb content in drinking water or river water using the Atomic Absorption Spectrophotometry (SSA/AAS) method as the standard method due to its high sensitivity and accuracy.
2. Comparison of test results with national quality standards, such as Permenkes or SNI, to assess the feasibility of water for consumption or domestic needs.
3. A location-specific approach, such as rivers, refillable drinking water depots, or areas around industrial and urban activities.

However, most previous studies:

1. Emphasizing drinking water or water in the open environment (rivers, lakes),
2. Using a limited number of samples,

3. It is rare to place research results in the context of regional health laboratory services that function as a reference for water quality monitoring.

This article expands the study by making sanitary-hygiene water the primary focus, which has so far received relatively little attention compared to drinking water.

LITERATURE REVIEW

Based on the review of articles and similar research, the following research gaps were found :

1. Limitations of heavy metal studies on sanitation–hygiene water. Most studies focus on drinking water, while sanitary–hygienic water (bathing, washing, etc.) used daily can also potentially be a source of chronic exposure to Cd and Pb.
2. The lack of data from regional health laboratories. Empirical data from the UPTD Provincial Health Laboratory is still rarely published, even though this institution has a strategic role in monitoring environmental quality.
3. Lack of evaluation of compliance with the latest regulations. Many studies still refer to the old regulations. At the same time, this article relies on the Minister of Health Regulation No. 2 of 2023, leaving gaps in policy updates that have not been widely studied.
4. There have not been many studies with a relatively large and diverse sample size. Analysis of 78 samples (Cd and Pb) provides a more representative picture than the dominant small-scale studies.

The main novelties of this article can be formulated as follows:

1. Focus on sanitary–hygienic water, not just drinking water. This article highlights the types of water that are often overlooked but used intensively in daily activities and have the potential to pose long-term health risks.
2. The use of routine data from regional health laboratories as scientific data. This study elevates the data from testing results at the Lampung Provincial Health Laboratory into an academic contribution, bridging health service practice with scientific research.
3. The use of the latest regulations as a reference for water quality evaluation. The evaluation of Cd and Pb levels is in accordance with the Indonesian Minister of Health Regulation No. 2 of 2023, ensuring the research results are relevant to policy and practice.
4. A comprehensive approach through laboratory quality control. The application of quality control measures, such as linear regression ($r \geq 0.995$), blanks, duplicates, and RPD, strengthens the validity of the results, which have not always been reported in detail in similar studies.

METHOD

Tools used in conducting the test: SSA carbon furnace, measuring cup 20 mL; and 100 mL, drip pipettes, hyacinth pipettes, 1 mL micropipettes; 5 mL; 10 mL; and 20 mL, whatman 0.45 µm sieve, funnel, erlenmeyer, flask measuring 100 mL; and 1000 mL, 10 mL volumetric pipettes; and 100 mL, 20 mL test tube, 150 mL glass beaker; and 500 mL, hotplate, and acid cabinet.

Materials used in conducting the test: Aquadest, HNO3, nitric acid, diluting solution, standard solution Cd 0.01 ppm; 0.05 ppm; 0.1 ppm; 0.5 ppm; and 1.0 ppm, standard Pb solution 0.05 ppm; 0.1 ppm; 0.5 ppm; 1 ppm; and 1.5 ppm.

Manufacture of the diluent solution starts by preparing a 1000 mL measuring flask and a funnel. The measuring gourd is then aquadest to half its volume. 1.5 mL of HNO3 solution was added using a volumetric/measuring pipette in an acid cabinet, then homogenized. The final step was to add Aquadest to the tera limit, and homogenization was repeated.

Manufacture of cadmium and lead standard solutions involves preparing the standard solution by pipetting 10 mL of a 100 ppm solution using a water hyacinth pipette. The solution is put in a 100 mL measuring flask. A diluent solution is added to the impression limit, and the mixture is homogenized. Cadmium solutions with concentrations of 0.01 ppm, 0.05 ppm, 0.1 ppm, 0.5 ppm, and one ppm, while lead solutions at concentrations of 0.05 ppm, 0.1 ppm, 0.5 16 ppm, one ppm, and 1.5 ppm were pipetted and put into a separate 100 mL measuring flask. Each such solution is added to the teras limit with a diluent solution and homogenized. Standard solutions of cadmium with different concentrations are ready for use.

Preparation of total metal test samples (Destruction with HNO3) involves preparing the water sample for testing by adding 100 mL of the water sample to a 250 mL Erlenmeyer flask using a measuring cup. Next, 5 mL of HNO3 nitric acid was added to the Erlenmeyer using a volumetric pipette inside the acid cabinet. The mixture is heated on a hot plate with a funnel lid until the solution volume is reduced to 10-20 mL. Once the heating process is complete and the mixture has cooled, the solution is filtered using a 0.45 µm Whatman sieve into a 100 mL measuring flask. A diluent solution is added to the tera limit, then the mixture is homogenized. Thus, the water samples are ready for further testing.

Preparation of dissolved-metal test samples (Destruction with HNO3) involves preparing the water sample for testing, which begins by adding 100 mL of the water sample to a 250 mL Erlenmeyer flask using a measuring cup. Then, 5 mL of HNO3 nitric acid was added to the Erlenmeyer using a volumetric pipette inside the acid cabinet. The mixture is filtered using a 0.45 μm Whatman sieve into a 100 mL measuring flask. After filtering, a diluent solution is added to the impression limit, and homogenization is performed. Thus, the water samples are ready for further testing.

Creation of Calibration Curves is the process of analyzing cadmium and lead using Atomic Absorption Spectrophotometry (AAS), which begins with inserting a blank solution into the AAS apparatus. The purpose of this step is to ensure that the concentration of the tested metals is negative so that it can be used as a reference for subsequent measurements. After that, the blank solution is fed into the SSA apparatus one by one, and the absorption of these metals is measured at specific wavelengths: 228.8 nm for cadmium and 217.0 nm for lead. Rinsing is performed on the aspirator hose using a diluent solution to ensure that the SSA appliance remains clean and ready for the subsequent measurement. The results of the analysis were then obtained using calibration curves and straight-line determination. Calibration curves are used to determine the relationship between metal concentrations and measured absorbance, while straight-line calibration is used to ensure that analysis results are accurate and reliable. However, if the linear regression coefficient (r) is less than 0.995, the analysis should be repeated, and the SSA tool's condition should be re-examined. This is done to ensure the analysis results are accurate and reliable, and to minimize errors that can occur during the analysis.

Quantitative Analysis of Cadmium Metal Levels with SSA begins with preparing the calibration curve for cadmium analysis. It begins by preparing a standard solution of cadmium at different concentrations: 0.01 ppm, 0.05 ppm, 0.1 ppm, 0.5 ppm, and 1.0 ppm. These standard solutions are then fed into the autosampler tube. Furthermore, the standard solutions were measured using SSA at 228.8 nm. The absorbance measurements for the standard solution are then recorded and used to create a calibration curve. Once the calibration curve for the cadmium analysis test has been prepared, the next step is to measure the test sample using SSA at 228.8 nm. After the measurement is complete, the absorbance of the test sample is recorded.

Quantitative Analysis of Lead Metal Levels with SSA is preceded by measurement of the Standard Solution of Lead. The calibration curve for cadmium analysis begins with preparing a standard solution of cadmium at different concentrations: 0.05 ppm, 0.1 ppm, 0.5 ppm, 1.0 ppm, and 1.5 ppm. These standard solutions are then fed into the autosampler tube. The standard solutions were measured using SSA at 217.0 nm. The absorbance measurements for the standard solution are then recorded and used to create a calibration curve. In the sample after the cadmium analysis test, a calibration curve has been prepared. The next step is to measure the test sample using SSA at a wavelength of 217.0 nm. After the measurement is complete, the absorbance of the test sample is recorded.

To ensure test results are accurate, quality control is carried out. This test is carried out within a time period that does not exceed the sample's maximum storage limit. The quality control procedure includes two stages: calculating the linear regression correlation coefficient (r) with a minimum value of ≥ 0.995, and ensuring the intercept is < the detection limit. Blank analysis is carried out at a frequency of 5%-10% per batch, or at least once for test samples less than 10, as a contamination control. Duplex analysis was performed with the same frequency as the control. If the Relative Percent Difference (RPD) value ≥ 10%, then a third measurement is taken to ensure the accuracy of the test results:

$$\text{Persen } RPD = \left| \frac{(\text{Measurements results} - \text{duplicate measurements})}{(\text{Measurements results} - \text{duplicate measurements})/2} \times 100\% \right|$$

If the measurement results and duplicate measurements are below the Method Detection Limit (MDL), the % RPD is calculated using the Laboratory Fortified Matrix Duplicate (LFMD), a duplicate of the spike matrix. Accuracy control is carried out using a spike matrix or one of the working standards, with a frequency of 5% or 10% per batch, or at least once for test samples less than 10. The percent of feedback for the spike matrix should be in the range of 85%-115%, while for standard work, in the range of 90%-110 %. The above method refers to SNI No.6989.84 of 2019.

DISCUSSION

Table

Examination of water samples at the UPTD of the Lampung Provincial Health Laboratory in 2024-2025 showed as many as 37 samples of cadmium-contaminated water (Table 1) and 37 samples of lead-contaminated water (Table 2).

Tabel 1. Data from the examination of Cadmium metal content in water samples using the SSA method

No	Sample Code	Deuteronomy	Absorbance	Conc mg/L	Total
1.	9787	1	0.0018	0.0049	0.05015
	9787.2	2	0.0016	0.0023	
No	**Sample Code**	**Deuteronomy**	**Absorbance**	**Conc mg/L**	**Total**

No	Sample Code	Deuteronomy	Absorbance	Conc mg/L	Total
2.	9788	1	0.0014	0.0015	0.0154
	9788.2	2	0.0014	0.0008	
3.	9807	1	0,0011	0,0021	0.0025
	9807.2	2	0.0012	0.0008	
4.	0015	1	0.0010	0.0026	0.0025
	0015.2	2	0.0013	0.0002	
5.	9804	1	0.0018	0.0021	0.001
	9804.2	2	0.0016	0.0001	
6.	9805	1	0.0016	0.0002	0.0005
	9805.2	2	0.0016	0.0008	
7.	A.1	1	0.0029	0.0204	0.018
	A.2	2	0.0024	0.0156	
8.	AM 1	1	0.0049	0.0460	0.0479
	AM 2	2	0.0043	0.0498	
9.	AH 1	1	0.0022	0.0927	0.0923
	AH 2	2	0.0021	0.0919	
10.	AL 1	1	0.0316	0.1278	0.1295
	AL 2	2	0.0321	0.1312	
11.	3527	1	0.0013	0.0004	0.00375
	3527.2	2	0.0002	0.0071	
12.	3604	1	0.0003	0.0064	0.00695
	3604.2	2	0.0001	0.0075	
13.	3605	1	0.0001	0.0078	0.00815
	3605.2	2	0.0001	0.0085	
14.	3793	1	0.0001	0.0078	0.009
	3793.2	2	0.0004	0.0102	
15.	4265	1	0.0013	0.0085	0.00795
	4265.2	2	0.0011	0.0074	
16.	4266	1	0.0012	0.0076	0.0067
	4266.2	2	0.0008	0.0058	
17.	4267	1	0.0009	0.0062	0.00675
	4267.2	2	0.0011	0.0073	
18.	2.1	1	0.0002	0.0054	0.0085
	2.2	2	0.0008	0.0116	
No	**Sample Code**	**Deuteronomy**	**Absorbance**	**Conc mg/L**	**Total**

19.	1.1	1	0.0007	0.0108	0.01055
	1.2	2	0.0007	0.0103	
20.	4583	1	0.0024	0.0037	0.0022
	4583.2	2	0.0021	0.0007	
21.	5397	1	0.0021	0.0041	0.0016
	5397.2	2	0.0016	0.0009	
22.	5184	1	0.0025	0.0046	0.00265
	5184.2	2	0.0021	0.0007	
23.	8465	1	0.0019	0.0058	0.0073
	8465.2	2	0.0022	0.0088	
24.	8490	1	0.0020	0.0076	0.006
	8490.2	2	0.0017	0.0044	
25.	8489	1	0.0018	0.0054	0.006
	8489.2	2	0.0019	0.0066	
26.	8502	1	0.0021	0.0079	0.00665
	8502.2	2	0.0018	0.0054	
27.	8510	1	0.0021	0.0081	0.00805
	8510.2	2	0.0021	0.0080	
28.	8511	1	0.0023	0.0108	0.0108
	8511.2	2	0.0023	0.0108	
29.	8512	1	0.0025	0.0125	0.006725
	8512.2	2	0.0025	0.0122	
30.	8465	1	0.0008	0.0052	0.005
	8465.2	2	0.0008	0.0048	
31.	9278	1	0.0009	0.0059	0.00465
	9278.2	2	0.0006	0.0034	
32.	9376	1	0.0003	0.0000	0.0021
	9376.2	2	0.0007	0.0042	
33.	9230	1	0.0023	0.0041	0.0078
	9230.2	2	0.0022	0.0037	
34.	9279	1	0.0014	0.0037	0.0047
	9279.2	2	0.0016	0.0057	
35.	7046	1	0.0005	0.0059	0.00505
	7046.2	2	0.0003	0.0042	
No	**Sample Code**	**Deuteronomy**	**Absorbance**	**Conc mg/L**	**Total**

36.	7521	1	0.0003	0.0043	0.0056
	7521.2	2	0.0006	0.0069	
37.	6732	1	0.0008	0.0059	0.00345
	6732.2	2	0.0003	0.0010	

Table 2. Data from the examination of Lead metal (Pb) content in water samples using the SSA method

No	Sample Code	Deuteronomy	Absorbance	Conc mg/L	Total
1.	0020	1	0.0034	0.0509	0.04775
	0020.2	2	0.0036	0.0446	
2.	0021	1	0.0025	0.0924	0.0969
	0021.2	2	0.0023	0.1014	
3.	9787	1	0.0020	0.0364	0.0685
	9787.2	2	0.0014	0.0639	
4.	9788	1	0.0007	0.0951	0.1522
	9788.2	2	0.0003	0.1142	
5.	9807	1	0.0003	0.1415	0.2168
	9807.2	2	0.0005	0.1506	
6.	0015	1	0.0010	0.1739	0.18349
	0015.2	2	0.0014	0.1918	
7.	0508	1	0.0006	0.02161	0.01891
	0508.2	2	0.0007	0.01621	
8.	0705	1	0.0011	0.05402	0.02701
	0705.2	2	0.0011	0.05402	
9.	1.1	1	0.0007	0.0403	0.0039
	1.2	2	0.0007	0.0395	
10.	2.1	1	0.0005	0.0245	0.0385
	2.2	2	0.0009	0.0525	
11.	3.1	1	0.0004	0.0208	0.01105
	3.2	2	0.0352	0.0013	
12.	0196	1	0.0012	0.0611	0.0637
	0196.2	2	0.0013	0.0663	
No	**Sample Code**	**Deuteronomy**	**Absorbance**	**Conc mg/L**	**Total**

13.	0197	1	0.0012	0.062	0.0627
	0197.2	2	0.0013	0.0634	
14.	0198	1	0.0013	0.0666	0.07305
	0198.2	2	0.0016	0.0795	
15.	0199	1	0.0014	0.0688	0.0733
	0199	2	0.0015	0.0778	
16.	1754	1	0.0006	0.0183	0.01835
	1754.2	2	0.0006	0.0184	
17.	1829	1	0.0007	0.0148	0.01885
	1829.2	2	0.0005	0.0229	
18.	1830	1	0.0005	0.0233	0.02255
	1830.2	2	0.0005	0.0218	
19.	3.1	1	0.0003	0.0170	0.01005
	3.2	2	0.0001	0.00031	
20.	4.1	1	0.0005	0.0227	0.0165
	4.2	2	0.0003	0.0103	
21.	5.1	1	0.0005	0.0209	0.01965
	5.2	2	0.0004	0.0184	
22.	6.1	1	0.0006	0.0292	0.02545
	6.2	2	0.0005	0.0217	
23.	7.1	1	0.0004	0.0150	0.01585
	7.2	2	0.0004	0.0167	
24.	8.1	1	0.0005	0.0227	0.0208
	8.2	2	0.0004	0.0189	
25.	1245	1	0.0011	0.0540	0.05595
	1245.2	2	0.0012	0.0615	
26.	1246	1	0.0011	0.0559	0.06
	1246.2	2	0.0013	0.0641	
27.	0169	1	0.0013	0.0667	0.06675
	0169.2	2	0.0013	0.0668	
28.	0170	1	0.0010	0.0478	0.0504
	0170.2	2	0.0013	0.0670	
29.	1295	1	0.0012	0.0590	0.06305
	1295.2	2	0.0013	0.0671	
No	**Sample Code**	**Deuteronomy**	**Absorbance**	**Conc mg/L**	**Total**

30.	0195	1	0.0012	0.0609	0.06775
	0195.2	2	0.0015	0.0746	
31.	0196	1	0.0012	0.0611	0.0637
	0196.2	2	0.0013	0.0663	
32.	0197	1	0.0012	0.0623	0.06285
	0197.2	2	0.0013	0.0634	
33.	0198	1	0.0013	0.0666	0.07305
	0198.2	2	0.0016	0.0795	
34.	0199	1	0.0014	0.0688	0.0733
	0199.2	2	0.0016	0.0778	
35.	9600	1	0.0001	0.0128	0.0226
	9600.2	2	0.0004	0.0324	
36.	9601	1	0.0002	0.0269	0.04095
	9601.2	2	0.0009	0.0550	
37.	9279	1	0.0009	0.0558	0.05835
	9279.2	2	0.0010	0.0609	

Source: Research Data

The cadmium levels in water samples showed that from 37 samples, there were 21 samples of sanitary hygiene water and drinking water with dissolved cadmium levels that did not exceed the threshold limit value, in samples 9787.2 (0.0023 mg/L), 9788/FR (0.0015 mg/L), 9788.2 (0.0008 mg/L), 9807/FR (0.0021), 9807.2 (0.0008 mg/L), 0015/FR (0.0026 mg/L), 0015.2 (0.0002 mg/L), 9804/FR (0.0021 mg/L), 9804.2 (0.0001 mg/L), 9805/FR (0.0002 mg/L), 9805.2 (0.0008 mg/L), 3527/FR (0.0004 mg/L), 4583/AR (0.0037 mg/L), 4853.2 (0.0007 mg/L), 5397.2 (0.0009 mg/L), 5184.2 (0.0007 mg/L), 9278.2 (0.0034 mg/L), 9376 (0.0000 mg/L), 9230.2 (0.0037 mg/L), 9279 (0.0037 mg/L), dan 6732.2 (0.0010 mg/L).

This refers to the Indonesian Minister of Health Regulation No. 2 of 2023 concerning the sanitary hygiene water threshold limit value, which is 0.003 mg/L. Water containing heavy metals, specifically cadmium, with a threshold limit value that exceeds it can interfere with human health, such as causing disorders in the respiratory system, damage to the function of the liver and kidneys, bleeding, and disturbances to bone growth that cause bone fragility. Cadmium metal poisoning can also lead to acute pneumonia.

Acute lung disease can occur if the patient is exposed to cadmium vapor within 24 hours (Rosita & Andriyati, 2019).

The results of the lead (Pb) level examination of the water sample showed that, out of 37 samples, 1 sanitary hygiene water sample did not exceed the threshold limit value, namely sample 3.2 (0.0013 mg/L). This refers to the Indonesian Minister of Health Regulation No. 2 of 2023 concerning the limit value of sanitary hygiene water, which is 0.01 mg/L. Water containing lead and other heavy metals with a threshold limit value that exceeds can interfere with human health, such as nervous system disorders, disorders of the blood-forming system, kidney disorders, heart disorders, and reproductive system disorders. Lead can also cause high blood pressure and anemia. Lead comes from lead-contaminated food, beverages, air, the general environment, and work environments. Lead is commonly used as a gasoline fuel mixture in improving lubrication power and combustion efficiency, so that the performance of motor vehicles is improved. This chemical is mixed with gasoline and burned in the engine, and the rest of the combustion is emitted as gas pollutants that pollute the air, which then falls into water, causing environmental pollution (Ardillah, 2016).

Efforts are made to minimize heavy metal pollution by building a Wastewater Treatment Plant (WWTP) in industrial areas. The purpose of wastewater treatment is to remove pollutants to predetermined limits. Heavy metals in water can be reduced through remediation using biofilters such as green mussels (Perna viridis), which are among the best biological indicators of pollutant accumulation (Azlee *et al*., 2014). In addition, efforts to reduce heavy metal concentrations in water can be achieved through natural processes, such as phytoremediation. Phytoremediation is the use of plants, including their parts, to decontaminate waste and address environmental pollution problems, both ex and in situ, in areas contaminated with waste. One biological agent with potential as a bioremediator is aquatic plants (Hidrawati *et al.*, 2023).

CONCLUSION

The levels of cadmium and lead in the analyzed water samples exceeded the threshold values. The analyzed water samples contained cadmium and lead. Atomic Absorption Spectrophotometry (AAS) is an effective and accurate method for determining the levels of cadmium and lead in water samples. This pollution has the potential to cause health problems for humans

IMPLICATION

Efforts are made to minimize heavy metal pollution by building a Wastewater Treatment Plant (WWTP) in industrial areas. The purpose of wastewater treatment is to remove pollutants to a predetermined limit. Heavy metals in water can be reduced through remediation using biofilters such as green mussels (Perna viridis), which are among the best biological indicators of pollutant accumulation (Azlee *et al.*, 2014). In addition, efforts to reduce heavy metal concentrations in water can be achieved through natural processes, such as phytoremediation. Phytoremediation is the use of plants, including their parts, for the decontamination of waste and environmental pollution problems, both ex and in situ, in areas contaminated with waste. One biological agent with potential as a bioremediator is aquatic plants (Hidrawati *et al.*, 2023).

The novelty of this research lies in the analysis of the heavy metal content of Cd and Pb in sanitary-hygiene water based on data from regional health laboratories with a relatively large number of samples and refers to the latest regulation of the Minister of Health of the Republic of Indonesia No. 2 of 2023, so as to make a scientific and practical contribution to water quality supervision and public health protection.

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