JPPIPA 9(Special Issue) (2023)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

Contamination of Mercury (Hg) and Lead (Pb) in Seawater and Sediments in Coastal waters of Ohoitel Village, Southeast Maluku District

Nadira Fakoubun[1*], Etty Riani[2], Majariana Krisanti[1]

[1]Post Graduate Students at the Department of Aquatic Resources Management, Faculty of Fisheries and Marine Science, IPB University, Bogor, Indonesia

[2] Department of Aquatic Resources Management, Faculty of Fisheries and Marine Science, IPB University, Bogor, Indonesia

Received: September 18, 2023
Revised: November 27, 2023
Accepted: December 25, 2023
Published: December 31, 2023

Corresponding Author:
Nadira Fakoubun
nadirafakoubunfakoubun@apps,ipb.ac.id

DOI: 10.29303/jppipa.v9iSpecialIssue.5357

Abstract: Along with the increasing population in the coastal area of Ohoitel Village, it triggers the level of community settlement with an increase in anthropogenic activities. This study aims to determine the concentration of heavy metal mercury (Hg) and lead (Pb) dissolved in water and accumulated in sediments. Measurement of heavy metal levels using *Atomic Absorption Spectrophometer* (AAS). The results of the analyis og Hg content obtained in seawater at station I was 0.00100 ± 0.00007 mg/l, station II was 0.00096 ± 0.00026 mg/l and station III was 0.00101 ± 0.000026 mg/l. The results of Hg levels obtained in sediment at station I amounted to 0.08557 ± 0.0003 mg/l, station II amounted to 0.07761 ± 0.0004 mg/l and station III amounted to 0.08733 ± 0.0004 mg/l. The results of the analysis of Pb content in seawater at station I was 0.00050 ± 0.000003 mg/l, station II was 0.000047 ± 0.000003 mg/l and station III was 0.000038 ± 0.000005 mg/l. Based on the results obtained, it shows that it is still below the quality standard threshold that refers to PP RI No 22 0f 2021 for water and ANZECC 2000 for heavy metal Hg in sediment and USEPA for heavy metal Pb in sediment.

Keywords: Heavy metal; Mercury; Lead; Seawater; Sediment; Ohoitel Village.

Introduction

Currently, technology is progressing very rapidly, but its development often puts presure on the environment, resulting in soil, water and air degradation that causes disruption of environmental functions (Riani *et al.* 2018). Generally, hazardous chemical pollutans that are often found in aquatic ecosystems are heavy metals. According to (Darmono 1995), metals are classified into two categories, namely heavy metals and light metals. Heavy metals are metals that weigh 5 grams or more for every cm^3. Heavy metals are one of the most dangerous water pollutant chemicals because they cannot be destroyed (*non degradable*) by living organism and accumulate in environment, especially settling at the bottom of the waters forming complex compounds with other organic and inorganic marerials by absorption and combination (Shen *et al.* 2020). With rapid economic development, heavy metals generated by industry, agriculture or human activities enter water bodies through surface runof, precipitation, atmosphere or direct discharge and then settle in water through sedimentation (Liu *et al.* 2022).

According to (Barone *et al.* 2022) heavy metals with their high potential toxity and long presence in nature, the possibility of bioaccumulation in living organism and bioaccumulation along the food chain. Heavy metal

How to Cite:
Fakoubun, N., Riani, E., & Krisanti, M. (2023). Contamination of Mercury (Hg) and Lead (Pb) in Seawater and Sediments in Coastal waters of Ohoitel Village, Southeast Maluku District. *Jurnal Penelitian Pendidikan IPA*, *9*(SpecialIssue), 872–877. https://doi.org/10.29303/jppipa.v9iSpecialIssue.5357

contamination in marine biota can also damage the biochemical system in the animal's body and if consumed by humans, it will pose a threat to health (Khan *et al*. 2009;Alisa *et al.* 2020). Metalic elements such as mercury (Hg) and lead (Pb) have been classified as toxic to humans by the world Healt Organization (WHO) and the United States Environmental Protection Agency (USEPA). Both of these metals are known to potentially effect marine ecosystems. Hg and Pb are often used in the textile, paint, pharmaceutical, chemical, pesticide, detergent, printing and waste industries from other human activities (Caroline *et al*. 2017;Fendjalang *et al* 2022). Given their presence in the environment, their persistence, their bioaccumulative properties and their high potential toxity (Aissioui *et al.* 2022).

Heavy metals are found in many waters, but unfortunately not all water bodies throughhout Indonesia have information on their heavy metal content. For example, the waters of Tual City which has high potential for fisheries resources, still has very little information. Therefore, it is necessary to conduct research to find out whether the waters of Tual City, especially the coastal waters of Ohoitel Village, which is a location where the aquatic ecosystem is still well preserved have been contaminated with heavy metals mercury (Hg) and lead (Pb) in seawater and sediments or not.

Method

This research was conducted in September 2022, in coastal waters of Ohoitel Village, Tual City, which consisted of three stations that had been determined by purposive sampling, namely station I at the *water intake* at the locations of sand sea cucumber (*Holothuria scabra*) cultivation, station II at the cultivator and station III in the local residential area (Figure 1). Analysis of heavy metal content of Hg and Pb in seawater and sediments samples was conducted at the Laboratory of PT. RND Teknologi Indonesia.

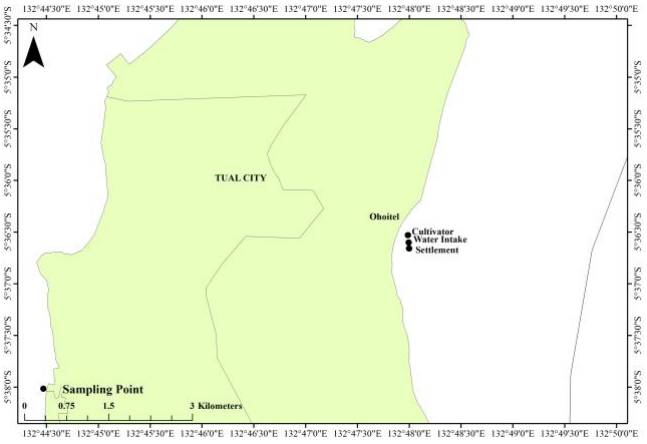

Figure 1. Research Location Map

Data Collection

Data collection obtained in this study consisted of primary and secondary data. Primary data were obtained from field observations and laboratory sample measurements. Measurements of Hg and Pb concentrations in seawater and sediments using the *Atomic Absorption Spectrophometer* (AAS) methods, then comparing the results obtained in seawater with reference to the quality standards set by PP RI No. 22 of 2021 which is intended for marine biota. Meanwhile, heavy metal Hg in sediments was compared with quality standards by the *Australian and New Zealand Environment and Conservation Council* (ANZECC) in 2000. Heavy metal Pb in sediments was compared with quality standards by the Swedish Environmental Protection Agency (SEPA) in 2000 and the *United States Environmental Protection Agency* (US-EPA) in 2004). Measurements of water quality parameters including temperature, salinity and pH values. Secondary data were obtained from reviewing literature journals and books related to study.

Data Collection Technique

Sampling was conducted at three predetermined stations. Determination of station point using the *Global Positioning system* (GPS) tool. Sampling time by following the condition of the seawater at low tide. Seawater samples were taken as much 150 ml at each observation station witht three repetitions. Then the sample is put into a sterelilized glass bottle, then given a 2 ml solution of nitric acid HNO_3 to preserve the sample. Then labeled and stored in coolbox to be taken to the laboratory for further analysis. Sediments samples were taken using an alumunium shovel with three repetitions, after which they were put into sterilized glass bottles. Then labeled and in a coolbox to be taken to the laboratory for further analysis.

Destruction Process of seawater and Sediments

Destruction of seawater samples refers to SNI 7387:2009 conducted by (Febriani 2022) namely, by taking a surface water sample of 50.0 ml, then putting it into a 100 ml glass cup. Then add 5.0 ml of concentrated HNO_3 and then closed using a watch glass. Then heat slowly until the remaining volume is 25.0 ml. If the decontruction is not perfect (not clear) then add another 5 ml of concentrated HNO_3 then cover with a watch glass and heat again. Transfer the sample into a 50.0 ml volumetric flask, filtered using whatman filter paper measuring 0.45 µm and add distilled water to the limit mark and then homogenized. Then measured using *Atomic Absorption Spectrophometer* (AAS) with a wavelength of 283.3 nm.

Destruction of sediments samples refers to SNI 4819:2013, namely as much as ± 2 gram of sediments samples dissolved with 5 ml of aqua regia and heated on a hotplate for 30 minutes. Then the solution was cooled and filtered using whatman filter paper measuring 0.45 µm. Then added 5 ml of HNO_3 and diluted with filtrate and distilled water in a 25 ml volumetric flask. Then measured using *Atomic Absorption Spectrophometer* (AAS) with a wavelength of 283.3 nm.

Data analysis

Analysis of the concentration levels of heavy metals Hg and Pb in seawater and sediments samples, calculated based on the concentration values displayed on the AAS device. Regression concentration were obtained based on calibration values. Elemental content was calculated using a formula based on (Supriatno and Lelifajri *et al.* 2009):

$$Heavy\ metals\ levels\ {}^{mg}/_{kg} = \frac{creg\ x\ p\ x\ v}{G} \quad (1)$$

Description:
Creg = Readable Concentration (mg/l)
P = Dilution factor
G = Sample weight (kg)
V = Volume of sample solution (L)

Result and Discussion

Water Quality Parameters

The results of the measurement of water quality parameters are presented in table 1 below. Stations I and II obtained walues with relatively the same temperature range of 32˚C. The results of salinity measurements at all stations, namely stations I, II and III obtained relatively the same value of 30 ppt. While the pH value obtained at stations I and II with the same range of 0,3 and at station III obtained a value of 8.8.

Tabel 1. Measurement Results of water Quality Parameters

Location	Temperatue (˚C)	Salinity (ppm)	pH
Stasiun I	30	32	8.3
Stasiun II	30	32	8.3
Stasiun III	30	30	8.8

Concentration of Heavy Metal Mercury (Hg) in Seawater

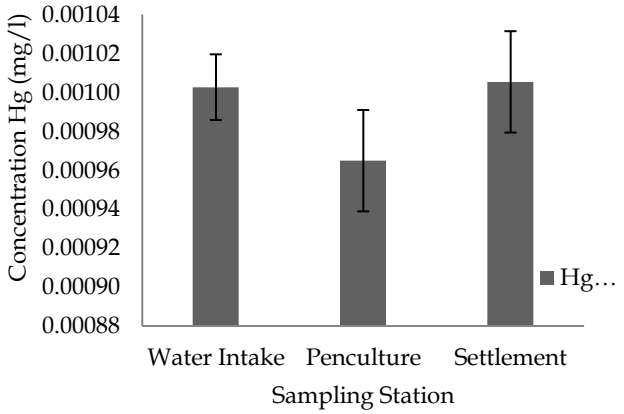

Figure 2. Result of Hg concentration (mg/l) in seawater

In figure 2, data on the concentration of heavy metal mercury (Hg) in seawater samples are presented in the form of mean and standard deviation. The results of heavy metal mercury concentration in seawater samples obtained at each observation station have varying values. Station I was obtained with a value range of 0.00100 ± 0.00007 mg/l, station II was obtained with a value range of 0.00096 ± 0.00026 and station III was obtained with a value range of 0.00101 ± 0.000026. It can be seen that the highest Hg heavy metal concentration value is found at station III which is not much different from the value obtained at station I and following by the lowest value found at station II. This is because station III is located in the location of local residents who have the opportunity to receive domestic waste disposal into the waters is quite large compared to other stations. According to (Chalkidis *et al*. 2020; Rasyadi 2023) traditional incandescent lam waste, various types of batteries, cosmetic and electronic equipment such as televisions and old computer monitors are houshold product that are known to

have mercury levels, although in relatively small amounts. It is said by (Afi 2005; Despri *et al*. 2022) that the high average concentration of dissloved organic matter at high tide is related to its proximity to settlements and industries.

Mercury enters the waters of Ohoitel Village Beach, Tual City throught the atmosphere, household waste and agriculture. From the result obtained, it shows that the concentration oh heavy metal mercury (Hg) found in seawater is still below the quality standard threshold set by PP RI No. 22 of 2021 for marine biota, which is 0.001 mg/l.

Concentration of Heavy Metal Mercury (Hg) in Sediments

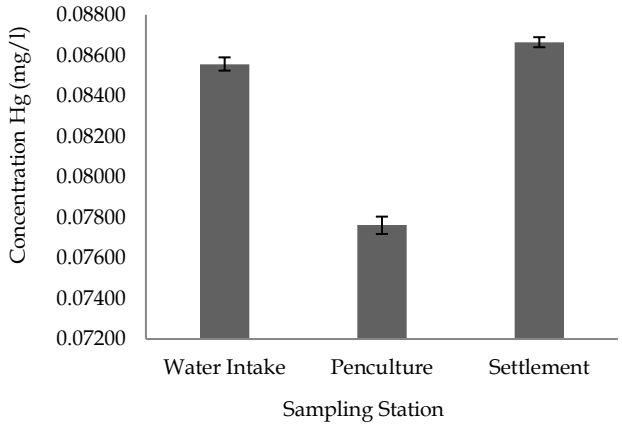

Figure 3. Result of Hg concentration in sediment

In figure 3, data on the concentration of heavy metal mercury (Hg) in sediments samples are presented in the form of mean values and standard deviations. The results of heavy metal Hg concentration in sediments samples obtained at each observation station have varying values. Station I was obtained with a value range of 0.08557 ± 0.0003 mg/l, station II was obtained with a value range of 0.07761 ± 0.0004 mg/l and station III was obtained with a value range of 0.08733 ± 0.0004 mg/l. It can be seen that the highest Hg heavy metal concentration value is found at station III which is not much different from the value obtained at station I and followed by the lowest value at station II.

This is because in addition to the presence of station III in the residential area of the local community, it is also caused by the texture of sediment. At station I has a type of sediment texture sand (coarse, fine grains) and a little muddy, station II also has type of sediments texture sand (coarse, fine grains) and a little muddy and station III has a type of sedimen texture sand (coarse, fine grains) and a lot of mund. According to (Kamaruzzaman *et al*. 2009; Septory *et al*. 2023) the smaller the size of the sediment fraction, the greater the accumulation of heavy metals in the sediment, which means that the finner the texture of the sediments, the higher its strength to bind heavy metals. This is reinforced by the statement from (Hasmalina *et al*. 2012) that fine sediments fractions are more likely to bind heavy metal mercury. From the result, it shows that the concentration of heavy metal mercury (Hg) found in sediments is still below the quality standard threshold referring to (ANZECC 2000) which is 150 mg/l.

Concentration of Heavy Metal Lead (Pb) in Seawater

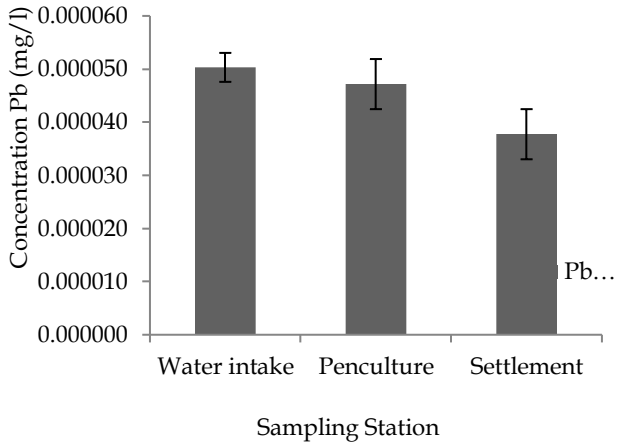

Figure 4. Result of Pb concentration in seawater

In figure 4, data on the concentration of heavy metal lead (Pb) in seawater samples are presented in the form of mean values and deviations. The results of heavy metal lead concentration in seawater samples at each observation station have varying values. Station I was obtained with a value range of 0.000050 ± 0.000003 mg/l, station II was obtained with a value range of 0.000047 ± 0.000003 mg/l and station III was obtained with a value range of 0.000038 ± 0.000005 mg/l. It can be seen that the highest Pb heavy metal concentration value is found at station I which is not much different from station II and followed by the lowest at station III. This is because station I is located at the water intake adjacent to the mainland (highway) where it has the potential to receive contamination by passing land transportation and sea transportation such as motorized boats on the move.

According to (Gusnita 2021; Mardina *et al.* 2023) that smoke from motor vehicles contributes about

75% in increasing Pb levels. Heavy metal lead can enter waters easly through several processes of precipitation, mining, erosion, dust fallout from the combustion of engines with lead content and industrial waste (Riani 2010a; Sitanggang 2023). Besides being sourced from human activities, the entry of heavy metals is also sourced naturally as natural cycles can transfer heavy metals from rocks to soil and living things then to water, then settle in sediments before returning to rocks (Yanuar and Isnawati 2023). From the result obtained, it shows that the concentration of heavy metal Pb in seawater samples is still below the quality standard threshold set by PP RI No. 22 of 2021 which is intended for marine biota is 0.008 mg/l.

Heavy Metal Concentration of Lead (Pb) in Sediments

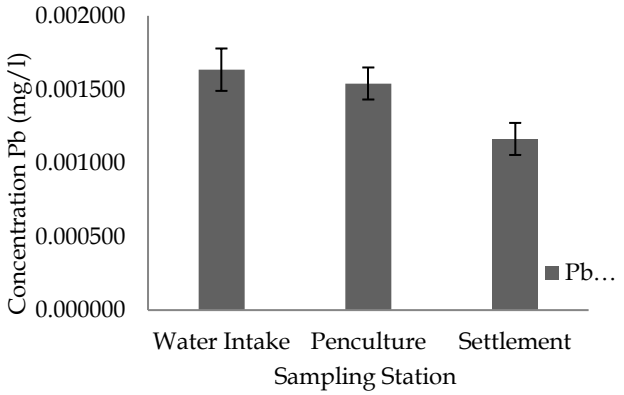

Figure 5. Result of Pb concentration in sediments

In figure 5, the results of heavy metal lead (Pb) concentration in sediments samples are presented in the form of mean values and standard deviations. The results of heavy metal concentrations of lead in sediment samples obtained at each observation station have varying values. Station I was obtained with a value range of 0.001634 ± 0.0001440 mg/l, station II was obtained with a value range of 0.001540 ± 0.0001089 mg/l and station III was obtained with a value range og 0.001163 ± 0.0001089 mg/l. It can be seen that the highest Pb heavy metal concentration value is found at station I which is not much different from station II and followed by the lowest value at station III. The high concentration of heavy metal Pb in the sediment at station I is not only due its proximity to the source of contamination, but also influenced by currents, up-welling and waves that cause heavy metals in sediement to be lifted. In addition it is also influenced by the pH of the water which is 8,3. The higher pH value, the higher concentration of heavy metals. The high pH value is influenced by the oxygen content derived from the photosyntesis pocess so that it can affect the pH value in a water body (Dewi *et al.* 2020). According to (Dewi *et al.* 2020) that if the degree of acidity (pH) in a body of water is high, the heavy metal content that settles on the sediment will also be higher. From the result obtained, it shows that the concentration of heavy metal Pb in sediments in the coastal waters of Ohoitel Village, Tual City is still below the quality standard threshold refering to (US-EPA) in 2004 wich states the highest limit of Pb in sediments is 49.98 mg/l

Conclusion

The coastal waters of Ohoitel Village, Southeast Maluku Regency, have been identified as contaminated with heavy metals mercury (Hg) and lead (Pb). These heavy metals have contaminated seawater and sediements with concentrations that are still below the established quality standard threshold. However, the presence of heavy metals mercury (Hg) and lead (Pb) in the coastal waters of Ohoitel Village, Southeast Maluku Regency must continue to be monitored and taken more seriously.

Acknowledgments
The authors would like to thanks the Operational Costs of State Universities (BOPTN) for funding research funds and all parties who helped in this research.

Author Contributions
Nadira Fakoubun conducted field data collection, data processing, analysis, drafting and writing design. Etty Riani who provided research funding and participated in collecting data in field, made adjusments to the gammatical writing structure and critical revisions to the intellectual content of important manuscripts. Majariana Krisanti provided guidance and input in the process of preparing the publication. All authors have read and approved the published version of the manuscript.

Funding
This research was funded by BOPTN, chaired by Prof. Dr. Ir. Etty Riani, MS with the title provision of "Pharmaceutical and Cosmetic Raw Materials Based on Sea Cucumber (Holothuria scabra) and its Conservation Efforts. LPPM IPB contact number. 3718/IT3.L1/PT.01.03/P/B/2022.

Conflicts of Interest
The author publishes this article for research and publication purposes. There are no conflicts or other interests in writing this article.

References

ANZECC. Autralian and New Zealand Environment and Conservation Council 2000. *Natl Water Qual Manag Strateg*. 54(2):117–128.

Aissioui S, Poirier L, Amara R, Ramdane Z. 2022. Concentrations of lead, cadmium and mercury in sardines, Sardina pilchardus (Walbaum, 1792) from the Algerian coast and health risks for consumers. *J Food Compos Anal*. 109 February:104490. doi:10.1016/j.jfca.2022.104490.

Alisa CAG, Albirqi P MS, Faizal I. 2020. Kandungan Timbal dan Kadmium pada Air dan Sedimen di Perairan Pulau Untung Jawa, Jakarta. *Akuatika Indones*. 5(1):21. doi:10.24198/jaki.v5i1.26523.

Barone G, Storelli A, Garofalo R, Mallamaci R, Storelli MM. 2022. Residual Levels of Mercury, Cadmium, Lead and Arsenic in Some Commercially Key Species from Italian Coasts (Adriatic Sea): Focus on Human Health. *Toxics*. 10(5). doi:10.3390/toxics10050223.

Darmono. 1995. Logam Dalam Sistem Biologi Makhluk Hidup. Penerbit Universitas Indonesia.

Despri Setya Rumoey, Nur Asia Umar H. 2022. *Pencemaran Logam Berat Pada Ekosistem Perairan*. Gowa-Sulawesi Selatan-Indonesia: Pustaka Almaida Jl. tun Abdul Razak I Blok G.5 No. 18 Gowa-Sulawesi Selatan-Indonesia.

Dewi NPSS, Perwira IY, Ernawati NM. 2020. Kandungan Timbal (Pb) pada Sedimen di Perairan Pantai Karang, Sanur, Bali. *Curr Trends Aquat Sci*. 3(1):76–80.

Febriani. 2022. Analisis Konsentrasi Logam Timbal (Pb) Pada Air, Ikan dan Tiram Di Wilayah Pesisir Baru Tengah Kota Balik Papan. Mulawarman, Samarinda.

Liu N, Liu H, Wu P, Meng W, Li X, Chen X. 2022. Distribution characteristics and potential pollution assessment of heavy metals (Cd, Pb, Zn) in reservoir sediments from a historical artisanal zinc smelting area in Southwest China. *Environ Sci Pollut Res*. 29(10):14288–14298. doi:10.1007/s11356-021-16824-9.

Mardina V, Rahmadani D, Nurul Makhfirah dan. 2023. Quimica: Jurnal Kimia Sains dan Terapan Analisis Kandungan Cadmium (Cd) dan Timbal (Pb) pada Kawasan Ekosistem Air Panas Terujak Aceh Timur dengan Metode AAS. *Quim J Kim Sains dan Terap*. 5(1):1–4. https://ejurnalunsam.id/index.php/JQ.

Peraturan Pemerintah Republik Indonesia. 2021. Penyelenggaraan Perlindungan dan Pengelolaan Lingkungan Hidup. *Sekr Negara Republik Indones*. 8(22):483. http://www.jdih.setjen.kemendagri.go.id/.

Rasyadi A. 2023. ANALISIS KESESUAIAN DAN DAYA DUKUNG KAWASAN PESISIR DAN BUDIDAYA TERIPANG PASIR Holothuria scabra Jaeger, 1833 (STUDI KASUS PANTAI LIMUNG DAN PRAJAK, KABUPATEN SUMBAWA). Fakultas Perikanan dan Ilmu Kelautan, IPB University.

Riani E, Cordova MR, Arifin Z. 2018. Heavy metal pollution and its relation to the malformation of green mussels cultured in Muara Kamal waters, Jakarta Bay, Indonesia. *Mar Pollut Bull*. 133 June:664–670. doi:10.1016/j.marpolbul.2018.06.029.

Septory AN, Mariwy A, Untailawan R. 2023. ANALISIS KANDUNGAN LOGAM BERAT MERKURI (Hg) PADA SEDIMEN DI. 13(1):23–31.

Shen T, Tang Y, Li YJ, Liu Y, Hu H. 2020. An experimental study about the effects of phosphorus loading in river sediment on the transport of lead and cadmium at sediment-water interface. *Sci Total Environ*. 720:137535. doi:10.1016/j.scitotenv.2020.137535.

Sitanggang Y gita. 2023. Kandungan Logam Berat (Pb, Hg) Pada ikan Kerong-Kerong (Terapon jarbua, Forsskal 1775) Di Perairan Pulau Bacan. Institut Pertanian Bogor.

SNI 4819. 2013. Tata cara pembuatan ekstrak sedimen untuk pengujian sifat kimia sedimen.

SNI 7387. 2009. Batas Maksimum Cemaran Logam Berat dalam Pangan. *Batas Maksimum Cemaran Logam Berat dalam Pangan Badan Stand Nas (BSN) ICS 67 222020.*, siap terbit. https://sertifikasibbia.com/upload/logam_berat.pdf.

Supriatno dan Lelifajri. Biologi JP, Kuala US, Kimia J, Pirak P. 2009. Analisis Logam Berat Pb dan Cd dalam Sampel Ikan dan Kerang secara Spektrofotometri Serapan Atom. *J Rekayasa Kim dan Lingkung*. 7(1):5–8.

Yanuar & Isnawati. 2023. Perbedaan Sedimen Terhadap Daya Serap Tembaga dan Timbal Pada Avicennia marina. 48(1):476–488.