Bioaccumulation of Lead (Pb) in Green Mussels (*Perna Viridis*) in Indonesian Waters

Martin Argustina Sari[1] , *Tri Widya* Edelwis[2], and *Hilfi* Pardi[1*]

[1]Chemistry Education, Teacher Training and Education Study Program, Raja Ali Haji Maritime University, 29124, Indonesia

[2]Biology Education, Teacher Training and Education Study Program, Raja Ali Haji Maritime University, 29124, Indonesia

Abstract. The environment is a place for the survival of living creatures which has an important role. Furthermore, pollution is a problem in the environment and really needs to be addressed because it can cause damage to the environment and ecosystem. Pollution that is very dangerous for life is heavy metals such as lead (Pb) in the sea. Green mussels *(Perna Viridis L.)* are examples of marine creatures in the bivalve group that can accumulate heavy metals and can be used as bioindicators of water pollution. The aim of this literature review is to determine the bioaccumulation of the heavy metal lead (Pb) in green mussels *(Perna Viridis L.)* in Indonesian waters. In the process of preparing this journal review, the method used is the comparative method. The results of the research that has been carried out show that green mussels contain the highest concentration of lead (Pb) in the waters of Jakarta Bay at 29.4 mg/kg, because Jakarta is a densely populated area and there are many industries in the city, followed by the concentration of green mussels. which was found in Badung Market, Bali at 28.878 mg/kg, then in the waters of Tambak Lorok, Semarang with levels of 8.0665 mg/kg.

[*] Corresponding author: hilfipardi@umrah.ac.id

1 Introduction

The environment is a place for the survival of living creatures which has an important role [1]. Furthermore, pollution is a problem in the environment and really needs to be addressed because it can cause damage to the environment and ecosystem [2]. One of the pollutions that we can observe is pollution in the sea, this occurs because river flows, whether large or small rivers, empty into the sea. Waste carried by river flows will collect in the sea. Of the various types of waste that can be found in waters, the most dangerous waste is heavy metals because they are toxic to living creatures [3].

Heavy metals are easily deposited and easily carried by living creatures in the sea so they can accumulate in the body easily [4]. Green mussels (*Perna Viridis L.*) are examples of marine creatures in the bivalve group that can accumulate heavy metals and can be used as bioindicators of water pollution [5]. High levels of heavy metal content in green mussels can be dangerous for anyone who consumes them, especially people in coastal areas [6]. In the environment where green mussels live, seawater and sediments containing heavy metals can have an influence on increasing the concentration of heavy metals in green mussels [7].

Heavy metals found in the sea will increasingly settle to the seabed over time. Through the deposition process, the concentration of heavy metals in sediment will increase above its concentration in seawater [8]. The increasing use of coastal areas for various purposes has led to an increase in heavy metal levels in marine waters such as housing development, ports, industry, tourism, pond cultivation, as well as waste flows from several rivers [9]. In addition, increased maritime transportation activities can also be a source of metals [10]. A number of human activities also have the potential to pollute waters, such as tourism activities, landfilling of rubbish by residents, building fishing boats, and other marine transportation activities [11]. Metal mineral mining also often produces mining waste which contains heavy metals [12]. Lead (Pb) can have a negative impact on marine ecosystems and human survival [13]. Other heavy metals that are pollutants are iron, chromium, cadmium, and other elements [14].

Now, the problem of pollution due to heavy metals has become a very serious problem globally [15]. In accordance with research conducted in several countries, such as research conducted on the Yanbu Coast, Red Sea, Saudi Arabia [16], Black Sea coast, Türkiye [17], Klang Estuary, Malaysia [18], and the Yellow Sea, China [19]. which indicates that the waters have been contaminated by heavy metals. In Indonesian waters, heavy metal pollution is also widely reported to occur and accumulate by green mussels, which will be discussed further in this article.

2 Method

In the process of preparing this journal review, the method used is the comparative method, where information is obtained by combining various sources from research journals. The data used was obtained through a literature review using primary data. Search for English (international) and Indonesian (national) research journals using Google Scholar, Science Direct, PubMed, and related and latest scientific journals with a publication year limit of 2020-2023. Keywords used include "Marine pollution", "Heavy metals", "Green Shells", and "Lead (Pb)".

3 Results and discussion

3.1 Sources of Heavy Metal Lead (Pb)

Lead is very toxic, it is very dangerous, especially for children. In its natural state, this element can be found in the soil, it has odorless and tasteless properties. Sources of lead contamination include worn paint, dust particles, contaminated food, contaminated soil, and lead-containing fuel. Lead is used in a variety of fields, including in glass production, as a stabilizer in PVC compounds, in oil-based paints, as an oxidant, and in fuels.

Sources of lead (Pb) heavy metal contamination are mining and smelting metal ore, burning petrol containing lead, industrial waste containing Pb, and paint [20]. Industrial activities and household waste can cause high levels of lead in water [21]. Lead pollution in waters is mostly caused by sources such as industrial waste, emissions from vehicles that use lead-containing gasoline, air pollution such as smoke and dust particles, emissions from coal-fired power plants, and toxic gases [22].

3.2 Impact of the Heavy Metal Lead (Pb) on Living Creatures

Lead is the heavy metal with the largest amount that can be absorbed by the kidneys, followed by the liver and then other soft tissues. The most vulnerable target of lead poisoning is the central nervous system [23] Lead (Pb) can have a bad influence on human health, disrupting the work of the central nervous system and circulatory system, can damage organs such as the kidneys and heart, and can affect reproductive health. Additionally, lead exposure can cause high blood pressure and a lack of red blood cells [24]. Lead also has an effect on children, continuous exposure to lead can reduce intelligence, and decreased intelligence can decrease to below 80, if the lead content in the blood exceeds three times the normal limit (0.3 milligrams per day) [25].

Heavy metals can enter the body through various routes such as the digestive tract, skin, and breathing [26]. One of the events that can accumulate the heavy metal lead is through food contaminated with lead metal and consumed over a long period of time. In general, humans do not need Pb metal, so the body will get rid of some, while the rest will settle in several areas of the body, namely the kidneys, liver, fat tissue, and hair[27].

Preventing heavy metal contamination is very necessary, so the government issued regulations regarding the threshold for consuming green mussels that contain heavy metals.

Table 1. Threshold values for the heavy metal lead (Pb) in green mussels.

Regulations	Maximum Limit	Unit
SNI 7387:2009	1.5	mg/kg
KEP-51/MNLH/2004	0.008	mg/L
492/Menkes/Per/IV/2010	0.01	mg/L

Apart from knowing the threshold values for heavy metals, people also need to know the safe limit for consuming green mussels in a week. This amount varies depending on the concentration of heavy metals found in green mussels. For example, the average threshold

for consuming green mussels from Mekar Beach, Bekasi is 11.698 mg/kg body weight in a week [28], The maximum weight of green mussels permitted for consumption within a week from Morosari waters, Demak Regency is 0.284 kg [29], amounting to ± 2.15 kg and 2.55 kg for green mussels in Tanjung Mas Harbor and Mangunharjo Waters per week [30], and 2.43 kg/week for the Demak area [31].

3.3 Heavy Metal Lead (Pb) Content in Green Mussels in Indonesian Waters

Indonesia is a maritime country with an area surrounded by oceans. This makes Indonesia rich in marine products that can be utilized by the community, however, this will have a negative impact if the quality of the sea is polluted, especially pollution by heavy metals. Furthermore, the content of heavy metals in waters can increase the risk of contamination of marine biota. If humans and animals consume marine biota that have been exposed to these heavy metals, this has the potential to disrupt biochemical systems and become a serious threat to the health of living creatures [32].

Currently, there has been a lot of research discussing the lead (Pb) content in Indonesian waters, through bioindicators for green mussels (Perna Viridis L.)

Table 2. Recapitulation of Lead (Pb) in green mussels in Indonesian waters

Research sites	Method	Unit	Rate	Reference
Makassar	AAS	mg/kg	6.57885	[13]
Makassar	AAS	mg/kg	5.9125	[28]
Makassar	AAS	mg/kg	0.00306	[24]
Bali	AAS	mg/kg	28.878	[32]
Bekasi	AAS	ppm	0.129	[9]
Jakarta	TSS	mg/kg	7.4276	[21]
Jakarta	AAS	mg/kg	29.4	[27]
Jakarta	AAS	mg/kg	0.296	[35]
Cirebon	AAS	mg/kg	2.66	[29]
Cirebon	ASS	mg/kg	0.305	[31]
Semarang	AAS	mg/kg	0.333	[26]
Semarang	AAS	mg/kg	8.0665	[34]

Semarang	AAS	mg/kg	0.6336	[23]
Pekalongan	AAS	ppm	1.7915	[23]
Demak	AAS	mg/kg	3.9626	[29]
Demak	AAS	µg/g	7.637	[33]
Demak	AAS	mg/kg	0.3374	[15]
Gresik	AAS	mg/kg	0.4103	[17]
Lamongan	AAS	mg/kg	0.2115	[14]
Brebes	AAS	mg/kg	3.52	[18]
Pasuruan	AAS	mg/kg	1.375	[16]

Based on the results of a literature study that has been carried out, it was found that the highest concentration of lead (Pb) is in the Jakarta Bay area at 29.4 mg/kg, this value is very far from the threshold value, the high levels of lead in this area are because Jakarta is a densely populated area. population and the number of industries in the city. Research by [33](Andayani et al., 2020) also reported that the results of measurements of other heavy metals in Jakarta Bay such as mercury (Hg) were also very high, even far above the threshold permitted by BPOM.

This was followed by the concentration of lead in green mussels found at Badung Market, Bali, which was 28.878 mg/kg. The high levels of lead are caused by community activities which often throw market waste, household waste, and industrial waste into the sea. High lead concentrations also occur in the waters of Tambak Lorok, Semarang with levels of 8.0665 mg/kg, this is caused by industrial activities and community waste found in the waters of Tambak Lorok which also involve many cultivation efforts in stepped net cages such as cultivating green mussels. and milkfish.

Differences in lead (Pb) concentrations are not only caused by the area where the samples were taken but also by sample size and the influence of season. According to [34](Wulandari et al., 2012) Shells with a larger size have a greater capacity to accumulate metal. Meanwhile, older green mussels can eliminate heavy metals better [35-40]. Heavy metal levels in green mussels decreased in concentration during the rainy season [17, 40-42].

4 Conclusion

The results of literature studies show that the increase in lead (Pb) content in the sea is caused by industrial activities and high levels of household waste. High concentrations of lead (Pb) in the body can cause several problems for human health, disrupt the work of the central nervous system and circulatory system, can damage organs such as the kidneys and

heart, and can affect reproductive health. Additionally, lead exposure can cause high blood pressure and a lack of red blood cells. Lead (Pb) with the highest concentration is found in the waters of Jakarta Bay with a value of 29.4 mg/kg, because Jakarta is a densely populated area and there are many industries in the city, followed by the concentration of green mussels found in Badung Market, Bali at 28.878 mg/kg, then the waters of Tambak Lorok, Semarang with levels of 8.0665 mg/kg.

References

1. Suryo, R. A., Yulianto, B., & Santoso, A *Journal of Marine Research*, **10**(3), (2021).
2. Aphrodita, S. V., Santoso, A., & Riniatsih, I. *Journal of Marine Research*, **11**(2), (2022).
3. Munadi, R., & Hamid, P. *Cokroaminoto Journal of Chemical Science*, **4**(1), (2022).
4. Juharna, F. M., Widowati, I., & Endrawati, H. *Buletin Oseanografi Marina*, **11**(2), (2022).
5. Ulinuha, D., & Perwira, I. Y. *Journal of Marine and Aquatic Sciences*, **8**(2), (2023).
6. Firmani, U., & Safitri, N. M. *Journal of Aquatropica Asia*, **8**, (2023).
7. Salman, S. *Bio-Lectura: Jurnal Pendidikan Biologi*. **7**(2), (2020)
8. Robi, R., Aritonang, A., & Juane Sofiana, M. S. *Jurnal Laut Khatulistiwa*, **4**(1), (2021).
9. Suryono, C. A., & Indardjo, A. *Jurnal Kelautan Tropis*, **25**(3), (2022).
10. Priambodo, B. A., Arief, M., & Rahardja, B. S. *Marinade*, **4**(01), (2021).
11. Husna, A. *Arwana: Jurnal Ilmiah Program Studi Perairan*, **4**(2), (2022).
12. Mustafa, A., Asaf, R., Kamariah, & Radiarta, I. N. *Jurnal Ilmu Dan Teknologi Kelautan Tropis*, **13**(1), (2021).
13. Amaliah, N., Rostina, & Rifai, A. **22**(2), (2022).
14. Ismaturrahmi, Lensoni, Fajri, N., Wati, S., & Jannah, R. **10**(10). (2022).
15. Nugraha Putra, M. D., Widada, S., & Atmodjo, W. *Journal of Oceanography*, **4**(3), (2022).
16. Alharbi, O. M. L., Khattab, R. A., Ali, I., Binnaser, Y. S., & Aqeel, *Marine Pollution Bulletin,* **149**, (2019).
17. Mutlu, T. *Spectroscopy Letters*, **54**(6), . (2021).
18. ELTurk, M., Abdullah, R., Mohamad Zakaria, R., & Abu Bakar, N. K. *Estuarine, Coastal and Shelf Science,* **226**, (2019).
19. Lin, Y., Lu, J., & Wu, J. *Ecotoxicology and Environmental Safety*, **208**, (2021).
20. Okewale, I. A., & Grobler, H. *Geosystems and Geoenvironment*, **2**(4), (2023).
21. Budiastuti, P., & Raharjo, M. *Jurnal Kesehatan Masyarakat*, **4**(5). (2016).
22. Lee, W. P., Payus, C., Ali, S. A. M., & Vun, L. W. *International Journal of Environmental Science and Development*, **8**(7), (2017).
23. Ardillah, Y. *Jurnal Ilmu Kesehatan Masyarakat*, **7**(3), (2016).
24. Agustina, T. *Teknobuga*, **1**(1), (2014).
25. Witkowska, D., Słowik, J., & Chilicka, K. *Molecules*, **26**(19). (2021).
26. Siringoringo, V. T., Pringgenies, D., & Ambariyanto, A. *Journal of Marine Research*, **11**(3), (2022).

27. Arifin, A. A., Suryono, C. A., & Setyati, W. A. *Journal of Marine Research*, **10**(3), (2021).

28. Tris Haryanti, E., & Kariada Tri Martuti, *N. Life Science*, **9**(2), (2020).

29. Andayani, A., Koesharyani, I., Fayumi, U., Rasidi, R., & Sugama, K. *Oseanologi Dan Limnologi Di Indonesia*, **5**(2), (2020).

30. Wulandari, E., Herawati, E. Y., Arfiati, D., *Jurnal Penelitian Perikanan*, **1**(1), (2012).

31. Nurhayati, D., & Putri, D. A. *Akuatika Indonesia*, **4**(1), (2019).

32. Dharmadewi, I. M., & Wiadnyanab, I. G. A. G. *Jurnal Emasains: Jurnal Edukasi Matematika Dan Sains,* **8**(2), (2019).

33. Falah, S., Purnomo, P. W., & Suryanto, A. *Jornal Of Maquares*, **7**(2), (2018).

34. Kusuma, R. B., Supriyantini, E., & Munasik, M. *Journal of Marine Research*, **11**(2), (2022).

35. Putri, A., Cahyadi, F. D., & Rudi, M. *Fish Scientiae,* **13**(1), (2023).

36. .Y. Rilda, R. Rinaldi, S. Syukri, A. Armaini, R. Refinel, A. Agustien, and H. Pardi, ChemistrySelect **7**, (2022)

37. H. Pardi, D. Fitriyah, F. S. Silitonga, T. W. Edelwis, and E. P. Ramdhani, Port. Electrochim. Acta **41**, 185 (2023)

38. T. S. Raza'i, H. Pardi, Thamrin, Nofrizal, V. Amrifo, I. Pangestiansyah Putra, T. Febrianto, and A. Fadhli Ilhamdy, F1000Research **10**, 1 (2022)

39. I. Putra, Z. Chaidir, Syafrizayanti, and H. Pardi, Res. J. Chem. Environ. **24**, 68 (2020)

40. Deswati, H. Suyani, R. Zein, H. Pardi, Buchari, and H. Setiyanto, Rasayan J. Chem. **13**, 2045 (2020)

41. P. Hilfi, Deswati, S. Hamzar, and E. T. Widya, Res. J. Chem. Environ. **24**, 159 (2020)

42. Deswati, H. Suyani, Safni, U. Loekman, and H. Pardi, Indones. J. Chem. **13**, 236 (2013)