Sainteknol Vol 21, No 1 (2023): June 2023

https://journal.unnes.ac.id/nju/index.php/sainteknol

Study of Heavy Metal Content in Lola Snail (*Trochus niloticus*) in The Karang Island of Central Tapanuli Regency

Aisyah Umi Ramadhani Samosir[a], Rahmatsyah, Rita Juliani

Faculty of Mathematics and Natural Sciences, Universitas Negeri Medan, Indonesia
[a)]Corresponding author: aisyahumi1812@gmail.com

Abstract

Research on the analysis of heavy metal content in the waters of Karang Island, Central Tapanuli Regency aims to know the metal content in Lola Snail meat, sediment, and Lola Snail shells. The research method begins with taking samples of Lola snails and sediments on Karang Island and preparing the samples. Then, the samples were analyzed by AAS (Atomic Absorption Spectrometry) to determine the content of heavy metal elements in the meat of Lola Snail, followed by XRD (X-Ray Diffraction) testing to determine the content of heavy metal elements in sediments, and also testing with EDX (Energy Dispersive X-Ray) to determine the content of heavy metals in the shell. The results of the analysis on the AAS test showed that the order of heavy metal concentrations in Lola snail meat at station I was Zn > Cr > Cu > Cd > Pb, while at station II was Zn > Cu > Cr > Cd > Pb. The results of the sequence of heavy metal concentrations using XRD in sediments around Karang Island at the station I was Zn > Cr > Cu > Cd > Pb, while at station II was Zn > Cd > Cu > Cr > Pb. The results of the analysis on the shells of Lola snails using EDX at both stations showed they did not contain heavy metal elements (Pb, Cd, Cu, Cr, and Zn), but only contained O, Ca, Mg, Na, Al, and Si elements.

Keywords : Lola Snail, Sediment, AAS, XRD, EDX

INTRODUCTION

Central Tapanuli Regency is one of the regencies in North Sumatra Province. Data obtained from the Central Agency on Statistics (BPS) 2021, Central Tapanuli has an area of 2,194.98 km^2 with a population of 365,177 people and has 20 sub-districts and there are 181 small industries of which 65 of them are non-formal industries. Central Tapanuli is a district on the west coast of Sumatra with a coastline of 200 km and beautiful natural attractions. There are 37 beautiful water attractions, one of which is Coral Island, which has marine life such as the Lola Snail.

The Lola Snail is a large mollusk of the *gastropod* class that lives on reef flats and is affected by sea tides. Lola has a very high economic value in the community (Persada, 2018). Economically, the presence of Lola Snail can be used as a source of livelihood for fishermen. Lola's meat can be used as a source of protein for consumption and the shell is used to make buttons, jewelry, and aquarium decorations. Lola Snail is often found at the bottom of the water which is right at the bottom of the sediments. However, Lola Snail's activities were disrupted by heavy metal waste flowing from the Watershed (DAS) into the coast of Karang Island. This happens because the Lola Snail is one of the marine biotas that looks for food on the substrate. In accordance with research (Anam, et al., 2019) said that sea slugs usually eat by scraping the surface of the substrate that is attached or overgrown by flora and fauna (*grazer*). It is very possible for Lola Snail to consume organic materials that have been contaminated with heavy metals so that the snails contain heavy metals.

Heavy metals are pollutants that are easily accumulated by large consumers, such as marine organisms, and increase as they move up the food chain, with direct effects on human health. Hutton (1987) stated that the most toxic heavy metal pollutants are lead (Pb), copper (Cu), cadmium (Cd), and chromium (Cr). Increasing urbanization and industrialization have polluted the environment with

toxic wastes, including heavy metal compounds. Several heavy metals are essential elements for living things (Wulandari, 2021).

The heavy metal content in the waters which is affected by the presence of waste, pollution from motorized vehicles, and river flows to the waters of Karang Island has the potential to cause sediment containing heavy metals. The presence of the Lola Snail which often settles at the bottom of the sediment has the opportunity to cause the Lola Snail's flesh to be affected by heavy metals. This finding is also related to the research by Rahmatsyah and Julyha (2015) which stated that seawater and sediments affected by the seawater industry which operates every year causes the entry of waste and accumulation of heavy metals. At a certain point, the heavy metals contained in the water will sink to the bottom of the water and a sedimentation process will occur to form sediment so that the concentration of heavy metals accumulated in the sediment will be high in the water body (Amelia, 2019).

The entry of contaminants into the marine environment can cause a decrease in the quality of Karang Island waters and marine organisms such as the Lola Snail will have a very high chance of being contaminated with heavy metals. Based on previous research theory, the authors are interested in knowing the content of heavy metal elements (Pb, Cd, Cu, Cr, and Zn) in Lola Snail's meat, Lola Snail's shells and sediment in the waters of Karang Island using three different tools.

METHOD

A sampling of Lola snail's meat, Lola snail shells, and sediment was carried out at two stations and was carried out on Karang Island, Barus District, Central Tapanuli Regency, North Sumatra. The collected shells and sediments were washed with distilled water and dried in the sun for one day. The shells and sediment were ground into powder with a mortar and filtered using a sieve. The prepared shells and sediments were then placed in plastic samples and labeled as Station I and Station II. The study of the content of Lola snail meat was carried out using the Atomic Absorption Spectrometry (AAS) of Shimadzu type AA-7000 at the Medan Industrial Research and Standardization Center. Sediment content studies using X-Ray Diffraction (XRD) Shimadzu type 6100 were then processed with *Match! 3* software and Lola Snail's shells with Energy Dispersive X-Ray (EDX) FEI type inspect S50 EDAX AMETEX, tests were carried out at the Physics Laboratory of Universitas Negeri Medan.

RESULTS AND DISCUSSION

Lola Snail Meat Test Results Using Atomic Absorption Spectrometry (AAS)

The content study on testing the Lola Snail meat sample using AAS is shown in Table 1 and Figure 1.

Table 1. Results of the study of the metal content of Lola Snail meat

Heavy Metal Elements	Station I	Station II
Lead (Pb)	<0,003 mg/kg	<0,003 mg/kg
Cadmium (Cd)	<0,02 mg/kg	<0,02 mg/kg
Copper (Cu)	6,90 mg/kg	9,59 mg/kg
Chromium (Cr)	10,4 mg/kg	<0,005 mg/kg
Zinc (Zn)	74,2 mg/kg	101,4 mg/kg

The results of the heavy metal Lead (Pb) content of <0.003 in Lola snail meat indicate that it has not exceeded the quality standard threshold that has been set. The low content of lead metal in the body of Lola Snails is due to the fact that both research sites are located in locations with low toxicity, due to the lack of industrial waste that produces Pb metal, which affects the low accumulation of heavy metal lead (Pb) in Lola Snail meat. Data obtained from the 2021 Central Agency on Statistics (BPS), industry and trade in Barus District have small and medium-sized companies engaged in various fields and are developing and managed individually. These industries include salting fish, coffee factories, and crackers, where industrial waste disposal in Barus District does not produce waste containing Pb metal.

Based on research by Yulaipi and Aunurohim (2013), the presence of lead metal (Pb) is caused by waste that enters the waters from the chemical industry waste, printing industry, and industries that produce metals and paints. This is also related to the research locations of the two stations which

are located in locations with low toxicity, due to the lack of industrial waste that produces Pb metal which affects the low accumulation of heavy metal lead (Pb) in the meat of Lola Snails.

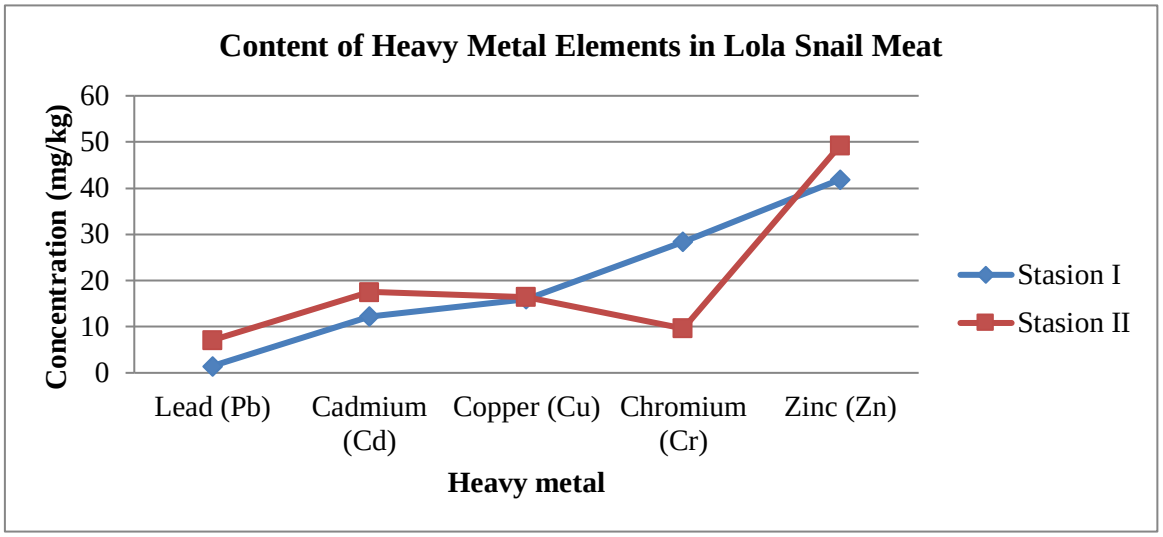

Figure 1. Graph of the metal content of Lola Snail's meat

The content of heavy metal cadmium (Cd) in Lola Snail meat in both station areas is <0.02 which is still below the quality standard. The content of Cd metal of <0.02 in the body of Snail Lola needs to be investigated as a factor for contamination. The Cd heavy metal pollution in Lola Snail is influenced by environmental factors around Karang Island. Environmental factors affect the acceleration of Cd metal accumulation at two coral island water stations including seawater salinity, currents, and tidal movement. A sampling of Lola snails in the waters of Karang Island was carried out when the water salinity was high. Salty seawater increases chloride ions and releases chloride complexes, thereby reducing the concentration of the heavy metal Cd. The slow flow and minimal tidal movement during sampling also contributed to the low levels of the heavy metal Cd in the body of Snail Lola. Therefore, the concentration results obtained for Cd metal in Lola Snail meat were still low and below the quality standards.

This is related to research by Wulandari (2008), the content of the heavy metal Cd in marine biota is affected by low salinity, strong currents, and tidal movements. Sampling during high tides has a high toxicity for Cd metal because seawater may contain high levels of heavy metals from polluted waste dumped in estuaries and watersheds leading to the waters of the sampling area. The existence of tidal movement will move the water mass horizontally, resulting in mixing of metals (Lessy, et al, 2021).

Based on the results of research on copper (Cu) metal in Lola Snail meat at both stations produced different concentrations of the metal but were still below the quality standard. The difference in heavy metal content is due to different activities at each station, so the addition of heavy metal content is different for each parameter. The highest copper content was found in the area of station II which is the location of island waters close to the estuary of the river for disposal of industrial waste and the port area which produces many sources of pollution such as ship oil residue which is the main source of heavy metals with high concentrations in waters, while the area of Station I is fish processing industrial area, spoilage, and fish waste.

This is in accordance with the research by Rahmatsyah and Julyha (2015) in Pondok Batu waters, Central Tapanuli Regency, which stated that industrial areas have a lot of activity so the input of copper (Cu) into the waters is getting bigger. Station locations that produce high concentrations come from sources of pollution from factory activities that dispose of liquid waste and metal alloys containing copper. The heavy metal copper (Cu) is a pollutant in marine waters that comes from various industrial, household, or agricultural wastes. Very low concentrations of Cu become an essential metal for marine biota, but at higher concentrations, it can be toxic to marine biota including the Lola Snail. The high concentration of copper at both stations is because they are located in an industrial area.

Analysis of heavy metal chromium (Cr) in the Lola Snail meat samples from the Station I area

revealed that chromium metal was above the maximum permissible limit, so it is necessary to review the source of contamination and warn about consumption behavior. The difference in Cr concentration between the Lola Snail samples collected at stations 1 and 2 was caused by several factors. In sampling at the first station, the Cr concentration exceeded the maximum value because the sampling location was at a source of heavy metal pollution. Metal accumulation in Lola Snail is influenced by environmental factors so that different sampling areas lead to different accumulations. Environmental factors affecting the acceleration of Cr metal accumulation at Station I include erosion, dust, and rainwater particles as seasonal factors. This is corroborated by the research of Melinda, et al (2021) which states that differences in seasons affect the accumulation of heavy metals in shellfish.

Based on research by Hidayah, et al., (2014) in Rawa Pening Lake, the source of Cr metal in the waters mostly comes from the erosion process of mineral rocks from the sampling area and also household waste containing Cr metal such as detergent soap. The erosion of mineral rocks originates from andesite mining waste in the sampling area. Therefore, the high content of Cr metal at the first station in the area around the coast of Karang Island at Lola Snail can be influenced by physical factors. This is related to the sampling of the Lola Snail at the first station, chromium toxicity is influenced by physical factors, including erosion that occurs on mineral rocks, besides that dust and particles in the air will be carried down by rainwater. In addition, human activities produce waste that contains the heavy metal of chromium (Juharna, et al., 2022).

The high concentration of Zn in the meat of the Lola Snail was due to the sampling of Lola Snails in the two-station carried out in the afternoon in the waters of Karang Island. In the afternoon, many human activities cause the accumulation of zinc in the water such as boats and ships crossing the waters of Karang Island. Speedboats also contribute to emissions of heavy metal zinc through the use of vehicle diesel fuel and brakes. Heavy metals released into the water are diluted and dispersed by turbulence and ocean currents. This is also related to research by Maddusa, et al (2017) which states that sampling in the morning and evening causes high concentrations of Zn because it is influenced by increased community activities such as agriculture, speedboats, and household waste. The increase in zinc increased significantly in the afternoon due to the disposal of zinc-containing household waste and agricultural waste in the form of pesticide fertilizers which contain a lot of zinc.

Based on the results of the concentrations of heavy metals, i.e., Pb, Cd, and Cu at both stations, they were still below the maximum threshold so they were suitable for consumption. Likewise, Cr at station II and Zn at station I are still suitable for consumption. However, Cr at station I and Zn at station II are not safe for consumption because they can have negative effects on health. Heavy metals that exceed the quality standard limits can have a negative impact on the life of organisms such as disrupting chemical reactions and inhibiting the absorption of essential nutrients. Heavy metals also interfere with the activity of enzymes that can damage health such as the body's metabolism, cause allergies, and are teratogenic, mutagen, and carcinogenic in humans and animals. (Hananingtyas, 2017). The sequence of accumulation of heavy metal concentrations at station I is Zn > Cr > Cu > Cd > Pb, while at station II that is Zn > Cu > Cr > Cd > Pb. Therefore, it is very important to maintain vigilance when consuming Lola Snail because every year there will be an increase in activity around the waters of Karang Island and an increase in industrial waste that flows from the watershed around the river in Central Tapanuli Regency.

Sediment Testing Results Using X-Ray Diffraction (XRD)

The results of the content study on testing sediment samples using XRD are shown in table 2 and figure 2.

Table 2. Results of studies on metal content in sediments

Heavy Metal Elements	Station I	Station II
Lead (Pb)	1.5 %	7.1 %
Cadmium (Cd)	12.2 %	17.5 %
Copper (Cu)	16.0 %	16.4 %
Chromium (Cr)	28.4 %	9.6 %
Zinc (Zn)	41.9 %	49.3 %

The order of heavy metal concentrations in sediments around Karang Island using XRD at station I is Zn > Cr > Cu > Cd > Pb, while at station II is Zn > Cd > Cu > Cr > Pb. The distribution of heavy metals from the sediment resulted in a sequence of concentrations that match the order of

concentration in Lola Snail's meat.

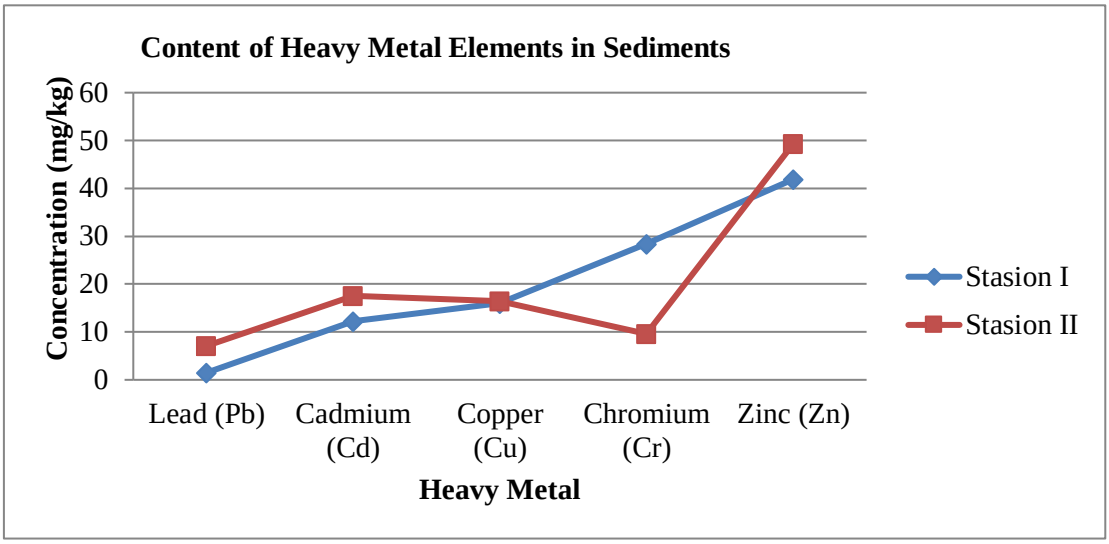

Figure 2. Graph of metal content in sediments

Sediment products around the waters of Karang Island come from a collection of results of the destruction of the surrounding rock which will have a heavy metal content determined by the mineralogy of the original rock. The content of heavy metals in sediments that are affected by human activities consists of natural geochemistry and the results of activities from the area.

Based on the results of the study, the lowest heavy metal content in the sediments from the two stations was lead (Pb), with station I of 1.5% and station II of 7.1%. The low heavy metal lead is due to the presence of the metal in the waters of Karang Island is still safe, where there are minimal sources of pollution from industrial waste containing Pb. This is consistent with the results obtained by lead metal in Lola Snail's meat. This is also related to research by Permata, et al (2018) which states that the low concentration of the heavy metal Pb in sediments is caused by a lack of industrial waste treatment resulting in Pb levels. Industries that use lead metal in their production processes can produce lead in sediments such as the cement industry, fertilizer industry, Pertamina, coal industry, and chemical industry. These five industries are not found around the Karang Island research area.

The highest concentration of heavy metals in sediments is zinc (Zn), 41.9% at station I and 49.3% at station II. The high concentration of the heavy metal Zn in sediments is caused by a deposition process that takes place with a momentary time scale pattern, causing the heavy metal to accumulate in the sediment. Sampling of sediments in the waters of Karang Island which was carried out in the afternoon when there were many activities had an impact on the high Zn metal concentration in the sediments. The results of Pratama's research (2021) state that based on the pattern of distribution of the heavy metal Zn in sediments, it is not absolutely determined by the pattern and speed of the currents. This is due to the increased flow pattern and velocity which will affect the accumulation of Zn metal in sediments. Accumulated over the past few years, Zn heavy metal sediments distribute grain sizes originating from various activities such as industrial waste, shipping activities, household activities, and residential areas.

Test Results of Lola Snail Shells Using *Energy Dispersive X-Ray* (EDX)

EDX analysis resulted in the percentage of chemical elements contained in the Lola Snail Shell samples at both stations. It shows the distribution of elements in the Lola snail from stations I and II did not contain heavy metal elements of Pb, Cd, Cu, Cr, and Zn but contained elements such as O, Ca, Mg, Na, Al, and Si.

The distribution of station I elements shows that the particle diameter represents about 5µm and the spectral peak is dominated by element O. The elements present in (Figure 3) include O (72.30%), Ca (26.75%), Mg (3.26%) , Na (1.43%), Al (0.48%), and Si (0.33%).

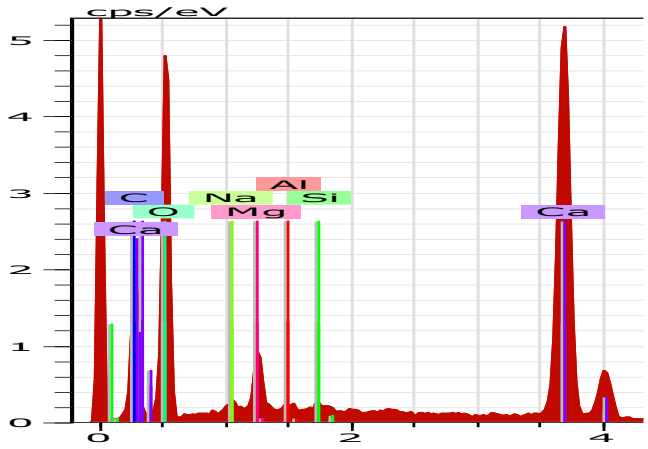

Figure 3. The EDX spectrum of the distribution of station I elements

The distribution of station II elements shows that the particle diameter represents about 5µm and the peak of the spectrum is dominated by element O. The elements present in (Figure 4) include O (78.18%), Ca (26.22%), and Na (1.80%).

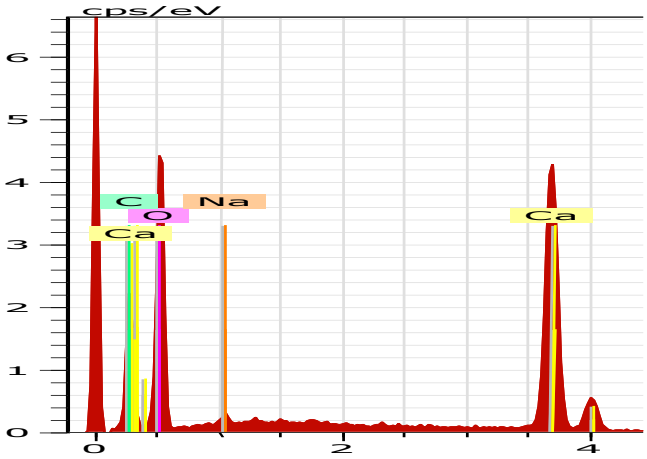

Figure 4. The EDX spectrum of the distribution of station II elements

CONCLUSION

Analysis using AAS shows that the accumulation of heavy metal concentrations in the meat of Lola snails cultivated around the waters of Karang Island at the station I was as follows Zn > Cr > Cu > Cd > Pb, while at station II was Zn > Cu > Cr > Cd > Pb. The analysis using XRD shows the content of heavy metal concentrations in sediments around Karang Island at the station I was as follows Zn > Cr > Cu > Cd > Pb, while at station II was Zn > Cd > Cu > Cr > Pb. The EDX analysis on the Lola Snail shells showed that they did not contain the following elements, i.e., Pb, Cd, Cu, Cr, and Zn, but only O, Ca, Na, and C elements.

REFERENCES

Amelia. (2019). Biokonsentrasi Faktor Logam Berat Pada Kerang Dari Perairan Batam, Kepulauan Riau, Indonesia. *Jurnal Kimia dan Pendidikan*, 4(2): 152-163.

Anam, K., Idris, F., Syakti, A, D. (2019). Analisis Kandungan Logam Berat Pb dan Cd pada Siput Gonggong (Strombus sp) di Perairan Kecamatan Bukit Bestari. *Jurnal Buana Sains*, 19(1): 37-46.

Badan Pusat Statistika (BPS). (2021). *Kabupaten Tapanuli Tengah Dalam Angka. 2021*. BPS Kabupaten Tapanuli Tengah.

Badan Pusat Statistik (BPS). (2021). *Kabupaten Tapanuli Tengah Kecamatan Barus Dalam Angka*. 2021. BPS Kecamatan Barus.

Hananingtyas, I. (2017). Studi Pencemaran Kandungan Logam Berat Timbal (Pb) dan Kadmium (Cd) pada Ikan Tongkol (Euthynnus, sp) di Pantai Utara jawa. *Biotropic The Journal of Tropical Biology*, 1(2): 41-50.

Hidayah, A. M., Purwanto & Soeprobowati, T. R. (2014). Biokonsentrasi Faktor Logam Berat Pb, Cd, Cr, Dan Cu Pada Ikan Nila (Oreochoromis Niloticus Linn) Di Karamba Danau Rawa Pening. *Jurnal BIOMA*, 16(1): 1-9.

Hutton, M. (1987). Human Health Concerns of Lead, Mercury, Cadmium and Arsenic. In: Hutchinson, T.C. and Meema, K.M., Eds., Lead, Mercury, Cadmium and Arsenic in Environment. *John Wiley and Sons*, h. 53-68.

Juharna, F, M., Widowati, I., endrawati, H. (2022). Kandungan Logam BeratTimbal (Pb) dan Kromium (Cr) Pada Kerang Hijau *(Perna Viridis)* di Perairan Morosari, Sayung, Kabupaten Demak. *Buletin Oseanografi Narina*, 11(2): 139-148.

Lessy, M, R., Bemba, J., & Wahidin, N. (2021). Karakteristik Pasang Surut dan Pergerakan Massa Air di teluk Kao Bagian Dalam, Kabupaten Halmahera Utara-Indonesia, *Jurnal Ilmu Kelautan Kepulauan,* 4(2).

Maddusa, S. S., & Paputungan, M. G. dkk. (2017). Kandungan Logam Berat Timbal (Pb), Merkuri (Hg), Zink (Zn) dan Arsen (As) pada Ikan dan Air Sungai Tondano Sulawesi Utara. *Al-Sihah : Public Health Science Journal*, 9(2): 153-159.

Melinda, T., Samosir, A, M., Sulistiono & Simanjuntak, C, P, H. (2021). Bioaccumulation of Lead (Pb) and Mercury (Hg) in Green Mussel Perna Viridis (Linnaeus, 1758) in Cengkok Coastal Waters, Banten Bay, Indonesia. in *IOP Conference Series: Earth abd Environmental Science*: 1-19.

Permata, M, A, D., Purwiyanto, A, I, S., & Diansyah G. (2018). Kandungan Logam Berat Cu (Tembaga) dan Pb (Timbal) Pada Air dan Sedimen di Kawasan Industri Teluk Lampung Provinsi Lampung, *Journal Of Tropical Marine Science.*1(1): 7-14.

Persada, N. P., Mangunjaya, F. M., & Tobing, I. S., (2018). Sasi Sebagai Budaya Konservasi Sumber Daya Alam di Kepulauan Maluku. *Jurnal Ilmu dan Budaya,* 41(59): 6869-6900.

Pratama, R, A., Maslukah, L., & Atmojo, W. (2021). Pola Persebaran Horisontal Logam Berat Timbal (Pb) dan Zeng (Zn) pada Sedimen di Perairan Muara Sungai Kaligung Tegal. *Jurnal Kelautan,* 14(1): 11-19.

Rahmatsyah & Julyha. (2015). *Prosiding Semirata Bidang MIPA 2015; BKSPTN Barat: Penentuan Kandungan Unsur Logam Pada Kerang (Bivalvia) Di Daerah Pesisir Pantai Kabupaten Tapanuli Tengah*. Pontianak: Universitas Tanjungpura Pontianak.

Wulandari, A.D., & Meitiniarti, V.I. (2021). Bioremediation of Pb and Cd contaminated soil using microorganism: A review. *Journal of Science and Science Education*, 5(1): 1-11.

Wulandari, S. Y., Yulianto, B., Sukristiyo. (2008). Pola Sebaran Logam Berat Pb dan Cd di Muara Sungai Babon dan Seringin Semarang. *Jurnal Ilmu Kelautan,* 13(4): 70-175.

Yulaipi, S., Aunurohim. (2013). Bioakumulasi Logam Berat Timbal (Pb) dan Hubungannya dengan Laju Pertumbuhan Ikan Mujair (Oreochromis mossambicus). *Jurnal Sains dan Seni Pormits*, 2(2): 2237-3520.