Biota
Biologi dan Pendidikan Biologi

http://biota.ac.id/index.php/jb
DOI: http://dx.doi.org/10.20414/jb.v17i2.515

Research Article

Identification of the Heavy Metal Lead (Pb) in Red Macro Algae (*Gracilia sp*) In the waters of Tanjung Luar, East Lombok

Almahera[1], Ahmad Aldi Kurniawan[1], B Firia Maharani[1], Yusfina Himayanti[2], Novia Dara Puspita[1], Baiq Repika Nurul Furqan[1*]

[1]*Departement of Pharmacy, Universitas Nahdlatul Ulama Nusa Tenggara Barat*
[2]*Departement of D-III Medical Records and Health Information, Universitas Nahdlatul Ulama Nusa Tenggara Barat*

**Corresponding author: repika.nf@gmail.com*

Abstract

Tanjung Luar Village is located in Keruak District, East Lombok Regency, West Nusa Tenggara, is a densely populated body of water human activity. In Tanjung Luar waters, household and ship waste dumped directly into the sea, polluting the local ecosystem. this condition important because people in the area consume a lot of produce marine catches, including red macroalgae (*Gracilaria Sp*). If *Gracilaria Sp.* is contaminated with levels of the heavy metal lead (Pb) that exceed threshold of 0.2 mg/kg, can be dangerous to human health impact on the nervous system, urinary system, endocrine system, problems gastrointestinal, and a very high risk of cancer. That thing based on BPOM Regulation No. 23 of 2017 (<0.2 mg/kg) for consumption materials. Therefore pollution and controlling the use of the heavy metal lead (Pb) important, especially in waters that play a supporting role life and food of local communities. The aim of this research is to determine the levels of the heavy metal lead (Pb) contained in the sample red macroalgae (*Gracilaria Sp.*) in Tanjung Luar Waters. Purposeful research to provide an overview and explanation of the issues discussed. This research uses the wet digestion method to identify heavy metal lead (Pb) of *Gracilaria sp* in waters Tanjung Luar, East Lombok. Next, levels of the heavy metal lead (Pb) were tested with ICP-OES spectrophotometry. With this method, researchers can identify the concentration of the heavy metal lead (Pb) in *Gracilaria Sp.* with a high level of accuracy. The results of the study showed that all sampling points of *Gracilaria sp.* did not exceed the threshold, which was less than 2 mg/kg. where at the sampling location point 1 had Pb concentrations of 0.072 ppm (location A), 0.063 ppm (location B), 0.057 ppm (location D), 0.051 ppm (location E) and 0.046 ppm (location F). for point 2 had Pb concentrations of 0.096 ppm (location A), 0.083 ppm (location B), 0.071 ppm (location C), 0.065 ppm (location E) and 0.059 ppm (location F). for point 3, the Pb concentrations were respectively 0.142 ppm (location A), 0.108 ppm (location C), 0.097 ppm (location D), 0.084 ppm (location E) and 0.070 ppm (location F).

Keywords: identification; heavy metals; red macroalgae; outer cape; east Lombok

1. Introduction

Metal pollution is a serious environmental concern in coastal areas. Metals, often referred to as heavy metals due to their density exceeding 5 g/cm^3, can accumulate in seawater from various sources. These metals may enter the ocean through human activities on land, such as industrial waste, agricultural runoff, and mining. They can also be deposited from the atmosphere or result from natural occurrences like volcanic eruptions (Hartati et al., 1993).

Once metals enter the water, they are persistent and difficult to break down, allowing them to accumulate in aquatic environments over time (Nontji, 1993). This accumulation can harm marine life, both directly, through toxicity, and indirectly, by disrupting ecosystems. Some metals, including mercury, lead, and cadmium, can build up in the food chain, leading to higher concentrations in marine animals and, eventually, humans. This bioaccumulation poses significant risks to both ecological and human health.

The heavy metal lead (Pb) is a pure toxic substance that is commonly used in industry to stabilize certain compounds. In daily life, lead (Pb) is used in various fields such as mining, metal smelting and fuel oil. However, its use has the potential to become a toxic material when accumulates in living things. Lead (Pb) is usually used in various products, such as paint mixtures, pesticides, and as ingredients addition to vehicle fuel (Afandi, dkk 2017). Lead (Pb) is currently one of the primary pollutants in aquatic environments (Suhendrayatna, 2001). Lead is a neurotoxin that accumulates in organisms, causing harmful effects (Winarno, 1993). The main source of lead pollution comes from motorized vehicles, which release lead waste into the environment (Fardiaz, 1992). Lead enters water bodies through rainwater, following a crystallization process. Additionally, the corrosive action of waves and wind contributes to the presence of lead in marine environments (Palar, 2012).

West Nusa Tenggara, especially Lombok Island, is a producer of quite a lot of macroalgae (no. 5 in Indonesia), one of the locations where macroalgae are widely cultivated is the Tanjung Luar area, Keruak, East Lombok. The macroalgae that are widely cultivated are Kappaphycus alvarezii, Eucheuma sp. and Gracilaria sp. which are generally cultivated in the sea (Anggadiredja et al., 2008).

Gracilaria sp. is a type of red macroalgae that has a beta carotene content that is almost close to carrots (Phang et al, 2010). This makes it widely used as a thickener and stabilizer in the food, pharmaceutical, and cosmetic industries and is needed for its cell wall polysaccharides. In addition, it has been used in health drinks and anticancer nutraceuticals because of its antioxidant content and other nutritional compounds (Cornish and Garbary, 2010).

Based on data from the Ministry of Maritime Affairs and Fisheries' "REA CoFish Project 2022", a number of locations in the southern coastal area of East Lombok that are contaminated with heavy metal Lead (Pb) include Tanjung Luar (0.0163 ppm), Gili Maringkik (0.0367 ppm), Tanjung Sagui (0.0183ppm), Gili Linus (0.0343 ppm), Surga Beach (0.0193 ppm). This is based on the regulation in PP No. 22 of 2021 that the threshold for Pb content is <0.008 mg/L for sea water. The heavy metal that polluted the southern coastal area of East Lombok came from waste. This Environmental NGO figure suspects that PT. AMNT's tailings were dumped into the sea in Senunu Bay.

Therefore, it is necessary to identify the lead concentration in Glaciralia sp found on Tanjung Luar Beach, whether it is contaminated above the threshold or not, where based on BPOM Regulation No. 23 of 2017, the Pb threshold value is around <0.2 ppm for consumption materials

2. Material and Method

2.1 Materials

Red macroalgae, Hydrochloric acid (HCL), Nitric acid (HNO3), Aquabidest, ICP-OES, measuring cup, beaker, analytical balance

2.2 Methods

The method used in this study is the transect method with quadrant transects. This method is used to collect data on the distribution and presence of red macroalgae in the waters of Tanjung Luar, East Lombok. The sampling location is shown in Figure 1, which consists of 33 square points from three transects. Coordinates of the 33 square points. The squares used are rectangular with a size of 50 x 50 cm. The distance between squares on the same transect line is around 5 m, so there are 11 squares along the 50 m transect line. The distance between transects is around 25 m.

Location 0 indicates the shoreline (0 m), location A is indicated by 5 m which is the distance of the sampling location from the shoreline, location B is indicated by 10 m, location C for 15 m, location D for 20 m, location E for 25 m, location F is marked by 30 m and so on up to location J for 50 m. the same applies to sampling points 1, 2 and 3 (Figure 1).

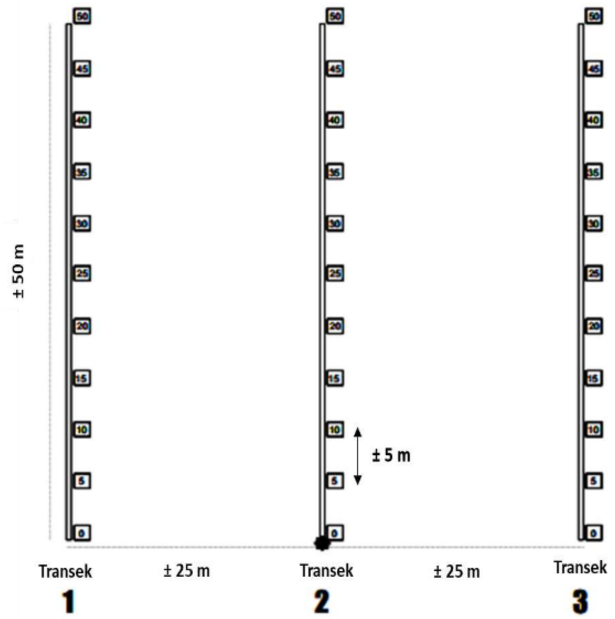

Figure 1. Sketch of the quadrant transect where samples of red macroalgae Gracilaria sp were taken.

Sample Determination

Morphological analysis of macroalgae samples was guided by an identification key (Jaasund, 1977; Koeman and Hoek, 1981; Atmadja et al., 1996; Ateweberhan et al., 2005; Lyer et al., 2013). Morphological analysis was carried out based on visual observation and documented using digital camera photos. Parameters observed included color, shape and branching of the thallus. The morphology of macroalgae samples was evaluated and compared with the morphology of macroalgae found in the literature. Some of the literature used were Miller et al. (1998), Kogame et al. (2001), McKenzie et al. (2003), Uwai et al. (2005) and Guiry and Guiry (2017 and 2018).

Sample Preparation

The sample preparation process carried out on red macro algae is quite important to prepare samples before further analysis. Sampling: macro samples of red algae are taken in large quantities 500 grams. This sample is then dried to remove moisture and maintain stability during the analysis process. Sample cutting: after dried, the red algae macro samples were cut into small and thin pieces. The purpose of this cutting is to reduce the surface area of the sample, thus making the subsequent drying process easier. Sample grinding: The sample pieces were then crushed using mortar and Stamper until it becomes small and fine flakes. This erosion is purposeful to speed up the sample destruction process, namely decomposing the sample with strong acid to obtain the analyte in solution

Destruction

The sample destruction process was carried out at the University's Integrated Laboratory Nahdlatul Ulama West Nusa Tenggara is an important step in sample preparation before testing using ICP-OES. Sample preparation: 1 gram macro sample of red algae was put into a beaker measuring 100 ml. The purpose of this step is to prepare a sample will be destroyed. Addition of aqua regia: aqua regia, which is a mixture of nitric acid (HNO3) and concentrated hydrochloric acid (HCl), are added to the glass beaker with a ratio of 3:1 (HNO3:HCl). A total of 4 ml of aqua regia added to the sample. Aqua regia is a strong acid that can dissolve heavy metals in the sample, including the heavy metal lead (Pb). Warmup: the sample to which aqua regia has been added is heated using hot plate at 80°C for 30 minutes. This heating process aims to dissolve the sample and turn it into a solution so that the content the elements in it can be measured. Cooling: after heating process Once completed, the sample is taken from the hot plate and cooled. This is done for Cool the sample so it is ready for the next step. Addition aquabidest: after the sample has cooled, aquabidest (purified water) is added to it in the sample until the volume increases to 25 ml.

Addition

Aquabidest aims to dilute the sample solution so that it is ready for use tested using ICP-OES. iltration: samples that have been digested and form a solution and then filter it using filter paper. Filtration process This aims to separate the solution from debris or other particles may be present in the sample. Testing with ICP-OES: filtered filtrate and clear, ready to be tested for metal content using ICP-OES. ICP OES is a spectroscopic analysis method for measuring the concentration of elements in samples.

Testing for Heavy Metal Lead (Pb) Levels

After the digestion process is complete, the organic substances in the sample will be taken and tested with ICP-OES spectrophotometry. ICP-OES spectrophotometry can determine up to 70 elements simultaneously, in an inert environment and atomization temperature higher, and has a lower analyte detection limit than AAS instrument.

3. Results and Discussion

3.1. Results

Only 15 samples were obtained from 33 points in the quadrant transect, while at point 1 collection location 5 samples were obtained from 5 points, namely points A (5 m), B(10 m), D (20 m), E (25 m) and F (30 m), point 0 (shoreline), points C, G, H, I and point J did not find *Gracilaria sp* samples.

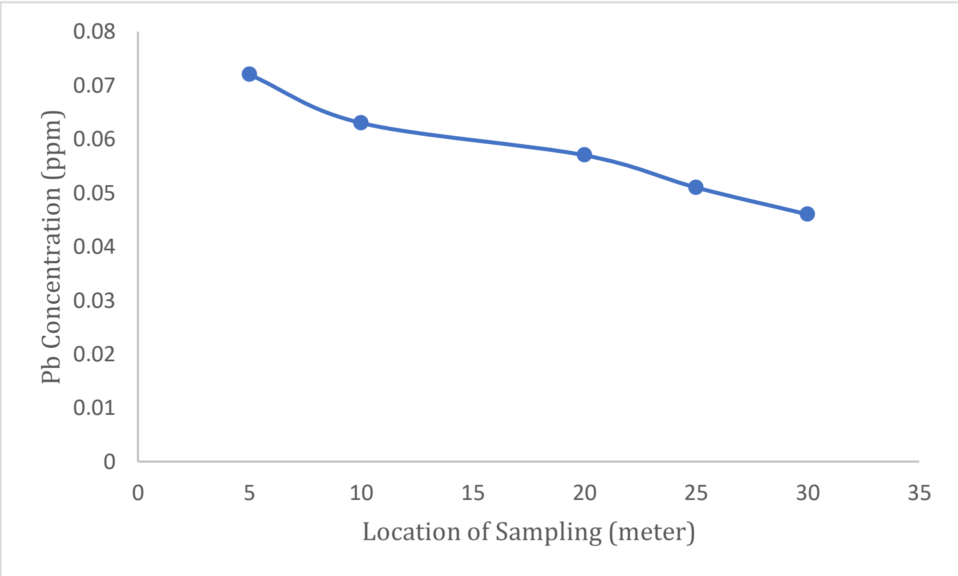

Figure 2. Graph of Pb concentration data in point 1 at each sampling location A (5 m), B (10 m), D (20 m), E (25 m) and F (30 m)

At Point 1, Gracilaria sp seaweed samples were taken from several distances starting from the shoreline. The following are the results of the concentration of heavy metal lead (Pb) at each sampling point, as seen in figure 2:

1. A distance of 5 meters (location A) obtained a concentration of heavy metal lead (Pb) of 0.072 ppm.
2. A distance of 10 meters (location B) obtained a concentration of heavy metal lead (Pb) of 0.063 ppm.
3. A distance of 20 meters (location D) obtained a concentration of heavy metal lead (Pb) of 0.057 ppm.
4. A distance of 25 meters (location E) obtained a concentration of heavy metal lead (Pb) of 0.051 ppm.
5. A distance of 30 meters (location F) obtained a concentration of heavy metal lead (Pb) of 0.046 ppm.

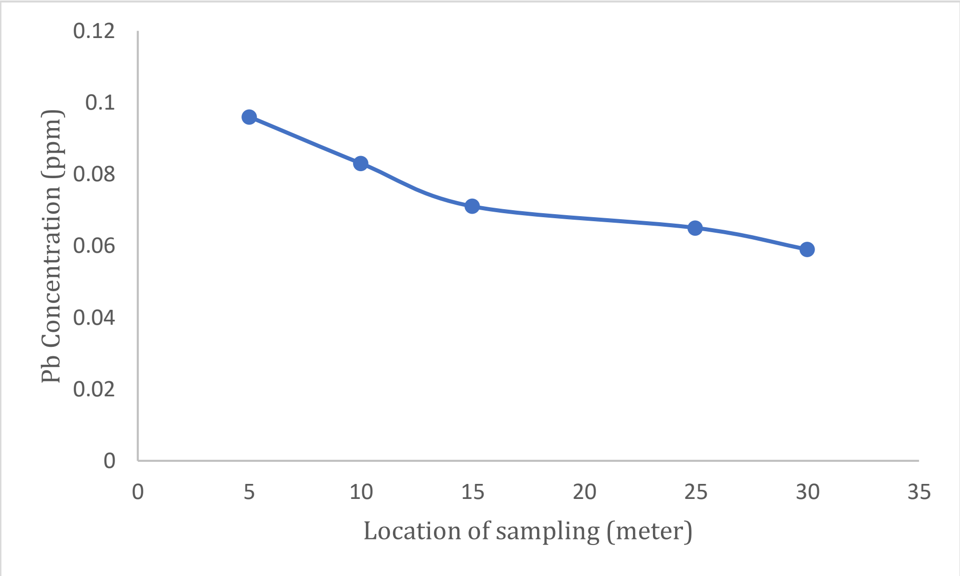

Figure 3. Graph of Pb concentration data in point 2 at each sampling location A (5 m), B (10 m), C (15 m), E (25 m) and F (30 m)

At Point 2, collection location 5 samples were obtained from 5 points, namely points A (5 m), B (10 m), C (15 m), E (25 m) and F (30 m), point 0 (shoreline), points D, G, H, I and point J did not find Gracilaria sp samples. The following are the results of the lead (Pb) heavy metal concentration at each sampling point, as seen in figure 3:

1. A distance of 5 meters (location A) obtained a lead (Pb) heavy metal concentration of 0.096 ppm.
2. A distance of 10 meters (location B) obtained a lead (Pb) heavy metal concentration of 0.083 ppm.
3. A distance of 15 meters (location C) obtained a lead (Pb) heavy metal concentration of 0.071 ppm.
4. A distance of 25 meters (location E) obtained a lead (Pb) heavy metal concentration of 0.065 ppm.
5. A distance of 30 meters (location F) obtained a lead (Pb) heavy metal concentration of 0.059 ppm.

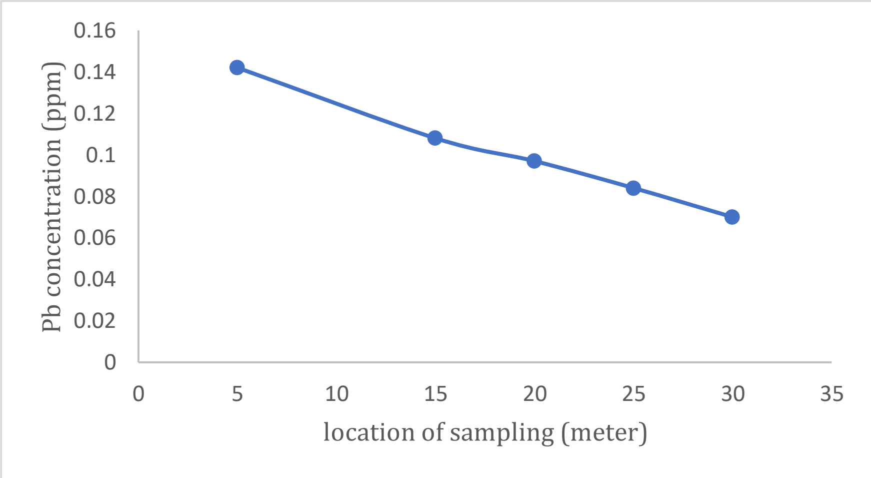

Figure 3. Graph of Pb concentration data in point 3 at each sampling location A (5 m), C (15 m), D (20 m), E (25 m) and F (30 m)

At Point 3, collection location 5 samples were obtained from 5 points, namely points A (5 m), C (15 m), D (20 m), E (25 m) and F (30 m), point 0 (shoreline), points B, G, H, I and point J did not find Gracilaria sp samples. The following are the results of the lead (Pb) heavy metal concentration at each sampling point, as seen in figure 4:

1. A distance of 5 meters (location A) obtained a lead (Pb) heavy metal concentration of 0.142 ppm.
2. A distance of 15 meters (location C) obtained a lead (Pb) heavy metal concentration of 0.108 ppm.
3. A distance of 20 meters (location D) obtained a lead (Pb) heavy metal concentration of 0.097 ppm.
4. A distance of 25 meters (location E) obtained a lead (Pb) heavy metal concentration of 0.084 ppm.
5. A distance of 30 meters (location F) obtained a lead (Pb) heavy metal concentration of 0.070 ppm.

3.2. Discussion

The heavy metal lead (Pb) in the waters of Tanjung Luar, East Lombok is suspected to come from PT. AMNT tailings waste which is dumped into the sea in Senunu Bay, based on data from the "REA CoFish Project 2022" of the Ministry of Maritime Affairs and Fisheries, their data states that a number of locations on the southern coast of East Lombok are contaminated with heavy metal Lead (Pb), one of which is located in Tanjung Luar with Pb contamination of 0.0163 ppm (where the threshold for Pb content in seawater is <0.008 ppm) (Hidayatullah, et al., 2023).

In addition, it is suspected that the lead (Pb) found in the waters of Tanjung Luar, East Lombok comes from natural sources, rainwater can crystallize lead (Pb) in the air, and the process of mineral rock corrosion is one way for lead (Pb) to enter the waters (Azizah et al., 2018). Neurotoxins are the properties of heavy metal lead (Pb). can enter and accumulate in the human body, animals, and plants. Heavy metals can enter the bodies of aquatic organisms through the gills, body surface, digestive tract, muscles, and heart. The toxicity of the heavy metal lead (Pb) is more important as a therapy. The body absorbs lead (Pb) very slowly, which causes accumulation and triggers poisoning (Septriani et al., 2023).

The distribution graph of heavy metal lead (Pb) showing a decrease from each sampling point on red macroalgae shows variations in heavy metal concentrations in the waters. The decrease in lead (Pb) concentration along with the increasing distance from the coastline to the middle of the sea in the Tanjung Luar Waters of East Lombok can be interpreted that the distribution of tailings contamination that has polluted seawater affects the concentration of Pb in macroalgae Gracilaria sp. dimming each point. The closer the sampling location is to the coastline, the higher the concentration of heavy metal lead (Pb) in red macroalgae Gracilaria sp. Conversely, the further from the coastline, the concentration of heavy metal lead (Pb) in red macroalgae Gracilaria sp. is getting lower (Siaka, 2016).

This could be due to the lifespan of *Gracilaria sp*. At each point, where Gracilaria sp. is able to absorb heavy metals in high concentrations at the beginning of planting and is able to release them again before harvest, so that the older the age of Gracilaria sp. The lower the Pb content. This is in accordance with the results of a study that measured the Pb content in sampling Gracilaria sp. where 20 days in Pond 1 were 7.61 ppm and Pond 2 were 5.35 ppm. Analysis of Pb levels in the holdfast and talus of Gracilaria sp. obtained the highest Pb content at the age of 0 days before planting, which was 3.38 ppm and decreased until the post-harvest age of 40 days, which was 0.84 ppm (Tega et al, 2019). So it is still below the permitted threshold.

Factors that can affect the distribution of heavy metal lead (Pb) in waters include the amount and type of human activities that produce heavy metal waste, air discharge, wind direction, and physical and chemical conditions of the waters. Therefore, spatial monitoring of lead (Pb) heavy metal levels in waters is important to determine its distribution pattern and identify potential sources of pollution. Efforts to manage and overcome heavy metal pollution in waters need to be carried out to maintain environmental quality and human health (Siaka, 2016).

Conclusion

The results of the study showed that all sampling points of Gracilaria sp did not exceed the threshold, which was less than 2 mg/kg. where at the sampling location point 1 had Pb concentrations of 0.072 ppm (location A), 0.063 ppm (location B), 0.057 ppm (location D), 0.051 ppm (location E) and 0.046 ppm (location F). for point 2 had Pb concentrations of 0.096 ppm (location A), 0.083 ppm (location B), 0.071 ppm (location C), 0.065 ppm (location E) and 0.059 ppm (location F). for point 3, the Pb concentrations were respectively 0.142 ppm (location A), 0.108 ppm (location C), 0.097 ppm (location D), 0.084 ppm (location E) and 0.070 ppm (location F).

References

Affandi, A. S., Rahardja, B. S., & Suprapto, H. (2017). Pengaruh Kombinasi Biofilter Dan Zeolit Terhadap Logam Berat Timbal (Pb) Pada Media Air Laut , (2), 10-17.

Alhafizoh, F. (2021). Kandungan Logam Berat Pada Alga Hijau Di Perairan Way Ratai Kabupaten Pesawaran Provinsi Lampung.

Amanda, R., Nuraini, R. A. T., & Supriyantini, E. (2021). Korelasi Antara Daya Serap Terhadap Konsentrasi Logam Berat Cu di Media Pemeliharaan. Journal of Marine Research, 10(3), 363-368 .

Anggadiredja, J.T., A. Zatnika, H. Purwato, & S. Istini. 2008. Rumput laut, pembudidayaan, pengolahan dan pemasaran komoditas perikanan potensial. Penebar Swadaya: Jakarta.

Bila, V. S. (2022). Analisis Logam Berat Pb Dan Cd Pada Rumput Laut *(Eucheuma Cottonii),* Air Dan Sedimen Pada Daerah Budidaya Kabupaten Bantaeng Dengan Menggunakan Spektrofotometer Serapan Atom (SSA). (*Doctoral Dissertation*, Universitas Hasanuddin).

Cornish, M., D. Garbary. 2010. Antioxidants from macroalgae: potential applications in human health and nutrition. *Algae.* 25. 155171.

Guiry, M.D. dan Guiry, G.M. (2018): AlgaeBase, www.algaebase.org.

Harahap, M. R., Yulian, M., & Agusti, A. N. (2019). Analisis Logam Timbal Dan Tembaga Terhadap Daya Serap Rumput Laut *Gracilaria Sp*. Sebagai Biosorben. *Amina*, *1*(2), 45-58.

Hartati, R.I., Riyantini, & A. Djunaedi. 1993. Pemantauan Logam-Iogam Berat pada Kenangkerangan yang Dihasilkan dari Perairan Pantai Utara Gunung Muria, PPLH Undip, Semarang, 38 Hal.

Hidayatullah, N., Yasir, I., & Tahir, A. (2023). Heavy Metals Content of Copper (Cu) and Lead (Pb) in Codium Fragile Seaweed. *Jurnal Ilmu Kelautan SPERMONDE*, 27-32.

Iyer, R., De Clerck, O., Bolton, J. J., Coyne, V. E., & Sym, S. D. (2013): Morphological and taxonomic studies of Gracilaria and Gracilariopsis species (Gracilariales, Rhodophyta) from South Africa, *South African Journal of Botany*, **70**(4), 521–539.

Jaasund, E. (1976): *Seaweeds in Tanzania: A field guide*, University of Tromsø,Tromsø, 160.

Kementrian Kelautan dan Perikanan RI. REA Proyek Cofish. Kawasan Pesisir Selatan Lombok Timur Tercemar Logam Berat Timbal. November 2022. NTB Poss.

Kogame, K., Uwai, S., & Kawaguchi, S. (2001): First record of Asteronema rhodochortonoides (Phaeophyceae) for the Pacific Ocean. *Phycological Research*, **49**(4), 281–284.

Laut, A. (2016). Distribusi Logam Berat Pb Dan Cu Pada Air Laut, Sedimen, Dan Rumput Laut Di Perairan Pantai Pandawa.

Millar, A.(2011): Marcroalgae, New South Wales Department of Primary Industries, Sydney.

Nontji, A. 1993. Laut Nusantara: Djambatan, Jakarta.

Peraturan Badan Pengawas Obat Dan Makanan (BPOM) Nomor 23 Tahun 2017 Tentang Batas Maksimum Cemaran Logam Berat Dalam Pangan Olahan.

Peraturan Pemerintah Republik Indonesia Nomor 22 Tahun 2021 tentang Penyelenggaraan Perlindungan dan Pengelolaan Lingkungan Hidup.

Phang, S.M., H.Y. Yeong, P.E. Lim, A.R.M. Nor, K.T. Gan. 2010. Commercial varieties of *Kappaphycus* and *Eucheuma* in Malaysia.*Mal. J. Sci.* 29(3). 214-224.

Puspaningrum, D. A. D. (2021). Pengaruh waktu detensi tumbuhan eceng gondok (*Eichornia crassipes (Mart.) Solms*) terhadap penyerapan timbal (pb) sebagai sumber belajar biologi *(Doctoral dissertation*, Universitas Muhammadiyah Malang).

Saraswati, A. R., & Rachmadiarti, F. (2021). Analisis Kandungan Logam Berat Timbal (Pb) Pada Rumput Laut Di Pantai Sendang Biru Malang. Lenterabio: Berkala Ilmiah Biologi, 10(1), 67-76.

Tega, Y. R., Herawati, E. Y., & Kilawati, Y. (2019). Heavy Metal (Pb) and Its Bioaccumulation in Red Algae (Gracilaria sp.) At Kupang Village, Jabon Sub-District, Sidoarjo District. *The Journal of Experimental Life Science*, *9*(2), 139-146.