

PAPER • OPEN ACCESS

Pb heavy metal distribution patterns in seaweed (*Kappaphycus alvarezii*) cultivation locations by season in Bantaeng Waters, South Sulawesi

To cite this article: A Asni and Najamuddin 2020 *IOP Conf. Ser.: Earth Environ. Sci.* **564** 012037

View the [article online](#) for updates and enhancements.

A promotional banner for the PRiME 2020 conference. The background is a dark blue space-themed image with a globe and satellite lines. On the left, there are three circular logos: ECS (Electrochemical Society), The Electrochemical Society, and The Korean Electrochemical Society. The central text reads 'Joint International Meeting PRiME 2020 October 4-9, 2020' in white and blue. Below this, a blue bar contains the text 'Attendees register at NO COST!'. On the right, there is a large logo for 'PRiME' with 'PACIFIC RIM MEETING ON ELECTROCHEMICAL AND SOLID STATE SCIENCE' and '2020' below it. At the bottom right, a blue button says 'REGISTER NOW' with a right-pointing arrow.

ECS
The Electrochemical Society
The Korean Electrochemical Society

Joint International Meeting
PRiME 2020
October 4-9, 2020

Attendees register at **NO COST!**

PRiME
PACIFIC RIM MEETING
ON ELECTROCHEMICAL
AND SOLID STATE SCIENCE
2020

REGISTER NOW ►

Pb heavy metal distribution patterns in seaweed (*Kappaphycus alvarezii*) cultivation locations by season in Bantaeng Waters, South Sulawesi

A Asni¹ and Najamuddin²

¹Teaching staff at Faculty of Fisheries and Marine Science, Indonesia Moslem University

²Teaching staff at Faculty of Marine Science and Fisheries Hasanuddin University

Email: andiasni26@gmail.com

Abstract. Heavy metals found in the waters can be absorbed and accumulated in the seaweed thallus. Heavy metals affect plants by changing the position of essential ions in cells. Seaweed is useful in absorbing heavy metals so that the heavy metals contaminating the water can enter the seaweed thallus. This research was conducted at the seaweed cultivation location in the coastal waters of Bantaeng Regency, South Sulawesi. The method used is a survey and laboratory testing. Each location is determined by 3 substations (short, medium, and long-distance). Water and seaweed sampling at each station are carried out twice a month. Pb heavy metal analysis from water and seaweed samples was carried out in the laboratory of the Faculty of Mathematics and Natural Sciences of Hasanuddin University. Distribution pattern of Pb heavy metal content with spatial analysis of Geographic Information Systems (GIS) based on a mapping approach. The results showed that the concentration of Pb heavy metals in waters during the rainy season ranged from 0.25 to 0.98 ppm and during the dry season ranged from 0.20 to 1.13 ppm, whereas seaweed in the wet season ranged from 4.64 to 7.00 ppm and in the dry season ranged from 1.20 to 20.87 ppm. Pb heavy metal distribution patterns in waters and seaweed are high in areas close to the coast and low in areas far from the coast. The average concentration of Pb heavy metals in waters and seaweed is higher in the dry season than in the rainy season. The content of Pb heavy metal in water has exceeded the threshold for the designation of fishery water 0.08 ppm (KEP. MENLH N0 51, 2004). The content of Pb heavy metals in seaweed has passed the threshold for food 2.0 ppm.

1. Introduction

Along with the rapid progress of the times, the activities of the population, both in terms of the settlement, agriculture, and industry, will increase. This results in increased disposal of waste from human activities that will end up in river and sea waters. As a result, the quality of marine waters has dropped and become polluted.

One of the pollutants due to human activities is heavy metal lead (Pb). The presence of Pb heavy metals in the waters can directly endanger the life of marine aquatic organisms, and indirectly threaten



human health through food chain contamination. The nature of heavy metals that are difficult to decompose can easily accumulate in aquatic environments, sediments, as well as in marine life. Heavy metals are generally toxic to living things, although some of them are needed in small quantities [1].

Seaweed is one of the abundant biological resources in Indonesian waters. Seaweed, as a marine macroalga, is a major source of carrageenan, alginate, and agar, which are multipurpose in various aspects of human life. One type of seaweed that is abundant and has a high economic value is *Kappaphycus alvarezii*, it contains carrageenan, which has been widely used as raw materials in the food, cosmetics, feed, fertilizer, textile, paper and so on. Seaweed has the ability of biofilter that can absorb compounds in the water, including heavy metal lead (Pb). Seaweed has the ability to absorb nutrients dissolved in the waters and also absorb heavy metals dissolved in the waters with a high enough concentration so that it can also be used as a bioindicator of pollution as well as biocontrol of water [2].

One of the seaweed producing areas in South Sulawesi is Bantaeng Regency. Bantaeng Regency is on the southern coast of Sulawesi Island and has a coastline of 27.5 kilometers. Along the coast, there is a large potential of marine fisheries, including the development of seaweed, the area of seaweed cultivation reaches 875 hectares [3]. However, the location of cultivation in these coastal waters has been feared to be contaminated with pollutants, including Pb heavy metals because it is very close to highways, rivers, and cities. Seeing the condition of coastal waters that are close to urban centers and streams that continually get waste from land and surrounding waters, then the heavy metal elements that enter the waters can reduce the environmental feasibility and food safety, especially on the quality of seaweed cultivation commodities. The results of the study [4] showed that waters near the coast had higher heavy metal content compared to outer waters far from the coast, Pb 0.796 mg / L, Cu 0.62 mg / L, Zn 0.060 mg / L, whereas in the outer waters far from the coast Pb 0.699 mg / L, Cu 0.55 mg / L, Zn 0.55 mg / L.

The quality of seaweed is very important because it is one of the success factors of seaweed entering the market and accepted by consumers. Therefore seaweed as an export commodity is very vulnerable if it contains heavy metals, where the content of heavy metals is one of the parameters in the seaweed quality standards.

This study aims to analyze the spreading pattern of Pb heavy metals in seaweed (*Kappaphycus alvarezii*) spatially and temporally in the coastal waters of Bantaeng Regency.

2. Materials and methods

The material used in this study is seaweed (*Kappaphycus alvarezii*), which is cultivated in Bantaeng waters.

2.1. Data collection

This study was conducted by survey method in seaweed cultivation locations that have been done by farmers and laboratory testing. The location of the study was conducted in three districts, namely Bissappu (Station A), Bantaeng (Station B), and Paju'kukang (Station C). At the observation station, three substations are determined by transect point based on the distance from the coastline, which is around 0 - 500 m (near), 500 - 1000 m (medium), and 1000 - 1500 m (far). Each station is determined by three substations as a repeat point.

Observation of the quality of water and seaweed content of heavy metals is carried out by taking about 200 grams of seaweed-based on the season and distance from the coastline at the location of seaweed farmers in accordance with a predetermined station. Then seaweed samples were analyzed for heavy metal content in the chemistry laboratory of the Faculty of Mathematics and Natural Sciences at Hasanuddin University.

2.1.1. Analysis of pb heavy metal in seaweed. Analysis of heavy metals was carried out using AAS (Atomic Absorption Spectrophotometry). Determination of heavy metals using Beer-Lambert Law:

$$A = a \times b \times c \quad (1)$$

Where:

A = Absorbance

a = Tetapan

b = Tetapan (tebalnya Kuvet)

c = Konsentrasi logam

2.1.2. analysis procedure for heavy metals in seaweed: The heavy metal to be analyzed is Pb. The procedure for analyzing metals in seaweed is as follows:

- Test samples of dried seaweed were taken as much as 1 gram
- Then the sample is mashed and then put into a beaker glass
- Added 10 mL of concentrated HNO_3 and stirred slowly until mixed
- Added HClO_4 60%
- Then heated it on the Hot Plate (raise the temperature of the Hot Plate slowly), until it is almost dry
- Added 10 mL of HNO_3 and continue heating it until the white smoke disappears
- Cooled and added 10 mL of HCL 1: 1 and transferred to a 50 mL volumetric flask, mixed with distilled water
- Metals are measured using Atomic Absorption Spectrophotometry (AAS)

2.2. Data analysis

Spatial analysis was carried out with a Geographic Information System (GIS) based on a mapping approach that is applied to determine the condition of seaweed quality on Pb heavy metals spatially and temporally.

3. Results and discussion

3.1. Pb Heavy metals in waters

In general, Pb heavy metal concentrations in the waters of the study site, during the rainy and dry seasons, were obtained between 0.25 - 0.98 ppm and 0.20 - 1.13 ppm. The pattern of Pb heavy metal distribution in waters during the rainy and dry seasons was highest in the waters around Station C and lowered in the waters around Station A and Station B (Figures 1 and 2).

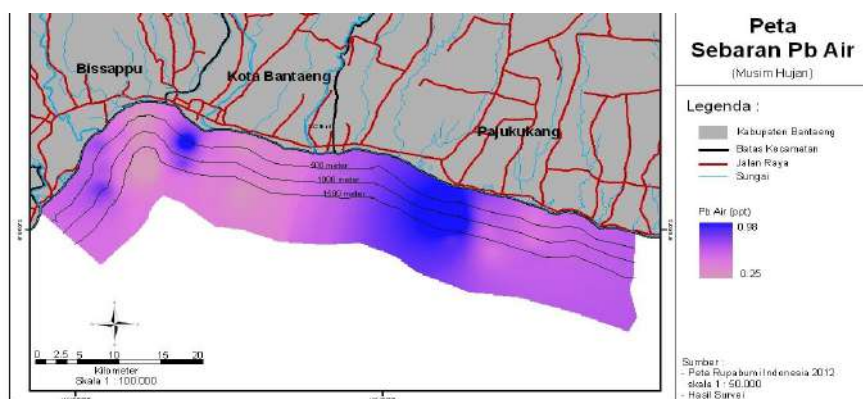


Figure 1. Map of Pb distribution in waters during the rainy season.

Whereas the Pb heavy metal distribution pattern in waters, in general, is found to be relatively high in areas close to the coast and decreases in distant areas as it approaches the high seas, resulting

in dilution and mixing of seawater. The concentration of Pb heavy metals in waters tends to decrease with increasing distance from the source [5].

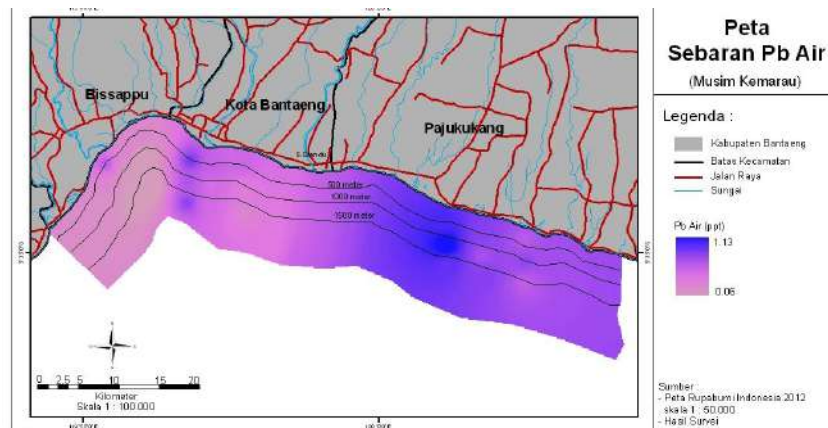


Figure 2. Map of Pb distribution in waters during the dry season.

The results of measurements of the average Pb heavy metals in waters during the rainy and dry seasons are highest at Station C, respectively $0.70 \text{ ppm} \pm 0.17$ and $0.85 \text{ ppm} \pm 0.11$ at close range (Figure 3). Pb heavy metal measurement data during the study are presented in Appendix 1. The average concentration of Pb heavy metals in waters in the dry season is higher than in the rainy season. In the rainy season, dilution occurs due to rainwater so that the concentration of Pb heavy metals in waters decreases, whereas in the dry season the current pattern tends to be quieter and less dilution occurs so that the concentration of Pb heavy metals in waters in all sampling locations tends to be high.

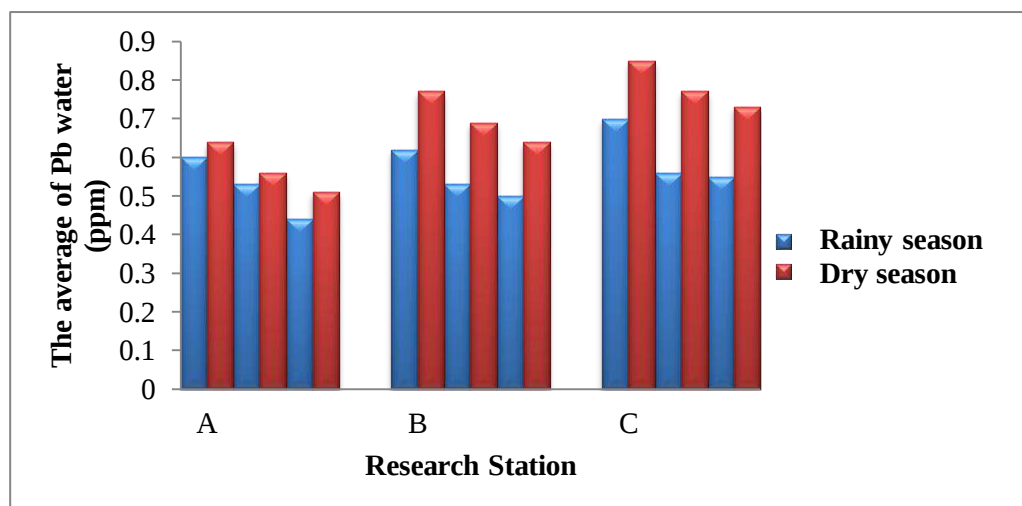


Figure 3. The average content of Pb water in waters during the rainy and dry season.

The content of Pb water in waters during observation at the study site had passed the threshold for the designation of fishery water 0.08 ppm (KEP. MENLH N0 51, 2004). However, the growth of seaweed so far has been good, and it means that the presence of Pb heavy metals in the waters has not been the main thing inhibiting the growth of seaweed in the coastal areas of Bantaeng Regency [6].

The concentration of Pb heavy metals in waters is sourced from air, soil, waters, and human activities on land [5]. Furthermore, it is said that Pb metal is a pollutant in the sea, which is very dangerous for marine life and marine plants. Pb metal is used in the modern industry as a material for making water pipes, while Pb pigment is used as the manufacture of paints, batteries, and a mixture of tetracetyl gasoline fuel, which functions as a lubricant so that the engine works well.

3.2. Pb metal in seaweed

In general, the Pb heavy metal concentrations in seaweed at the study site during the rainy and dry seasons were found to range between 4.64 - 7.00 ppm and 1.20 - 20.87 ppm. The pattern of Pb heavy metal distribution in waters during the rainy and dry seasons is highest in the waters around Station C, and the lower is obtained leading to waters around Station A and Station B (Figure 4). Pb heavy metal distribution pattern in waters, in general, is found to be relatively high in areas close to the coast and decreases in distant areas as it approaches the high seas, resulting in dilution and mixing of seawater. The concentration of Pb heavy metals in waters tends to decrease with increasing distance from the source [7].

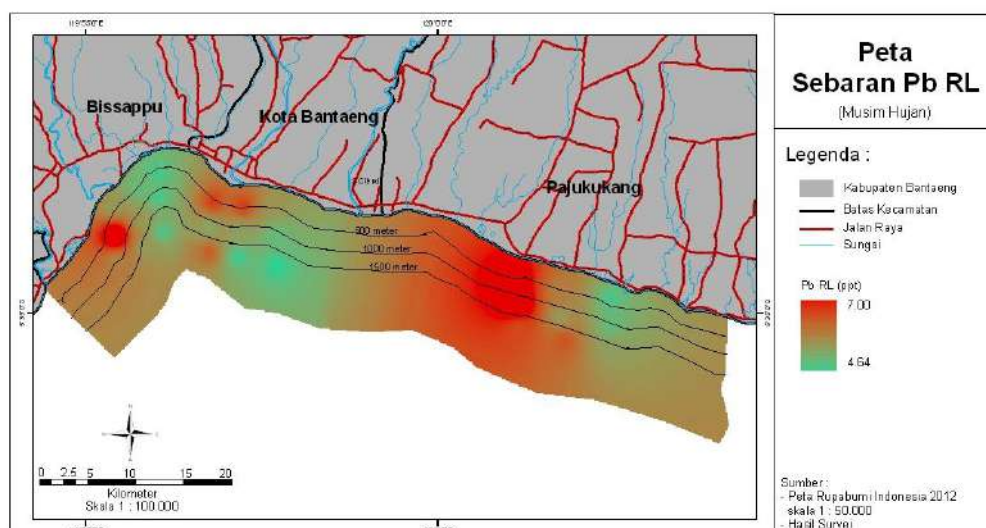


Figure 4. Map of Pb seaweed distribution during the rainy season.

The concentration of Pb heavy metal in high waters in the waters of Station C is caused by several factors, including transportation fuel emissions from land and ships at sea and also strongly influenced by the existence of a Fish Landing Place at that location. Combustion of fuel oil by ships is the biggest contribution of lead (Pb) pollution in the waters. The heavy metal lead contained in the fuel as an anti-oil solver (such as Pb tetraethyl and tetramethyl) is then released into the atmosphere through a smoke removal device, and this part is then dissolved in the sea [8].

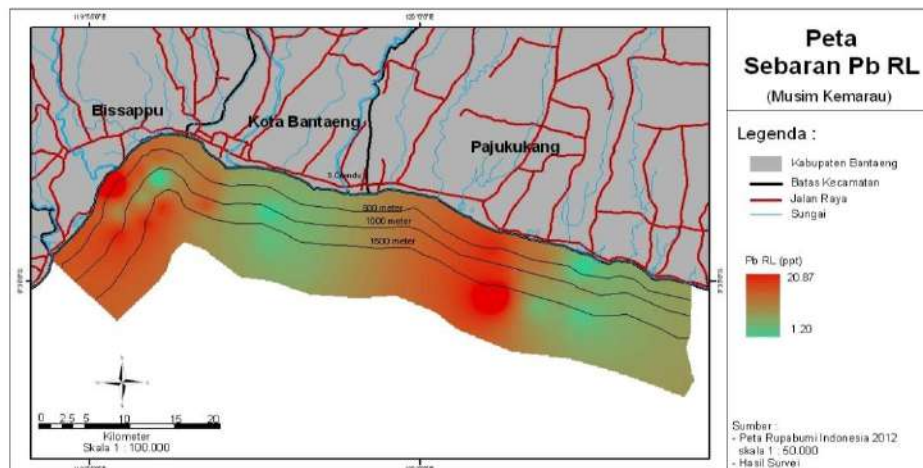


Figure 5. Map of Pb seaweed distribution during the dry season.

The highest average measurement of Pb heavy metal in seaweed during the rainy season at Station C is $5.52 \text{ ppm} \pm 1.18$ at close range. Whereas in the dry season, the highest average measurement of Pb seaweed at Station C is $12.48 \text{ ppm} \pm 5.80$ at close range (Figure 6). The content of Pb heavy metals in seaweed is higher in the dry season than in the rainy season. Similar studies have been carried out [9] bioaccumulation of Pb heavy metals in seaweed is higher in the summer than in the rainy season.

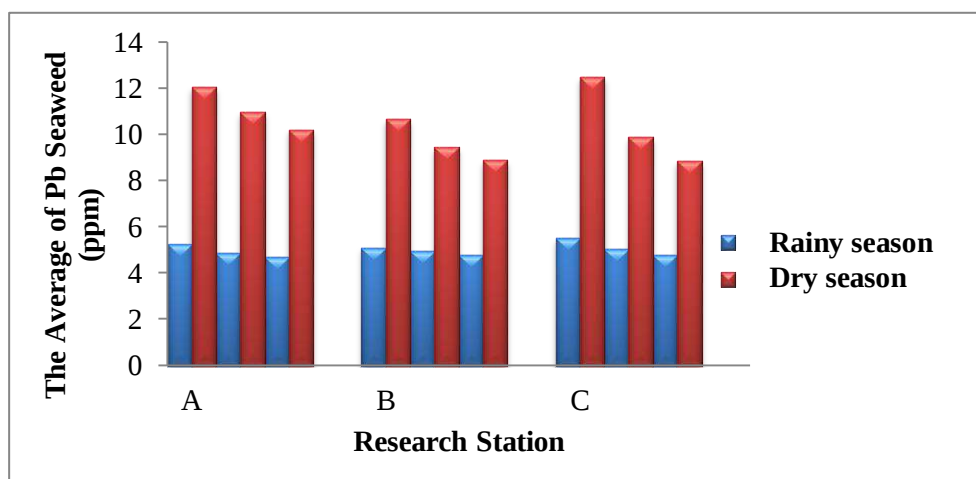


Figure 6. The average content of Pb seaweed during the rainy and dry season.

The content of Pb heavy metals in seaweed from the three research locations has passed the threshold for foodstuffs 2.0 ppm [10]. The high heavy metal Pb in seaweed due to the water already contained Pb heavy metals. The greater the concentration of Pb media and the longer the exposure, the greater the Pb that accumulates in seaweed tissue [11]. This is consistent with the results of the study [12] on the concentration of heavy metals in seaweed around the coastal waters of the City of Parepare that the highest average content of Pb heavy metal in seaweed is 0.85 ppm. The study of [13] found that *Eucheuma cottonii* cultivated in Situbondo waters accumulated Pb with an average concentration ranging from 0.19-0.94 ppm, which caused the growth rate of *Eucheuma cottonii* to decrease.

While the results of the study conducted in the waters of Tonra Bone found the average content of Pb in tallus species of *K. alvarezii* seaweed is quite high ($10.39 \pm 2.92 \text{ ppm}$) and in tallus *Eucheuma denticulatum* ($14.53 \pm 1.96 \text{ ppm}$) [14]. Meanwhile, the results of the content of Pb heavy metals in seaweed *K. Alvarezii* at different ages in Takalar Regency, were weeks 0 to week VI, Pb = 1.909 – 14.840 mg/kg. *Eucheuma cottonii* is a seaweed that has the ability to accumulate Pb in its thallus.

The results of the study on the concentration of heavy metals in seaweed around the coastal waters of the City of Parepare, that the content of Pb heavy metals in seaweed shows the highest average is 0.85 ppm [15]. Found that *Eucheuma cottonii* cultivated in Situbondo waters accumulates Pb with an average concentration ranging from 0.19 – 0.94 ppm, which causes the growth rate of *Eucheuma cottonii* to decrease [16]. *Eucheuma cottonii* is a seaweed that has the ability to accumulate Pb in its thallus. The greater the concentration of Pb media and the longer the exposure, the greater the accumulated Pb [17].

4. Conclusion

The content of Pb heavy metal in the waters and seaweed during the dry season is higher than during the rainy season at a distance of near-shore cultivation and has passed the threshold for foodstuffs.

Acknowledgement

The researches would like to thank the Director for Research and Community Service, Directorate of Higher Education, Ministry of Research, Technology, and Higher Education for funding the research. The thanks also to Dean Faculty of Fisheries and Marine Science, Indonesia Moslem University, Head of Research and Resources Board of Indonesia Moslem University for their support and cooperation, and research member and also all participants that contributed to the research.

References

- [1] Paz S, Rubio C, Frías I, Gutiérrez Á J, González-Weller D, Martín V, Revert C and Hardisson A 2019 Toxic metals (Al, Cd, Pb and Hg) in the most consumed edible seaweeds in Europe *Chemosphere* **218** 879–84
- [2] Arulkumar A, Nigariga P, Paramasivam S and Rajaram R 2019 Metals accumulation in edible marine algae collected from Thondi coast of Palk Bay, Southeastern India *Chemosphere* **221** 856–62
- [3] Bantaeng B dan B 2018 *Data Statistik Kabupaten Bantaeng* (Kabupaten Bantaeng)
- [4] Samawi M F, Tambaru R and Metusalach 2009 *Studi Kandungan Keraginan Rumpun Laut Eucheuma spinosum Pada Berbagai Umur Panen. Laporan Akhir Hibah kompetitif penelitian sesuai prioritas nasional* (Makassar)
- [5] Rompas R M 2010 Toksikologi kelautan *Jakarta Sekr. Dewan Kelaut. Indones.*
- [6] Yu Z, Robinson S M C, Xia J, Sun H and Hu C 2016 Growth, bioaccumulation and fodder potentials of the seaweed *Sargassum hemiphyllum* grown in oyster and fish farms of South China *Aquaculture* **464** 459–68
- [7] Roleda M Y, Marfaing H, Desnica N, Jónsdóttir R, Skjermo J, Rebours C and Nitschke U 2019 Variations in polyphenol and heavy metal contents of wild-harvested and cultivated seaweed bulk biomass: Health risk assessment and implication for food applications *Food Control* **95** 121–34
- [8] Luo H, Wang Q, Liu Z, Wang S, Long A and Yang Y 2019 Potential Bioremediation Effects of Seaweed *Gracilaria lemaneiformis* on Heavy Metals in Coastal Sediment from a Typical Mariculture Zone *Chemosphere* 125636
- [9] Rajaram R, Rameshkumar S, and Anandkumar A 2020 Health risk assessment and potentiality of green seaweeds on bioaccumulation of trace elements along the Palk Bay coast, Southeastern India *Mar. Pollut. Bull.* **154** 111069
- [10] Badan Standardisasi Nasional 2010 Penentuan Batas maksimum cemaran logam berat dalam Pangan (SNI) 01-289-1998
- [11] Søndergaard J, Asmund G, Johansen P, and Elberling B 2010 Pb isotopes as tracers of mining-related Pb in lichens, seaweed, and mussels near a former Pb-Zn mine in West Greenland *Environ. Pollut.* **158** 1319–26
- [12] Azizah, R., Malau R, Susanto A B, Santosa G W and Hartati R 2018 Kandungan Logam Berat

- Timbal (Pb) Pada Air , Sedimen , Dan Rumpun **21** 155–166
- [13] Munir 2009 *Studi kandungan Logam Berat Pb dan Cd Pada Rumpun Laut (Kappaphycus alvarezii) Pada Umur yang Berbeda* (Universitas hasanuddin. Makassar)
- [14] Imah M M, Masak P P . and Tjaronge M 2007 *Kalender Musim Budidaya Rumpun Laut, Kappaphycus alvarezii dan Eucheuma denticulatum di pantai Timur dan Selatan Sulawesi Selatan* (Maros)
- [15] Djalil S N 2000 *Study Kandungan Logam Berat Pb Pada Rumpun laut (Eucheuma cottonii) yang Dibudidayakan Di Pantai Kotamadya Parepare* (Universitas Muslim Indonesia, Makassar)
- [16] Silvanandya 2003 *Studi Kandungan Logam Berat Pb Dalam Rumpun Laut (Eucheuma cottonii) Hasil Budidaya di Perairan Situbondo* (Institut Teknologi Sepuluh Nopember, Surabaya)
- [17] Filote C, Volf I, Santos S C R and Botelho C M S 2019 Science of the Total Environment Bioadsorptive removal of Pb (II) from aqueous solution by the biore fi nery waste of Fucus spiralis Sci. Total Environ. **6** 1201–1209