Study on the Level of Mercury Pollution in Sea Water around TanjungBayang Beach, Kota Makassar

Faishal Kirman, Achmad Zubair, Riswal K.

Abstract: Increasing heavy metals in seawater will cause heavy metals that were originally needed for metabolic processes will turn out to be toxic to organisms in the sea. Besides being toxic, heavy metals will also accumulate in biota and sediment through the gravity process. This research was conducted around TanjungBayang Beach in Makassar City in January 2017. Sampling was carried out at 3 stations and 9 points. This research is to measure physical and chemical parameters in sea water, heavy metal content of Hg in water, sediment, and marine biota. These results are then analyzed by the method of bio concentration of mercury metal in marine biota. The results of this study indicate that mercury content in sea water is <0,0005 mg / l on average. This sea water level is still low from the KEPMENLH 51 Threshold Value of 2004. Mercury levels in sediments are between 0.0156 - 0.0217 mg / kg, fish 0.0501 - 0.0796 mg / kg, and sea slugs 0.0516 - 0.2068 mg / kg. The levels of mercury in sediments and marine biota are still below the threshold value. The ability of fish and sea snails to accumulate heavy metal mercury (Hg) is indicated by the value of bio concentration factors (FBo-w) which are between 100.2 - 413.6 and (FBo-s) between 2.308 - 13.256.

Keywords: Bio concentration, mercury pollution, sea water.

I. INTRODUCTION

Humans as living creatures require very small amounts of metals such as manganese(Mn), iron (Fe), copper(Cu) and zinc(Zn) because they are very essential micronutrients, but there are several other metals such as mercury (Hg), cadmium(Cd), lead(Pb) and nickel(Ni) which are very unexpected in their existence in the body of living things even in very small amounts. Heavy metals transferred to waters, either rivers or sea will undergo processes such as deposition, adsorption and absorption by aquatic organisms [1].

Heavy metals enter the waters through rainwater, surface water flow, erosion, and human activities such as industry, mining, processing or use of metals and metal-containing materials.

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The entry of heavy metals into the body of aquatic organisms can be through the food chain and diffusion through the skin and gills resulting in bioaccumulation of heavy metals in the body of the organism [2]. Daily activities in the neighborhood or household like laboratory, pharmaceutical, and paint spills are a source of mercury pollution. Another activity that is a source of Hg pollution is the practice of dentists who use amalgam as dental filler [3].

Heavy metals are toxic because they cannot be destroyed (non-degradable) by living organisms in the environment so that the metals accumulate into the environment, especially settling in the bottom of the water and forming complex compounds with organic and inorganic materials. Ethyl mercury absorption reaches 95%, Hg contamination in humans can occur through the food chain, drinks, and breathing, and skin contact. Exposure to the skin line is usually in the form of compounds $HgCl_2$ or K_2HgI_4. The amount of Hg absorbed depends on the entry point, length of exposure, and the form of mercury compounds. If mercury gas is inhaled, it will cause bronchitis. Most of the mercury metal will accumulate in the kidneys, brain, liver and fetus. In the organ, the Hg metal will turn into an inorganic compound, then mercury will be removed through dirt, urine and breathing [4.]The form of mercury problem that often occurs in a population is methyl mercury from contaminated fish, organic mercury from food, and pure mercury from dental amalgam restoration. If the distribution of methyl mercury in the body by the compartment, and mercury mixes with more complex elements, it can interfere with brain tissue because the element enters the blood and mixed with the blood. If the element of mercury complex enters the brain tissue through the bloodstream, then the patient will experience a mental disorder and will eventually die [5].

Some research results on the quality of the waters around TanjungBayang namely the Jeneberang River Estuary and Losari Beach shows that several water quality parameters have been polluted. This is based on increasing organic matter and heavy metal content that crosses maximum limits. The decline in water quality will affect the people who use the waters of TanjungBayang for nautical tourism purposes or other purposes [5-7].Based on the description above problems, this study looked into the metal contamination levels of Hg in seawater around TanjungBayang Makassar City.

II. METHODOLOGY

1. Location of Study

This research was conducted at TanjungBayang Makassar City to examine the level of sea water pollution with metal parameters. The study area consisted of 9 sampling points. Shadow cape coast coordinates are 5 ° 11'3 "S 119 ° 23'9" E.

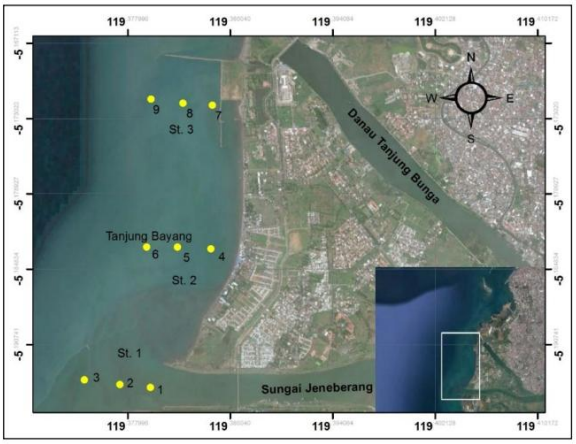

Fig. 1 Map Location of Sampling Water, Sediment and Biota

(Station 1): Represents Jeneberang river estuary. The distance between point 1 to 2 and 2 to 3 points of 200 m.
(Station 2): This is the location of the point of Tanjung Bayang. The distance between the point of 4 to 5 and 5 to 6 point is 200 m. The station is close to the housing area.
(Station 3): That is around Tanjung Bayang located in Tanjung Akkarena. The distance between the point of 7 to 8 and 8 to 9 point which is 200 m.

At the study site, distance between Station 1 to Station 2 and Station 2 to Station 3 is ± 1000 m. Sampling of data held on January 14, 2017 at 10:00 to 12:00 and in the rainy season, which is divided into two stages: the first stage sampling of seawater, sediments and biota in the field, then the second stage of the analysis of samples in the laboratory. The research location is located at Tanjung Bayang, Makassar - South Sulawesi.

2. Types of Data

Primary data collected were the results of pH, temperature, TSS, salinity and levels of mercury (Hg) in seawater at TanjungBayang 2. Secondary data is data of the monograph cape cast that included geography, topography, climate and season.

3. Data collection

Sampling for this study used method of instantaneous samples (grab sample). Determination of sampling points chosen randomly or intentionally (purposive sampling). Samples of water, sediment and biota are taken around TanjungBayang Makassar. Sea water samples are taken from nine points while samples for sediment and biota are each taken at3 points. Samples of water are then inserted into the Polyethylene bottle and labeled in accordance with the location and time of sampling. Sampling of seawater is used for the analysis of parameters of salinity, pH, DO, TSS and heavy metals Mercury (Hg). Determination of seawater sampling point based on ISO 6964.8: 2015 test sampling method is sampling sea water that affected coastal areas on land based activities that will represent the depth of surface water (Grasshoff) that is by 0.2 D; 0.5 D; and 0.8 D (where D is the depth of water sampling locations measured from the surface). Water samples preserved with preservatives that obtained in accordance with the parameters to be analyzed, the preservation goal is to retain the condition of the test sample until the time of analysis. The type of sample to be tested is sea water, sediment, biota (fish and sea snails). Testing of heavy metals in samples of water, sediment and biota using a SSA (atomic absorption spectrophotometer). Water proofing is divided into two, namely in situ (directly in the field) and ex situ (in the laboratory). Parameters that were inspected in situ were the temperature, pH, and salinity whereas examination in the laboratory were the total suspended solidified (TSS) parameters and Hg. Samples of sea water, sediments and biota were analyzed for metals using atomic absorption spectroscopy (AAS) method in the Center for Health Laboratory Makassar.

4. Data Analysis

Quantitative analysis is done by comparing the data generated with the quality standard of the Environment Decree No. 51 of 2004 on marine water quality standards. Moreover, the conducted qualitative data analysis used analytical methods for Bio-concentration metal. The data obtained from this study is the value of the measured parameter is pH, temperature, salinity, DO, TSS, and Hg Analysis bioaccumulation of metals in biota is study the ability of plankton and biota consumption to accumulate Hg in seawater and sediments were analyzed using a Bio-concentration factor (BCF) or Bio-concentration factor (BF). Bio-concentration factor analysis is performed by the content of heavy metals in biota being divided by the heavy metals contained in the sea or sediment. Bio-concentration factor (BCF) or BF is calculated using Equation 1 and Equation 2:

$$BF_{(o-w)} = \frac{C_{org}}{C_{water}} \quad (1)$$

$$BF_{(O-S)} = \frac{C_{org}}{C_{sed}} \quad (2)$$

Where
$BF_{(o-w)}$: Bio-concentration factor of organism in water
$BF_{(o-s)}$: Bio-concentration factor of organism in sediments
C_{org}: heavy metal content in organisms
C_{water}: heavy metal content in the water
C_{sed}: the content of heavy metals in sediment

According to Janssen et al., (1991) if the value of BF> 1: organisms have the ability to accumulate whereas if BF value ≤ 1: organisms are less / do not have the ability to accumulate in the body.

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III. RESULT AND DISCUSSION

Measurement of Environmental Parameters of Physical Chemistry of Seawater

The results of the environmental parameters of physical chemistry of seawater are tabulated as in Table 1. As seen from the table, the pH value is still within the normal status that is between pH 7 - 8.5. The highest pH value is at the station 1 and station 2 with an average value of 8.2. The degree of acidity is influenced by several factors such as soil conditions, accumulation of organic materials, currents and rain. According to Palar (1994), in water columns that have a degree of acidity (pH) close to normal 7–8, the solubility of this metal compound tends to be stable. Temperature parameters are still below the quality standard for marine biota. The highest temperature value is located at station 3. The low temperature at the research location was due to sampling taken during rainy season and conditions in the rainy location. Temperature affects life biota in it such as metabolism and respiration. The temperature in the water is influenced by the season, latitude, time of day, air circulation, cloud cover and water flow and depth. In general, the rate of growth increased in line with rising temperatures (Effendi, 2000).

Standard minimum temperature values are 28°C and maximum is 32°C. The highest Temperature is at station 3 point 8 which is located 400 m from the coast. Kusumastanto (2004) stated that the concentration of heavy metals accumulated with increasing environmental temperature, which resulted in heavy metal particles moving faster thus it accumulates more quickly. Salinity is between the values of (24-30) o/oo. The low salinity will cause the amount of metal accumulation in the waters (Wahab, 2009). The highest salinity is at station 3 because it is located at the farthest location from the mouth of the Jeneberang River of TanjungBayang and its surroundings. The intersection of the river and sea water is ± 700 m from the coast.

On the application tides shows that at 10.00 - 12.00, WITA has entered the tide period with low tides is 0.8 ft or 24.384 cm. Tides tend to affect salinity distribution towards land. Values of total suspended solid are highest at station 3. The high value of TSS too is influenced by the depth of the seabed and the type of water. At Station 1 which is the Jeneberang River estuary, the results of the study of suspended solids are also high. Suspended solids that exceed quality standards can affect marine biota.

It was also found that no mercury content is detected on the SSA tool. The level of accuracy of the tool is 0.0005. The low value of the metal content of Hg in the water column can be caused by the influence of climate. In this case heavy rain (the sampling conducted in January was quite large. Darmono (1995) said the metal content in water could change depending on the environment and climate. During the rainy season, the metal content would be smaller due to the dissolution process whereas in the dry season the metal content would be higher because the metal becomes concentrated.

Table. 1 Measurement results of parameters of chemical physics seawater

Location		pH	Temperature	Salinity	TSS	Metal mercury
		-	^{O}C	0/00	mg/l	mg/l
Station 1	Point 1	8.16	29.9	24	42	< 0.0005
	Point 2	8.21	30.6	27	42	< 0.0005
	Point 3	8.23	30.1	29	22	< 0.0005
Station 2	Point 4	8.19	30.3	22	24	< 0.0005
	Point 5	8.18	30.7	27	18	< 0.0005
	Point 6	8.24	30.3	28	56	< 0.0005
Station 3	Point 7	8.1	30.3	26	40	< 0.0005
	Point 8	8.22	30.8	30	70	< 0.0005
	Point 9	8.17	30.7	29	14	< 0.0005
Quality standards		**7 - 8.5**	**28 - 32**	**28 - 33**	**20**	**0.002**

Hg concentrations in sediments and biota

The bar graph in Figure 2 presented the mercury content in water, sediment and seawater biota. Based on the graph, it is seen that the Mercury in seawater at stations 1, 2 and 3 ie<0.0005 mg / L, while the sediment ranged 0.017-0.0217 mg / kg. Levels of mercury in fish were highest at station 2 with the concentration of 0.0796 mg / kg. Types of fish that were tested are Baronang fish that are bigger than both types of fish on station 1 and station 3. The larger the body size of the age biota, it is also expected to be higher so that the accumulation of heavy metals in the body of biota will be even greater. The mercury levels in sea snails were highest for station 2 with 0.2068 mg / kg, while at station 1 and 3, it was 0.1039 mg / kg and 0.0516 mg / kg respectively.

Accumulation of mercury in the body of aquatic biota can occur through the food chain, where the accumulation of the highest will be at the top of consumers. Aquatic organisms can accumulate mercury from the water, sediment, and food consumed. The amount of mercury is absorbed and distributed in the organism's body depends on the form of compounds and concentrations of pollutants, the activity of microorganisms, the texture of the sediment, and biota that live in the neighborhood [12].

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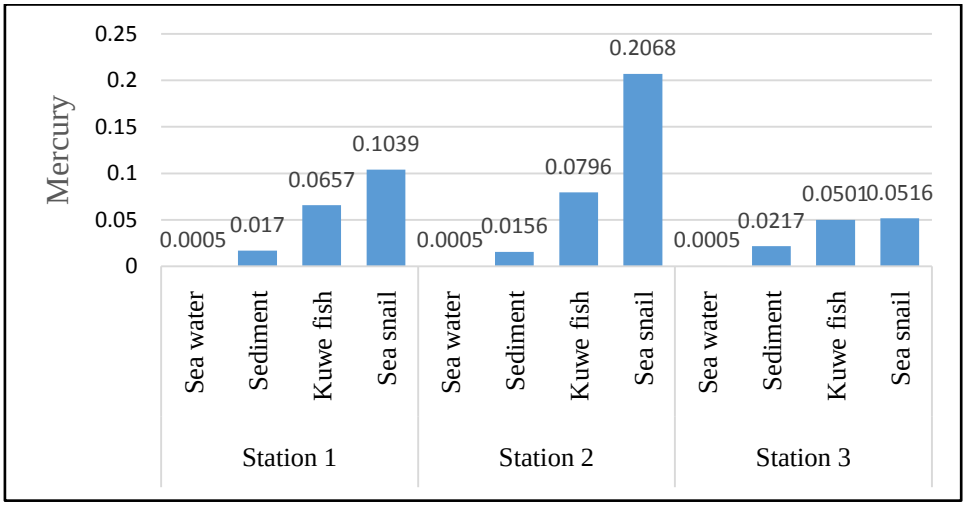

Fig. 2 Mercury content in water, sediment and seawater biota

Bio Concentration Factor

The results of BF of biota at station 1, 2 and 3 are tabulated as in Table 2. Based on the calculation value Bio-concentration factor (BF_{O-S}), the ratio of the concentration of metals in organisms with metal concentrations in sediments is> 1. Fish and sea snails indicated that these organisms have the ability to accumulate Hg. According to Siregar (2013) there are three categories of value index of concentration factor or Bio-concentration Factor (ow) as follows: (1) values greater than 1000 in the category of nature accumulative- high, (2) the value of BF 100 s/d in 1000 called accumulative nature - medium, and (3) BF is less than 100 categorized in a group of low accumulative nature- low. If based on these categories, the final results Bio-concentration factor values for Hg in both types of organisms can be deduced that the accumulation of Hg included in the category of medium accumulation. From the results of this study, it is shown that sea snails are able to accumulate heavy metals mercury than fish. The ability of snails is higher because snails are the habitat biota in the sediment. The size BF depending on the type of heavy metals, organisms, duration of exposure and the condition of the aquatic environment [14]. Although the content of Hg in sediments and organisms do not exceed the quality standards that have been established but it has the potential to cause pollution to the organism because it has the ability to accumulate mercury.

Table. 2 BF of biota at each sampled station

Station	Types of sample	Mercury level in Biota (mg/kg)	Mercury level in water (mg/L)	Mercury level in sediment (mg/L)	FB value (o-w)	FB value (o-s)
1	Kuwe fish	0.0657	< 0.0005	0.017	131.4	3.865
	Sea snail	0.1039	< 0.0005		207.8	6.112
2	Baronang fish	0.0796	< 0.0005	0.0156	159.2	5.103
	Sea snail	0.2068	< 0.0005		413.6	13.256
3	Yellow tail fish	0.0501	< 0.0005	0.0217	100.2	2.308
	Sea snail	0.0516	< 0.0005		103.2	2.378

Note:
BF_{o-w} = Bio-concentration Factor-water organisms
BF_{o-s} = Bio-concentration factor-sediment organisms

IV. CONCLUSION

Sea water quality based on physical parameters low level parameters and high salinity in the waters TSS is caused by the current direction of Jeneberang River estuary and the rainy season. Metal mercury in seawater <LD (lower detection limit) was <0.0005 mg /L, because sea waters have undergone a process of dilution and the effect of physical-chemical factors made the mercury in sea water settles at the bottom of the water and the test results of samples proved that there is so much of mercury in fish, sea snails, and sediment. Besides that, bio-concentration in biota and seawater was 100.2 to 413.6 while bio-concentration in biota and sediment was 2.308 to 13.256. BF value> 1 can be implied that biota has the ability to accumulate mercury in their bodies.

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REFERENCES

1. M.R. Kusumadewi, I.W.B. Suyasa, and I.K. Berata, ECOTROPHIC : JurnalIlmuLingkungan (Journal of Environmental Science) **9**, 25 (2015)
2. S. A. Zubayr, MAKARA of Science Series 8, (2009)
3. C. I. Prasasti, J. Mukono,.andS. Sudarmaji, JurnalKesehatan LingkunganUnair, 2,2 (2006).
4. G. Genchi, M. Sinicropi, A. Carocci, G. Lauria, and A. Catalano, International Journal of Environmental Research and Public Health 14, 74 (2017).
5. T.T Putranto, JurnalPendidikanTeknologiPertanian3, 197 (2011)
6. H. Umar, S. Rahman, A.Y. Baeda, and S. Klara, Procedia Engineering 116, 125 (2015).
7. A. Mallongi, R.L. Ane, and A.B. Birawida, JurnalKesehatan Lingkungan Indonesia 16, 51 (2014)
8. Efendi., International Journal of Environmental Protection 9 (2000).
9. T. Kusumastanto, PencemaranTeluk Jakarta. (2004).
10. F. Wahab, and I. Insan, ScriptaBiologica1, 57 (2009).
11. Darmono, PenerbitUniversitas Indonesia (1995).
12. H. P. Hutagalung, Pewarta Oceana IX, (1), pp.12, (1991)
13. N. M. A. Siregar, JurnalPascapanen Dan BioteknologiKelautan Dan Perikanan3, 69 (2013).
14. C. Supriyanto. and Z. K.Samin, 4,8 (2007)