Biofilm Application as Biomonitoring Agent in Heavy Metals Pb^{2+} and Cr^{6+} in Ngimboh Coastal, Ujungpangkah, Gresik

AGUNG RISWANDI[1], MOHAMMAD MAHMUDI[2], ANDI KURNIAWAN[2], AND LUTFI NIMATUS SALAMAH[2]

[1] Master Program of Aquaculture, Faculty of Fisheries and Marine Science, Brawijaya University, Malang, Indonesia.
[2] Faculty of Fisheries and Marine Science, Brawijaya University, Malang, Indonesia

ABSTRACT

Biomonitoring is the use of organisms to monitor and assess/detect the condition of an environment. Ngimboh Coast is a coastal line in Ujungpangkah Subdistrict, East Java (Indonesia) which functions as a vessel berth, TPI, and shipyard industry which has the potential to dispose of waste containing Pb^{2+} and Cr^{6+} which affect the physical condition of chemicals and organisms in these waters. This study aims to determine the Biofilm can be a biomonitoring agent in heavy metals Pb^{2+} and Cr^{6+} and to know the physical chemical conditions in the Ngimboh coast, Ujungpangkah District, Gresik. This study uses a survey method. Biofilm, sediment and water sampling was carried out at 3 sampling points, namely the first sampling point area close to the disposal of shipyard industrial waste, the second sampling point was an empty land area, and sampling point three was the estuary area. The parameters were measured such as physical properties (temperature, current speed, water depth), chemical properties (pH, DO, salinity), metal content of Pb^{2+} and Cr^{6+} on biofilms, sediments and water.

Key words: Biofilm, Heavy Metal Pb^{2+} and Cr^{6+}, Coastal Ngimboh.

INTRODUCTION

Sea is one component of the environment that has an important function for human life, including to designate environmental balance. However, as a result of various things both directly and indirectly it will have an impact on environmental damage including sea air pollution. One pollutant which is the main cause of marine pollution is waste that produces heavy metals (Budiastuti et al., 2016).

According to Sastrawijaya (2000), environmental pollution is an unfavorable environmental change, partly because of human actions, due to changes in the patterns of energy and material use, levels of radiation, physical and chemical materials, and the number of organisms. These changes can affect humans directly, or indirectly through water, agricultural products, livestock, objects, behavior in appreciation and recreation in the wild. While Darmono (2001), said that one of the examples of pollution is garbage. Waste is a serious environmental problem that is still faced in Indonesia. On average one person per day produces 1-2 kg of waste, and will continue to increase in line with the increasing welfare and lifestyle of the community.

The biggest sources of waste are settlements (households), followed by markets, shops and industries. Organic matter in the deposited waste will decompose to produce leachate (leachate). Where this leachate contains very fine dissolved and suspended substances as a result of decomposition by microbes. Leachate water contains high levels of organic matter and can contain heavy metals.

According to Makkasau (2011), stated that the aquatic environment in Indonesia was allegedly in certain regions to have been contaminated by various contaminants such as organic materials such as pesticides, detergents, oils, and inorganic materials in the form of heavy metals and acids sourced

Correspondence: Agung riswandi, Master Program of Aquaculture, Faculty of Fisheries and Marine Science, Brawijaya University, Malang, Indonesia. Email : Isdhary@gmail.com.

from domestic waste, industrial , workshops, and natural disasters. While Hutagalung (1984) said, heavy metal compounds are widely used for industrial activities as raw materials, catalysts, biocides and as additives. Waste containing heavy metals will be carried away by the flow and hence industrial waste is a potential source of heavy metal pollutants for water pollution. Water pollution due to heavy metal contamination can cause a decrease in water quality but it can also poison humans. One way to reduce water pollution due to heavy metals is by utilizing aquatic biota (Rondonuwu, 2014).

Biomonitoring is a collective term for all techniques that use living organisms to provide information about abiotic (nonliving) and biotic (living) components of the environment (Day, 2000). Biomonitoring is the use of living materials to confirm or validate that previously defined quality control conditions are important for living systems (Cairns, 2005). Whereas Ayeni et al. (2010), define biomonitoring as species that can provide information related to environmental pollution status by certain pollutants.

Biomonitoring has the ability to integrate the total chemical exposure in the environment. This includes exposure from various sources (i.e., air, soil, water, and leftovers). The benefits of biomonitoring are the ability to associate internal doses of chemistry or certain metabolites with measurable effects (either specific tissue or whole body), which can then be used for risk assessment purposes (Barry et al., 2009).

One of the industries that produce liquid metals containing heavy metals is the shipyard industry. This industry produces heavy metals Pb^{2+} and Cr^{6+}. Pb^{2+} and Cr^{6+} are dangerous pollutants because they are toxic. Then it will be very dangerous if the amount exceeds the threshold, which can affect the ecological and biological aspects of the waters. Metals can accumulate in food tissues, metal ions consumed by humans can prevent DNA replication as well as cause

neurological disorders (Fahruddin, 2014). This is related to the properties of heavy metals that cannot be decomposed (non-degradable) and are easily absorbed, so that they accumulate in the aquatic environment (Setiawan, 2013).

The principle used to answer problems in environmental quality. This is also called biomonitoring (Komarawidjaja and Titiresmi, 2006). Biomonitoring is one way to overcome this problem because it can reflect the bioavailability of metals. Biofilms have the advantage of being widely distributed, large in biomass, and preferred at the same time and more potential for pollution (Tien and Chen, 2013). Biofilms can accumulate heavy metals, are strongly influenced by water quality, live permanently, can be done using tools that simple, the density is quite large and easy to find. Therefore the determination of biomonitoring using biofilms becomes very important.

This research was carried out as a direct action to analyze Pb^{2+} and Cr^{6+} in water, sediment and biofilm and the use of biofilms as biomonitoring agents carried out in the Ngimboh Coast, Ujungpangkah District, Gresik. The aim of this study was to develop the use of biofilms as biomonitoring agents in the Ngimboh Coast.

RESEARCH METHODOLOGY

Sample collection

Biofilm, sediment and water samples were taken from 3 sampling points. Sampling point 1 is the area closest to waste disposal from the shipyard industry. Sampling point 2 is a mid area between sampling points 1 and 3. Sampling point 3 is located at the mouth of the Ujungpangkah River. Samples were taken with 3 replications. Water and sediment samples were taken as much as 250 ml and ± 1 gram. Biofilm samples in the stone were cleaned

from the attached organisms and sediments, then brushed and weighed 0.8 grams and stored in a container that had been given 80 ml of distilled water. The sample is placed in a cool box at $\pm 40^0$C then taken to the laboratory to be tested for its heavy metal content.

Analysis of Pb^{2+} and Cr^{6+} on Biofilm, Sediment and Water

The analytical method used to analyze the comparison of biofilm, sediment and water samples using the ANOVA test. It is a method to test the hypothesis of the similarity of the average of three or more populations. Analysis of repeated measurement data was conducted to investigate whether there were significant differences (Pritasari et al., 2013).

Analysis of Water Quality

The test of the quality parameters observed in this study were salinity and turbidity using AAQ, current velocity using a current meter, temperature using a thermometer, dissolved oxygen using DO meters, depth using a weighted rope, pH using a pH meter.

RESULTS

Concentration of heavy metals Pb^{2+} and Cr^{6+} on Biofilms

Based on the observations that have been made, the concentration of Pb^{2+} in the biofilm obtained in Figure 1 (A) analyzes the concentration of heavy metals Pb^{2+} using AAS obtained Pb^{2+} heavy metals at sampling points 1, 2 and 3 of 19.04, 54.11, 83.92 ppm respectively on the July. In August sampling points 1, 2 and 3 ranged from 143.96, 195.00, 221.04 ppm respectively. Whereas in September for sampling points 1, 2 and 3 respectively raise up to 143.96, 195.01, 221.04 ppm respectively.

Based on the result, the concentration of Cr^{6+} in water obtained in Figure 1 (B) analyzes the concentration of Cr^{6+} heavy metals obtained from Cr^{6+} heavy metals at sampling points 1, 2 and 3 of 31.57, 34.34, 39.31 ppm respectively in July. In August sampling points 1, 2 and 3 ranged from 48.31, 50.21, 50.21 ppm respectively. Whereas in September for sampling points 1, 2 and 3 were 46.33, 49.07, 56.67 ppm respectively.

Sampling point 1 which is the place closest to the disposal of ship industrial waste has a lower biofilm concentration value than sampling points 2 and 3. The highest concentration value found at sampling point 3, this may be due to the results of the disposal of household industrial waste that accumulates in the estuary and carried in the direction of the wind to the west (BMKG data). The high concentrations of Pb^{2+} and Cr^{6+} at sampling point 3 may be due to the high accumulation of Pb^{2+} in the estuary.

Lower concentration of Pb^{2+} at sampling point 1 may be due to the direction of the westward wind and heavy metals carried by the current. The Stronger currents make contact time between air that produces heavy metals and biofilms becomes shorter. Very short contact time is very useful for sampling point 1 not as big as other sampling point
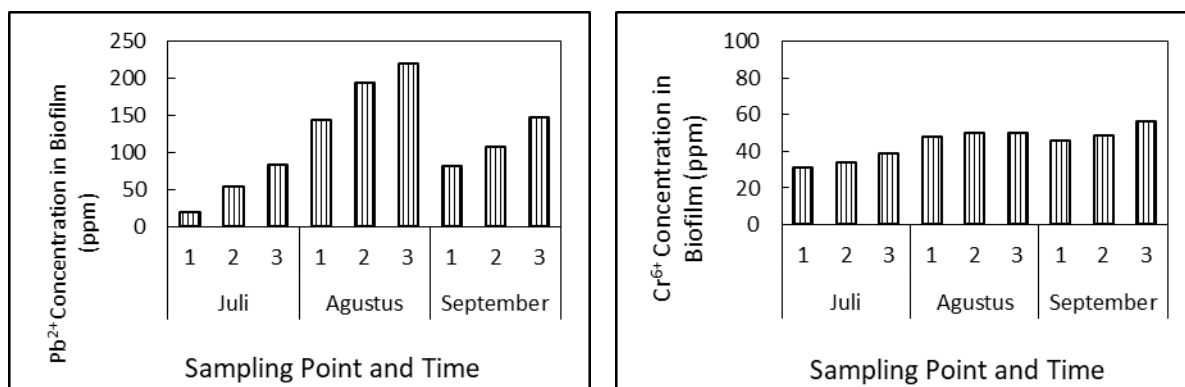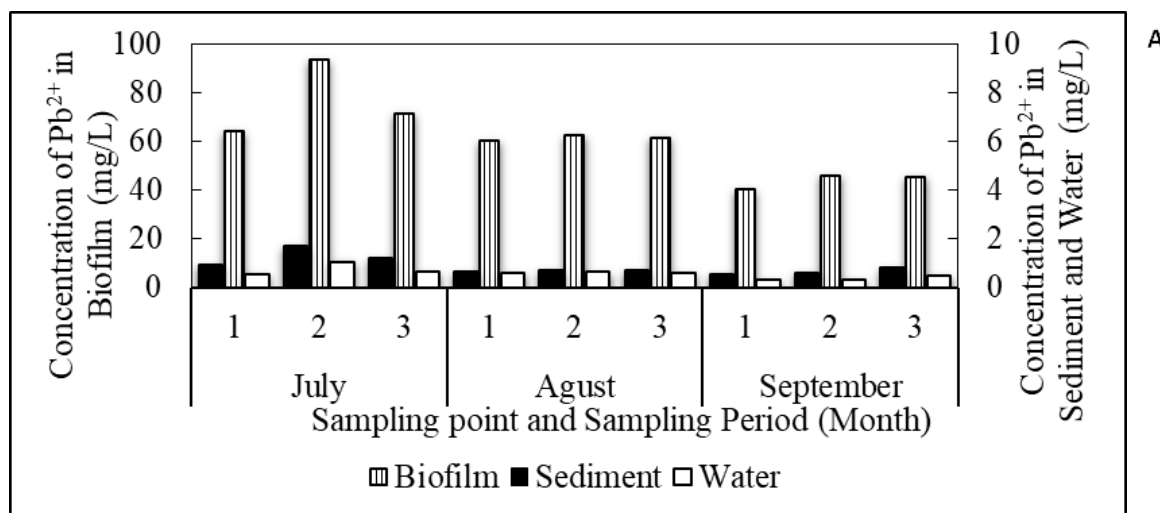
Figure 1. Concentrations of Pb^{2+} (a) and Cr^{6+} (b) in Biofilms on July, August, September

Comparison of Pb^{2+} and Cr^{6+} Concentrations in Biofilms, Sediments and Water

The results of the comparison of Pb^{2+} on biofilms, sediments and water are presented in Figure 3 (a), in July 2019 the highest concentration in biofilms was 93.12 mg/L, it is higher than sediment and water was 1.70 and 1.06 mg/L. In August the highest concentration of biofilms was 62.30 mg/L higher than sediment and water was 0.69 and 0.62 mg/L. Whereas in September the highest concentration in biofilms was 45.93 mg/L. It is higher than sediment and water was 0.80 and 0.46 mg/L.

The results of the comparison of Cr^{6+} on biofilms, sediments and water are presented in Figure 3 (b) in July the highest concentration in biofilms was 45.81 mg/L higher than sediment and water was 0,36 and 0.32 mg/L. In August the highest concentration of biofilms was 55.50 mg/L higher than sediment and water was 0.31 and 0.42 mg/L. Whereas in September the highest concentration in biofilms was 29.02 mg/L higher than sediment and water was 0.21 and 0.40 mg/L respectively.
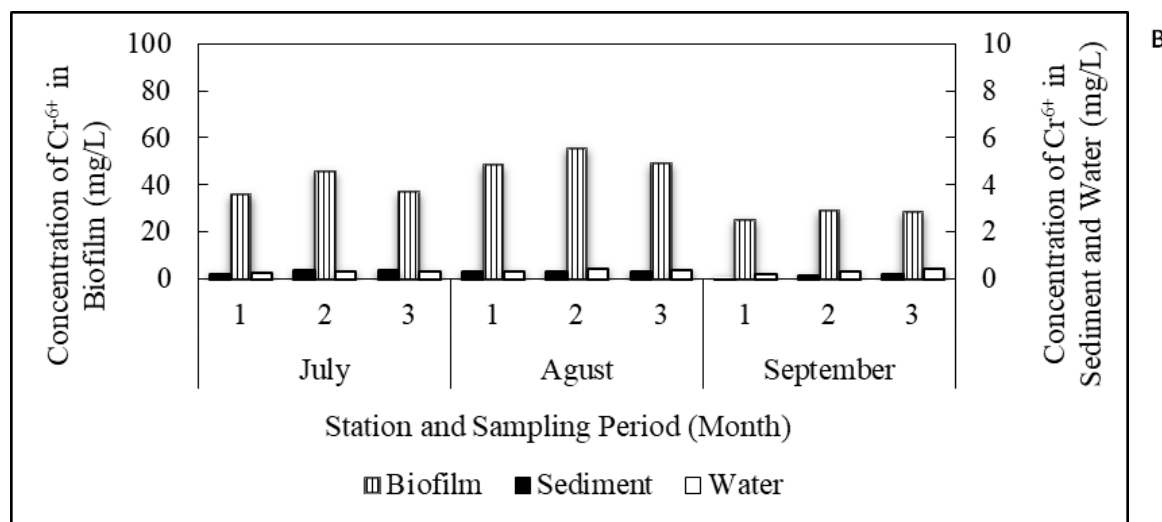
Figure 3. Comparison Concentration of Pb^{2+} (A) and Cr^{6+} (B) in Biofilms, Sediment and Water on July, August, September

Analysis of Water Quality Paramater

The quality of the waters in the Coastal Ujung pangkah is quite good. In accordance with the results presented in Table 1. That the temperature, DO and salinity are in a good range, each ranging from 27-31 (Temperature), 8 (DO), 39-40 (salinity), 7.2 – 7.3 (pH), 34 – 36 (depth), 0,041 – 0,047 (Current).

Table 1. Water Quality Measurement Results

PARAMETER	MONTH								
	JULY			AUGUST			SEPTEMBER		
	S1	S2	S3	S1	S2	S3	S1	S2	S3
Salinity (ppt)	40	40	40	40	39	40	40	39	39
Temperature (^{0}C)	27.8	28.3	28.4	28.5	28.7	29.9	30.51	29.58	31.03
Current (m/s)	0.046	0.044	0.041	0.048	0.047	0.043	0.044	0.042	0.041
Depth (cm)	36	34	36	35	34	34	34	36	36
DO (mg/L)	8.1	8.0	8.3	8.0	8.3	8.2	8.2	8.3	8.2
Ph	7.37	7.20	7.24	7.21	7.34	7.32	7.26	7.24	7.31

Information:

S1 = Station 1 (close to factories suspected of producing Pb^{2+} and Cr^{6+} waste)

S2 = Station 2 (between stations 1 and 3)

S3 = Station 3 (estuary of ujungpangkah river's)

CONCLUSSION

The results of this study indicate that biofilms are very likely to be used as biomonitoring agents. The concentration of Pb^{2+} and Cr^{6+} biofilm is higher than the concentration of Pb^{2+} and Cr^{6+} sediment and water, this is because biofilms have a high absorption capacity besides the biofilms living permanently and are very sensitive to changes in water conditions. Biofilms can be used as material for consideration in monitoring water quality and are expected to reduce the pollution of marine waters.

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