The Effectiveness of Combination of Seaweed (Gracillaria sp.), Blood Clamp (Anadara granosa), and Zeolite as Biofilter in the Reduction of Heavy Metal Copper (Cu)

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Abstract. The heavy metal Cu is an essential one, the one required to push enzyme activity during body metabolism. The metal Cu has the tendency to be toxic when its presence exceeds the threshold value. An aquatic environment contaminated with the metal potentially affects its surrounding. This study aims to find out the effectiveness of heavy metal Cu’s reduction by using biofilter combination of seaweed (Gracillaria sp.), blood clamp (Anadara granosa), and zeolite. This study used biofilter combination of seaweed (Gracillaria sp.) and blood clamp (Anadara granosa) at different concentration for each treatment. The result of this study shows that the proper use of biofilter combination can reduce the content of heavy metal Cu. The content of the heavy metal Cu went from 1 mg/L initially to 0.119 mg/L, with the best combination composition found in P4.

Keywords: biofilter combination, heavy metal Cu, gracillaria sp., Anadara granosa, Zeolite

1. Introduction

Water is a pollution-prone object besides soil and air. Seawater pollution has been an alarming issue. The wastes in waters seem to exceed the tolerance limit of marine biota. Seawater pollution impairs the balance of ecosystem (Supriyaningrum, 2006).

One of the alarming pollutants due to their high level of toxicity in aquatic environment is heavy metal. Based on the functions, heavy metals are divided into essential metal and non-essential metal. Essential metal is the metals whose presence is very important and highly required by aquatic organisms in small amount to push enzyme activity in body metabolism process. The types of metals categorized as essential metal are Cu, Fe, Zn, Mn, Mo, Se, and Sn.

All those essential metals have the tendency to be toxic when their presence in organisms’ bodies exceeds the tolerance limit required, while non-essential metals are those whose role in bodies remains unknown (Bambang 2006).

Heavy metal Cu’s huge amount in waters can bring negative impacts to fish, such as inhibiting lactic acid oxidation in the gill. Cu concentration of around 2.5-3.0 ppm in the body of water will kill the fish within (Palar 2004). Bivalves are often used as indicator biota of heavy metal pollution due to its ability to accumulate heavy metals from its surroundings, wide distribution, sedentary life, and filter-feeder nature (Mostafa et al. 2009). Gracillaria sp. is the macroalgae with high adaptability towards changes in water quality (Komarawidjaja, 2003). Zeolite is a porous material with extensive use. The use of zeolite is based on its ability to exchange ion, adsorption and catalysis (Ginting, 2007).
Biofilter is a system of wastewater management conducted by streaming wastewater into biological reactor filled with filter media to breed microorganisms that decompose pollutants in the wastewater with or without aeration (Filliazati et al., 2013).

2. Material and method

2.1. Time and place

This study was conducted from April 27 to May 1, 2017 at the Faculty of Fisheries and Marine Universitas Airlangga Surabaya. Biofilter was prepared in Wet Laboratorium of Faculty of Fisheries and Marine Universitas Airlangga.

2.2. Tools and materials

The tools used were 20 aquariums in the size of 40 cm x 30 cm x 30 cm that was divided into 3, aerator, scale, and water quality measurement tools (thermometer, refractometer, pH meter and DO meter). The materials used were blood clamps (*Anadara granosa*) obtained from the waters in Sedati area, Sidoarjo. The blood clamps used were 15 grams in weight. Each aquarium had different combination of blood clamps and seaweeds. The maintenance medium for blood clamps and seaweeds was seawater with salinity of 24 ppt. Zeolite (50 gram) was also used in each treatment. Heavy metal Cu solution was made by dissolving 1 gram of Cu(NO$_3$)$_2$·3H$_2$O into 1 liter of aquades, which later became stock solution.

2.3. Research procedure

As the initial preparation prior to the use, the aquariums were washed with clean water and dried out. The clean-washed tools were soaked in chlorine solution of 150 mg/l for 12-24 hours. To get rid of chlorine odour and dirt, the aquariums were washed using detergent by scrubbing the walls and aeration hose that functions to kill parasites, and were rinsed with fresh water afterwards (Prakosa 2013).

The aquariums were filled with seawater of 9990 ml with salinity of 24 ppt and then aeration, water pumps, nets, blood clamps, seaweeds and zeolites were put in each aquarium.

The blood clamps used were brought alive from the fishermen in the waters of Sedati, Sidoarjo. The blood clamps intended to be used as filters were acclimatized first before used as experimental materials. The amount of blood clamps used were 600 g for 100%, 450 h for 75% filter, 300 g for 50% filter and 150 g for 25% filter. The density of blood clamps used was 600 g with aquarium size of 40 cm x 30 cm x 30 cm. According to FAO 2008 standard, the density of blood clamps used for small-scale maintenance media is 500 liter with maximum density of 30 kg.

The seaweed type used is *Gracillaria* sp., brought alive from a pond in Medokan Ayu area, Surabaya. The seaweeds intended to be used as filter were acclimatized first before used as experimental materials. The amount of seaweeds used were 201 g for 100% filter, 158 g for 75% filter, 105 g for 50% filter, and 53 g for 25% filter. The amount of seaweed was determined based on the volume of water used. According to the previous study (Yulianto, 2006), the stocking density of seaweed used for filter is with the density of 500 gr in an aquarium sized 80 cm x 60 cm x 50 cm.

Five aquariums were used in this study, each containing biofilter combination of blood clamp, seaweed and zeolite. The treatments were then conducted for 5 days, with water quality being checked every day.

3. Results and discussion
Heavy metal pollution is hazardous for environment. Environmental pollution occurs when organisms, substances, energy, or other components enters the environment, reducing its quality to a certain level and causing its function to decrease or stop (Sastrawijaya, 2000).

Biofilter is a system of wastewater management conducted by streaming wastewater into biological reactor filled with filter media to breed microorganisms that decompose pollutants in the wastewater with or without aeration (Filliazati et al., 2013).

From the result of the research on the effectiveness of combination of seaweed (Gracillaria sp.), blood clamps (Anadara granosa) and zeolite toward the reduction of heavy metal Cu, it is known that the most effective treatment was P4 with Cu content of 0.119 ppm and composition of 100% blood clamp and zeolite. The second most effective treatment was P4 with Cu content of 0.125 ppm, followed by P0 with Cu content of 0.137 ppm, P1 with Cu content of 0.144 ppm, and P2 with Cu content of 0.145 ppm.

The result of ANOVA test on the absorption of seaweed (Gracillaria sp.) showed a significant value higher than 0.5. This indicates that all treatments did not differ significantly. The result of ANOVA test on blood clamps (Anadara granosa) showed a significant value lower than 0.05. This indicates that treatments P4, P2, and P1 differed significantly from P3. The result of ANOVA test on water showed a significant value lower than 0.05. This indicates that treatments P3, P2, P1, and P0 differed significantly from P4.

This implies that the most effective combination in Diagram 1 shows that Anadara granosa possesses different ability to accumulate heavy metal Cu.

The result of this study showed that Anadara granosa accumulates heavy metal Cu at around 0.063-0.214 ppm. It is because heavy metal Cu is required in blood clamps’ metabolism. According to (Selpiani et al., 2015) heavy metal Cu is an essential metal required by organism in small amount. Hutagalung (1997) argued that the ability of several heavy metals to bind with amino acid follows the following order: Hg>Cu>Ni>Pb>Co>Cd, indicating that heavy metal Cu possesses a high ability to bind with amino acid.

| Parameter | P0 | P1 | P2 | P3 | P4 |
|-----------|----|----|----|----|----|
| DO (mg/L) | 6.5| 6.8| 7  | 6.4| 6  |
Water quality was also observed during this study as a supporting variable (Tabel 1). According to Darmono (2001), aquatic environmental factors that affect heavy metal toxicity are temperature, salinity, acidity (pH) and dissolved oxygen (DO). Those parameters are used to determine the quality of waters (Afrianto dan Liviawaty, 1998). The average temperature among the treatments was around 28.5°C, while the pH was 8 and dissolved oxygen was 6.5. The quality of water can be seen in Table 1. The result of water quality observation did not show any significant difference.

4. Conclusion
The result of this study suggests that the use of biofilter combination is able to reduce the content of heavy metal Cu if the composition consists of 100% blood clamp (*Anadara granosa*) and Zeolite.

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