Bioaccumulation of Heavy Metals Pb and Hg in Green Shells (Perna viridis) in Pasuruan Waters Based on Different Seasons

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Abstract. This study aims to determine the bioaccumulation of heavy metals lead (Pb), and mercury (Hg) in green mussels (Perina viridis), sediment, and water in green mussel cultivation in Pasuruan waters, East Java based on different seasonal variations. The study was conducted in the rainy season (February) and dry season (July). Green mussels, sediment, and water were taken from the green mussel cultivation in the winding waters of Pasuruan. Samples were taken at harvest age, namely the age of 6 months of maintenance. Samples of seawater, sediment, and green mussels were taken 3 times. Heavy metal testing follows SNI 01-2354.6-2006. Based on the results of the study, the Pb content in the sediment increased in the summer compared to the rainy season, from 3.76±0.77 mg/Kg to 6.99±0.16 mg/Kg (P<0.05). The level of Hg in green mussels in the rainy season was 1.03±0.04 mg/Kg also did not show a significantly different value (P>0.05) compared to summer, namely 1.02±0.02 mg/Kg.

1. Introduction
Green mussel Perina viridismussel is a fishery commodity in Pasuruan waters which is very popular with the community. In addition to its high nutritional content, the price is also cheaper than fish, shrimp or crab. However, green mussels are also a fishery commodity that can accumulate high amounts of heavy metals because it is a type of marine biota that is a filter feeder [1]. Heavy metal levels in green mussels can be dangerous due to the bioaccumulation process.

Heavy metals are substances that are dangerous and toxic if the amount exceeds the threshold. Heavy metals such as mercury (Hg), lead (Pb) and cadmium (Cd) are non-essential metals for the body, because they are toxic in small amounts [2]. The high content of heavy metals in fishery commodities is caused by the aquatic environment that has been polluted by waste. Heavy metals will be distributed in various components of marine ecosystems and then accumulated by organisms from natural sources. A small concentration of heavy metals will be large (accumulate) in higher low-level trophic biota, related to the food chain system [3]. Many studies have been carried out on metal accumulation in various species such as Sparus aurata, Dicentrarchus labrax and Mugil cephalus [4], green mussel P. viridis [5], and European catfish Silurus glanis [6], Tilapia tilapia [7], and ax clams [8].

Bioaccumulation means an increase in the concentration of these chemical elements in the bodies of living things according to the food pyramid [9]. Heavy metals can accumulate through the food chain, the higher the level of the food chain occupied by an organism, the accumulation of heavy metals in the body also increases [9]. Accumulation of heavy metals in aquatic biota is influenced by various factors. Among them are size, stage of development and salt content of heavy metal toxicity to marine and estuarine organisms [10].
2. Material and methods

This research is a quantitative descriptive study using the transect method. Sampling used an exploratory method with direct observation in the field which aims to describe the condition of the object of research on water pollution from heavy metals Pb, Cd, and Hg in Lekok Coastal waters, Pasuruan Regency.

Sampling in the form of sea water, sediment, and green mussels (*Perna viridis*). Samples of water, sediment and green mussels were taken from the green mussel cultivation in Bondet Pasuruan waters, which is about 2 km from the coastline. Samples were taken in the rainy season in February at the age of harvest, namely the age of 6 months of maintenance. Samples of seawater, sediment, and green mussels were taken 3 times. Seawater samples were taken at the surface layer (30 cm below sea level) and put into a glass bottle (±100 ml volume). Sediment samples were taken from the bottom of the water just below the tancap chart where green mussels are cultivated. Samples of shellfish were taken as many as 5 tails in each replication. After that, samples of water, sediment and green mussels were put into a cool box during transportation to the laboratory.

This study used an experimental design in the form of a completely randomized design with three replications. The data obtained were analyzed using analysis of variance with a 95% confidence level using the SPSS 17 computer program.

3. Results and Discussion

3.1. Heavy Metal Concentrations of Lead (Pb) and Mercury (Hg) in Sediment and Shellfish Green *P. viridis*

Based on the results of the study of heavy metal levels lead (Pb) in sediments and green mussels (Figure 1), it is known that the heavy metal content of lead in sediments has increased in summer compared to the rainy season, from 3.66±0.77 mg/Kg to 5.99±0.16 mg/Kg and gave significantly different results (P<0.05). Meanwhile, the levels of heavy metals in green mussels in the rainy season decreased compared to summer, namely from 4.99±0.84 mg/Kg to 3.77±0.75 mg/Kg but were not significantly different between the rainy and summer seasons (P >0.05).

![Figure 1](image)

**Figure 1.** Heavy metal levels of lead (Pb) in sediments and green mussels in the rainy and summer seasons

Meanwhile, the results of the study showed that the levels of heavy metal cadmium (Cd) in sediments and green mussels (Figure 2) decreased in summer compared to the rainy season, namely from 1.08±0.14 mg/Kg to 0.71±0.22 mg/Kg, but did not show significantly different results (P>0.05). Meanwhile, the concentration of heavy metal Cd in green mussels in the rainy season was 0.87±0.14 mg/Kg, which was higher than in summer, namely 0.3±0.1 mg/Kg and showed significantly different values (P<0.05).

The concentration of other heavy metals, it is known that the concentration of mercury (Hg) in sediment (Figure 3) in summer is 0.00±0.01 and an increase in the rainy season is 0.05±0.06 mg/Kg, but does not show significantly different results. (P>0.05). Meanwhile, the concentration of heavy metal Hg in green mussels in the rainy season was 0.03±0.04 mg/Kg also did not show a significantly different value (P>0.05) compared to summer 0.02±0.02 mg/Kg.
The difference in the concentration of heavy metals Pb and Hg in sediment between summer and rainy season is influenced by various factors. Among them are physical processes. Physical processes are influenced by environmental conditions such as currents that affect the rate of deposition. In the rainy season, it is suspected that the current causes friction between the sediment surface and the water mass. This causes the release of particles in the sediment into the water column, thereby potentially reducing or increasing the concentration of heavy metal concentrations in suspended particles (Palar 2009). Sediments with a maximum concentration of 85 mg/Kg (IADC/DECA 1997).

3.2 Relationship between Pb and Hg Heavy Metal Concentrations in Marine Sediments and Green Shells *Perna viridis*

The heavy metal lead (Pb) correlation between sediment and green mussels in the rainy season and summer has a high value, reaching 0.810 and 0.993 (Table 2). The correlation value shows that Pb has a strong correlation between sediment and green mussels (>0.5). The presence of Pb in green mussels was influenced by the concentration of Pb in the sediment although the rainy season showed a lower coefficient of determination than the summer, which reached 98.7%.

The heavy metal mercury correlation between sediment and green mussels in the rainy season and summer also has a high value, reaching 0.991 and 0.756 (Table 2). The correlation value shows that Hg has a strong correlation between sediment and green mussels (>0.5). However, the coefficient of determination of Hg in green shellfish and sediment in the rainy season showed a higher value than the summer. They are worth 98.3% and 57.1%, respectively.

The concentration of heavy metals in the substrate/sediment naturally describes the presence of certain heavy metals/mineral deposits. Heavy metals in water are often associated with suspended particles and sediments, even sediments are more stable or less mobile than the water column (Riani *et al* 2017). Meanwhile, green mussels live as *filter feeders* that filter out particles in the waters where they live. In addition, green mussels are organisms that have minimal movement in waters or are known as sedentary animals, so it is not possible to avoid pollutants that pollute their environment (Yaqin *et al* 2015), especially pollutants found in sediments.

**Table 1. Heavy metal content of Pb, Cd, and Hg in shellfish**

| Type of Heavy Metal | Season | Regression Analysis |
|---------------------|--------|---------------------|
|                     |        | Equation          | R (%) | r    |
| Lead                | Rain   | y=1.291+0.875x     | 65.6  | 0.810|
|                     | Heat   | y=-23.463+4.618x   | 98.7  | 0.993|
| Mercury             | Rain   | y=0.005+6.5x       | 98.3  | 0.991|
|                     | Heat   | y=0.031-0.214x     | 57.1  | 0.756|

Description: *: y= heavy metal value in green mussels; x= heavy metal value in sediment; R= determination coefficient; r= correlation coefficient
4. Conclusion
Based on the results of the study, it was concluded that season affected heavy metal levels of cadmium, but had no effect on heavy metal levels of lead and mercury in bivalves of green mussel species. However, the season also affects the heavy metal content of lead in marine sediments which is strongly correlated with the heavy metal content of green mussels. The amount of heavy metal Pb in green mussels has exceeded the safe threshold, namely 3.77±0.75 mg/Kg and 4.99±0.84 mg/Kg.

5. References
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