Heavy metals (Pb, Hg) in blood cockle (*Anadara granosa*) in Cengkok Waters, Banten Bay, Indonesia

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Abstract. Blood cockle (*Anadara granosa*) is one of the biotas which has high economic and ecological value in Cengkok Waters, Banten Bay. Human activities such as settlements, agriculture, fisheries, mining, and industries are seen as main reasons for degrading the aquatic environment and have a negative impact on blood cockles. Pb and Hg from these human activities may pollute the Cengkok Waters and accumulate in the body of blood cockles. This research aims to analyze the content of heavy metals (Pb and Hg) in blood cockles' meat in Cengkok Waters, Banten Bay. Sampling was carried out monthly, from March to August 2019. Measurement of heavy metal contents was conducted using the AAS (Atomic Absorption Spectrophotometer). The result shows that the heavy metal contents (Pb and Hg) are still within the quality standard of Indonesian Food and Drug Authority (BPOM, 2018).

Keywords: Banten Bay; blood cockles (*Anadara granosa*); Cengkok Waters; heavy metals

1. Introduction

Cengkok Waters is one of the Banten Bay estuaries which is shallow water located 60 km west of Jakarta along the northern coastline of Java [1]. Cengkok waters are originating from the Cibanten River. Other rivers flowing into Banten Bay include Wadas and Pamong Rivers [2]. The types of fishery products found in these waters are not as many as those in the other estuaries. There are three types of dominant shells found in this area including blood cockles (*Anadara granosa*), feather shells (*Scapharca cornea*), and tofu shells (*Polimedosa bengalensis*). The presence of blood shells found reached 73.7% of the composition of shellfish in Serang waters, Banten [3].

Blood cockle (*Anadara granosa*) is one of the biotas which has high economic and ecological value in Cengkok Waters, Banten Bay. Human activities such as settlements, agriculture, fisheries, mining, and industries are seen as main reasons for degrading the aquatic environment in Cengkok Waters and have a negative impact on blood cockles. Pb and Hg from these activities pollute the Cengkok Waters and accumulate in the body of blood cockles [4].

Blood cockle is a benthic animal that has high economic and ecological value. Blood cockle is also consumed by the local community as an option in fulfilling the needs of protein and minerals. This biota is included in the group of biota that can accumulate heavy metals. Heavy metal accumulation can also occur from the food chain. Blood cockles have a suspension feeder feeding mechanism and deposit feeder. Blood cockles live in sandy, muddy, or hard substrates ecosystem. Due to this type of environment, blood cockles consume all substances in water and sediment. Blood cockles can survive...
in polluted aquatic environments, beyond the specified threshold, which makes this type of shellfish suitable as an environmental bioindicator [5].

Several types of research on blood cockles in Banten Bay have been conducted. One of the researchers examined morphometric characteristics, morphology, and spatial distribution of blood cockles [6]. However, research related to the contents of heavy metals in blood cockles in Cengkok Waters is still limited. Another comparable research related to heavy metals was focusing on the content of iron (Fe) in the meat of blood cockles, which was carried out in the Morosari River and Gonjol River, Demak Regency [7].

Therefore, research in analyzing the heavy metal contents of blood cockles in Cengkok Waters, Banten Bay needs to be conducted. This research aims to analyze the contents of heavy metals (Pb and Hg) that accumulate in the meat of blood cockles. The accumulation due to pressures from the surrounding environment. The process of accumulation and depuration of heavy metals enter the body of aquatic biota through the gills or the food chain [8]. These processes are called bioaccumulation or biomagnification [9]. As mentioned above, research about the content of heavy metals (Pb and Hg) in the meat of blood cockles in Cengkok Waters is still limited and needs to be updated. A database of heavy metal pollution in blood cockles needs to be created. Therefore, this research is useful as a parameter for estimating ecosystem health.

2. Methodology
A sampling of blood cockles (Anadara granosa) was conducted from March to August 2019 in Cengkok Waters, Banten Bay (figure 1). It was carried out at five stations that have their own characteristics. The blood cockles used as samples in this study were found only at Station 3 which is assumed to be its natural habitat.

![Figure 1. Map of blood cockles sampling location blood cockles (Anadara granosa) in the Cengkok Waters, Banten Bay.](image)
2.1. Materials and equipment

The materials needed in this study were aluminum foil, nitric acid, perchloric acid, and blood cockles (Anadara granosa). The equipment used in this study were cool boxes, ruler, surgical instruments, analytical scales, freezers, and Shimadzu atomic absorption spectrophotometer (AAS) type AA-7000.

2.2. Research methods

Blood cockles were captured using dredges. First, they were sorted into two sizes criteria: large (>3 cm) and small (≤3 cm). Second, the samples were then packaged separately based on size of the plastic. Third, the samples were put into a cool box containing ice. Thus, the cool box was used in maintaining the quality of the samples to be analyzed. Forth, morphometry is done by measuring blood cockles’ length and total weight. Fifth, the blood cockles were then dissected and approximately 50 grams of its meat were taken. Sixth, the meat was wrapped using aluminum foil and put in the freezer to maintain the durability of the samples. Seventh, the samples taken were labeled and analyzed in a laboratory according to the standard method, APHA [10].

Pb and Hg heavy metals in blood cockles’ meat were analyzed in two stages, wet destruction and measurement of Pb and Hg concentrations. The wet destruction was done by adding nitric acid-perchloric acid to separate the fat from the solution [11]. The solution was then analyzed by a spectrophotometric method using Atomic Absorption Spectrophotometer (AAS). The wavelengths used for each analysis of the heavy metal contents of Pb and Hg were 217.0 nm and 253.7 nm. The content of Pb and Hg in the water and sediment samples were also determined by the spectrophotometric method using AAS.

3. Result and discussion

3.1. Content of Pb and Hg in water

This study shows the Pb content in the water of Cengkok Beach, Banten Bay. The Pb and Hg content in the water of Cengkok Beach, Banten Bay ranged from 0.000-0.002 ppm (table 1). Overall, the Pb and Hg content in the water is still within the standard quality of Decree of Minister of Environment 2004.

| Parameter/Month | Pb (ppm) | Hg (ppm) |
|-----------------|----------|----------|
| April           | 0.002    | 0.000    |
| May             | 0.002    | 0.000    |
| June            | 0.002    | 0.000    |
| July            | 0.002    | 0.002    |
| August          | 0.002    | 0.002    |

Standard quality Decree of the Minister of Environment 2004 0.008 0.001

|Parameter/Month | Pb (ppm) | Hg (ppm) |
|-----------------|----------|----------|
| April           | 0.005    | 0.005    |
| May             | 0.005    | 0.005    |
| July            | 0.108    | 0.020    |
| August          | 0.020    | 0.020    |

ANZECC 2000 50 0.150
3.2. Content of Pb and Hg in sediment
This study also identified the Pb content in the sediment of Cengkok Beach, Banten Bay. The Pb and Hg content in the water of Cengkok Beach, Banten Bay ranged from 0.005-0.108 ppm (table 2). Overall, the Pb and Hg content in the sediment is still within the standard quality of ANZECC 2000.

3.3. Content of Pb and Hg in the meat of blood cockles (Anadara granosa)
This study revealed that the Pb content in the meat of blood cockles (A. granosa) taken in Cengkok Beach, Banten Bay was low as all of the monthly values were below the (<0.005 ppm). It can be stated that the Pb content was still within the quality standard of BPOM 2018, i.e., 0.20 ppm.

The values of Hg content in blood cockles’ meat observed for six months varied. The present study showed that the Hg content in the meat taken in Cengkok Beach, Banten Bay ranged from 0.002 to 0.447 ppm (Fig. 2). It can be stated that the Hg content was still within the standard quality of BPOM 2018, i.e., 0.50 ppm maximum.

![Figure 2](image)

**Figure 2.** Content of Hg in blood cockles’ meat, large and small, in March, April, May, June, July, and August 2019 in Cengkok Beach, Banten Bay.

Blood cockles can stay in one location for a long time, due to the slow movement. Its ability, stay longer in one location, makes blood cockles as a biota that has a high tolerance for heavy metal contamination. In addition, they accumulate heavy metals and still alive; thus, they can be used as bioindicators in aquatic environments [12].

The effect of the dry and rainy season causes variations in the content of heavy metals in water, sediments, and blood cockles. The blood cockles’ samples were taken from March to September. In general, the samples were taken during the dry season (April-August). Therefore, the accumulation of heavy metals should ideally increase in water, sediments, and blood cockles. This is because water input is reduced. When water input is reduced, source of heavy metals contamination is also reduced. Therefore, heavy metal contamination from water input into the body of biota is also reduced. On the
contrary, during the rainy season, the tendency for heavy metals to settle will decrease. This can occur because the dilution of heavy metals is higher in the rainy season [13]. The dilution causes the concentration to decrease in the water. However, the sedimentation and the entry of metals to the biota will still occur as long as a number of metals available in the water.

The accumulation of heavy metals in large blood cockles (>3 cm) is ideally higher than that of small blood shells (≤3 cm). Riani [14] states that small size shells have high heavy metal accumulation ability. The process of heavy metals accumulation will continue with increasing age of shellfish. Therefore, old age or large size blood cockles tend to accumulate higher heavy metals.

The value of the AAS detection limit for Pb used in the analysis is 0.005 ppm. All results obtained reached the detection limit value so that the Pb content read is less than 0.005 ppm. This indicates that the Pb heavy metal content in Cengkok Beach, Banten Bay is very low; thus, the method unable to detect the Pb content. Therefore, the Pb content in the meat is still within the quality standard of BPOM 2018, i.e., 0.20 ppm. The low result can be caused by low sources of contamination. The source of Pb contamination can come from industrial activities [15]. The low content of Pb in the meat is due to the location of blood cockles sampling which is far from industrial activities. The location of blood cockles sampling is surrounded by plantations.

The Pb content in water and sediment ranged from 0.000-0.002 ppm for water and 0.005-0.020 ppm for sediment (table 1 and 2). Overall, the Pb content in water and sediment still within the standard quality of Decree of Minister of Environment 2004 for water and ANZECC 2000 for sediment. The content Pb in sediment is higher than the Pb content in water and blood cockles. As stated by Irawati et al. [16], sediment is a place where heavy metal accumulates in waters.

Mercury (Hg) is a heavy metal that forms is liquid at normal temperatures. The content of Hg in the meat of blood cockle ranged from 0.002-0.047 ppm. This shows that the Hg content is still within the quality standard of BPOM 2018, i.e. 0.500 ppm. It shows that the source of contamination is low. The Hg content can come from the industrial wastes in the manufactures of paints and electrical components, batteries, and photography [17]. The Hg content of April, July, August is higher in small blood cockles. This can occur because it is influenced by the weight gain of blood cockles that is more dominant than the accumulation of heavy metals [16].

A sixfold decrease in Hg content occurred from April to May in large blood cockles (figure 2). This can be caused by blood cockles excrete heavy metals from their bodies to waters [12]. In addition, an eightfold increase occurred from June to July in large blood cockles. It shows that there are an accumulation and depuration of heavy metal Hg in large blood cockles. According to Yap et al. [18], the accumulation rate and depuration rate in blood cockles can be determined by control treatment.

The Hg content in water and sediment ranged from 0.000-0.002 ppm for water and 0.005-0.020 ppm for sediment (table 1 and 2). Overall, the result is still within the standard quality. The Hg content in the meat of blood cockles is higher than the Hg content in water and sediment. According to Effendi [17], heavy metal Hg that enter waters will be accumulated by blood cockles directly or indirectly. The Hg content that came from water and sediment can be accumulated by blood cockles through food nets [3].

4. Conclusion
The Pb and Hg content in the meat of blood cockles, water, and sediment still within the quality standards of BPOM 2018. Heavy metal content in large blood cockles tends to be higher than small blood cockles. The concentration of heavy metal fluctuated which is dependent on the amount of source of contamination and ability blood cockles to accumulate and eliminate heavy metal.

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