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Bioaccumulation of metals in mud crab (*Scylla paramamosain*) muscle from the certain coastal areas of East Java, Indonesia

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ABSTRACT

This study aims to find out the levels of Pb, Cd, and Zn in mud crab muscle (*Scylla paramamosain*) found in Sidoarjo, Gresik, and Probolinggo coast. Mud crab samples were caught using crab trap. Pb,Cd, and Zn levels in mud crab muscle were measured using atomic absorption spectrophotometer. The highest level of Pb was noted at Sidoarjo and the lowest at Probolinggo. The highest Cd was recorded at Sidoarjo, and the lowest level in the Gresik. The highest Zn content was found at the coast of Sidoarjo and the lowest at the coast of Gresik. Sidoarjo had the highest Pb content and exceeds the standard quality limit for all crab sizes, meanwhile Gresik and Probolinggo only crab with size 4 exceeded the standard quality limit. There is a positive correlation between crab body size and heavy metal levels in mud crab muscle found from all the sampling sites.

Key words : *Bioaccumulation, Heavy metals, Mud crabs, Marine resources, Marine pollution*

Introduction

North Coast of Java have a large coastal area with various characteristics of substrates ranging from sandy, muddy, and rocky coral. According to Setiawati (2009), this area is a potential fishing ground for crabs, fish, and shrimp. The waters of the North Coast of Java especially Gresik, Sidoarjo, and Probolinggo regencies are the main areas in supplying mud crabs (*Scylla paramamosain*) (Maryam *et al.*, 2012). However, Gresik and Sidoarjo regencies are the area with many industries and human activities that have the potential to produce wastes, one of them is heavy metal. The pollutions come from port activities, fertilizer factories, cement industry, and oil and gas drilling activities, as well as pond cultivation activities from these areas will deteriorate the surrounding environment where crabs live.

Mud crabs have a way of life, among others, by immersing themselves in the mud around the mangroves or digging holes to make their residence. Crab foods consist of plankton, shellfish, fish, shrimp, moss, and mangrove leaves (Indarjo *et al.*, 2020). When viewed from the habitat and type of food, mud crabs can be used as a bioindicator of marine pollution, especially heavy metal pollution

(Meirikayanti *et al.,* 2018).

Heavy metals in the water can settle at the bottom of the water for a long time (Rasyad, 2017). Heavy metals will be concentrated into the body of living beings by the process of biocalcification and biomagnification through several means, namely: through the digestive tract as well as through the respiratory tract and skin (Hayati *et al.,* 2017). Thus, the source of food that is contaminated with heavy metals is very dangerous for human consumption, including mud crabs (Ardiansyah *et al.,* 2012; Usman *et al.,* 2013, Putranto *et al.,* 2014). Heavy metal contaminants are known to concentrate on fine sediments because these sediments in addition to being rich in organic matter also have a greater ratio of particle surface area per total volume compared to larger particles (Tuheteru *et al.,* 2012). Both of these properties facilitate and promote greater metal adsorption (Svavarsson *et al.,* 2001). Hazardous heavy metals include mercury (Hg), lead (Pb), copper (Cu), arsenic (As), and cadmium (Cd) can entry into the food chain of coastal and marine ecosystem (Ruaeny *et al.,* 2015; Seta, 2017; Adhim *et al.,* 2017).

To the best of our knowledge there is no data that reveals the levels of heavy metals in *Scylla paramamosain*, especially those in the northern coastal waters of East Java. Considering that the genus Scylla crab is an important commodity and the most consumed by people in the northern waters of East Java, therefore further research is needed to evaluate the levels of heavy metals lead (Pb), cadmium (Cd) and zinc (Zn) in muscle of mud crab. This study aims to determine levels of heavy metals in crab muscleand quality standards of heavy metals for human consumption.

Materials and Methods

Sampling Locations

Mud crabs were collected from 3 stations in 3districts which are : (1) Banyuurip village, Ujung Pangkah District, Gresik Regency (2) Banjar Kemuning village, Sedati District, Sidoarjo Regency and (3) Curahsawo Village, Gending District, Probolinggo District (Fig. 1).

Sampling of crabs

Crab samples were taken using crab trap as many as 12 males representing three sampling points with each sampling point as many as 4 individuals from four different body size classes namely (1) 4-5.4 cm; (2) 5.5 – 7.5 cm; (3) 7.7 – 9.9 cm; (4) 10 – 12.9 cm. The samples were stored in cool box and transported to the laboratory for further analysis.

Preparation of crab muscle samples

Each sample of mud crab (*Scylla paramamosain*) was measured its body width and its weight (Overton *et al.,* 1997). Each mud crabs then dissected to separate the muscle from its exoskeleton using a dissecting set and weighted (approximately 5 g) for metals analysis.

Measurement of Pb, Cd, and Zn of mud crab muscle

Metal measurement was based on Indonesian National Standard (SNI 2354.5:2011). Muscle crab was digested using 10 mL concentrated nitric acid (HNO_3) 65% in a microwave digester for 3 hours at 100 - 400 ^oC. The temperature was gradually increased every 30 minutes. White ash obtained from microwave digester was moved into the Nessler tube, then added the Aqua Pro Injection (pyrogen-free water) until the volume reaches 50 mL, placed on a tube rack, and left for 12 hours. Approximately 30 ml of solution was used for metals measurement using AA - 7000 Shimadzu (Japan) atomic absorption spectrometer (AAS) with the element cathode lamps Pb, Cd, and Zn installed on instrument. The wavelengths used for each heavy metal were: Pb (283.3 nm), Cd (228.8 nm), and Zn (213.9 nm). The levels of Pb, Cd, and Zn werecalculated by following formula:

$$\mu g/g = \frac{(D–E) \times FP \times v}{w}$$

where:

D : Concentration of sample (µg/l) of AAS reading

E : Blank concentration of sample (µg/l) of AAS reading

Fp : Dilution factor

V : The final volume of the prepared sample solution (L)

W : Sample weight (g) ((BSN, 2009) SNI 2354.5:2011)

Statistical analysis

The magnitude of the correlation between mud crab sizes and Pb, Cd, and Zn levels in mud crab muscle was tested using the Pearson correlation test.

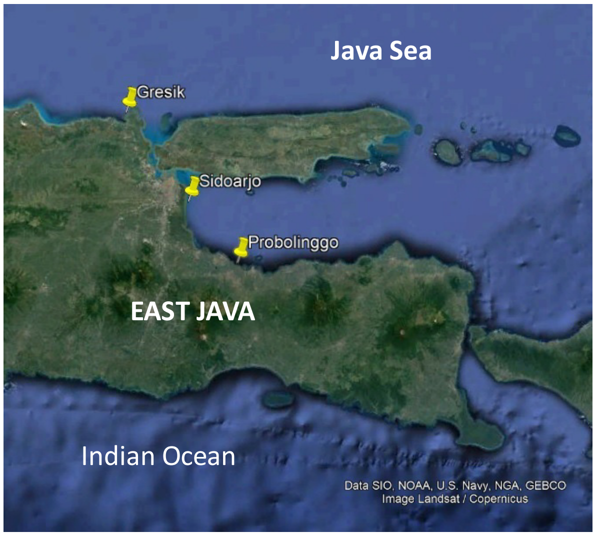

Fig. 1. Sampling location of crabs in East Java coast

Results and Discussion

Pb content in mud crab muscle in Gresik, Sidoarjo, and Probolinggo is presented in Table1. The sampling location of Sidoarjo has the highest Pb content and exceeds the standard quality limit for all crab sizes. At Gresik and Probolinggoonly size 4 exceeding the standard quality limit. According Perwira (2011), the source of Pb in the coast of Sidoarjo probably come from Porong River. The level of Pb in the sediment of this river was 3.08 mg/kg. The potential sources of Pb in this area comes not only from large industries but also middle-class industries such as the tanning industry where generally this class of industry does not have waste management and has the potential to dispose of its waste directly from the river (Perwira, 2011).

The sampling location Sidoarjo has the highest Cd content at all crab sizes. The lowest cd content was noted in Gresik location (Table 1). Cd contents in the crab muscle in all locations and all body sizesare still below the standard quality according to the National Standardization Agency. High levels of Cd in Sidoarjoarea, is due to several factors, namely from the ship service industry (because Cd is used as the painting electrical coating), the manufacture of alloys, from paint color pigment,as well as the existence of a battery and ceramic manufacturing plant that is also a source of Cd (Widowati, 2008). The sampling location of Sidoarjo has the highest Zn content at at all crab sizes. While the location of the lowest Zn content is noted in Gresik. Zn contents in the crab muscles in all locations and body sizesare still below the standard quality set by Food Standards Australia New Zealand (FSANZ, 2009).

Mud crab has higher Zn content in their body when compared to Pb and Cd; because Zn is needed in the development, growth, and metabolism. (Sanusi, 2006). Zn is an essential metal required by organisms in the formation of hemocyanin in the blood system and enzymatic.The sources of Zn are smelting and electrical coatings (Verma, 2013).This is in line with this study which found that the highest Zn levels are notedin the coast of Sidoarjowhich hasmore electricity industries than other locations.

Table 1. Metals content in mud crabs muscle (*Scylla paramamosain*)

Sampling Location	Size	Mud Crab Size range	Pb Content (mg/kg)	Cd Content (mg/kg)	Zn Content (mg/kg)
Gresik	1	4.4 - 5.4	0.21 ± 0.01	0.16 ± 0.01	0.24 ± 0.02
	2	6.8 - 7.5	0.26 ± 0.01	0.18 ± 0.01	0.27 ± 0.01
	3	8.9 - 9.9	0.28 ± 0.02	0.20 ± 0.01	0.30 ± 0.01
	4	10 - 12.9	0.31 ± 0.03	0.22 ± 0.01	0.34 ± 0.02
Sidoarjo	1	4 - 4.9	0.31 ± 0.01	0.25 ± 0.01	0.29 ± 0.02
	2	5.5 - 6.9	0.36 ± 0.02	0.31 ± 0.01	0.35 ± 0.02
	3	7.7 – 9	0.40 ± 0.02	0.36 ± 0.01	0.45 ± 0.03
	4	10.2 - 11.5	0.49 ± 0.02	0.42 ±0.01	0.52 ± 0.03
Probolinggo	1	4.3 - 5.3	0.18 ± 0.02	0.13 ± 0.01	0.19 ± 0.02
	2	6.6 - 7.5	0.23 ± 0.02	0.20 ± 0.01	0.22 ± 0.02
	3	9.2 - 9.8	0.29 ±0.02	0.24 ± 0.03	0.28 ± 0.02
	4	11 - 12.1	0.32 ± 0.02	0.30 ± 0.01	0.41 ± 0.02
Quality Standards (mg/kg)			0.3[a]	1[a]	25[b]

[a](BSN, 2009), [b](FSANZ, 2009)

The presence of Pb, Cd, and Zn that vary from various sizes of mud crabs, then conducted a statistical analysis using Pearson correlation to find out the relationship between size and heavy metal levels in the mud crab muscle in each location. There is a positive correlation value for the size of crab with heavy metal levels in all locations. A positive correlation is found in all sampling locations of Gresik, Sidoarjo, and Probolinggo, where the correlation is quite strong (Natanael, 2013). The positive correlation from Pearson correlation analysis can mean that the two variables have a direct relationship, meaning that the larger the size of the crab means the longer its life period, followed by the increasing levels of heavy metals accumulated in crab muscle where this happens in all sampling locations. One of the things that affect the accumulation of heavy metals in the tissues of marine organisms including shellfish is the size and phase of its life. This is following the opinion of (Connell and Miller, 1995) that age and body size affect the accumulation of heavy metals in the organism.

Conclusion

Based on the research results it can be concluded that the content of Pb in crabs from the coast of Sidoarjo has exceeded the standard quality limit, while Pb levels at the coast of Gresik and Probolinggo only at size 4 exceed the standard quality limit. Levels of Pb, Cd, and Zn in mud crab muscle (*Scylla paramamosain*) have a positive correlation with the mud crab which means the larger the size of the crab, the higher the level of heavy metals accumulated.

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