Heavy Metal Content In Green Mussels And Crabs As An Indicator Of Heavy Metals Presence In The Coastal Waters Of Karawang, Indonesia

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Abstract: The assessment of the aquatic environment condition is only by taking a sample of water quality, sometimes not clearly showing the actual alteration. Thus, to find out more about pollution conditions such as the presence of heavy metals in aquatic ecosystems, it requires to be supported by other types of samples, such as metal content in benthic biota and aquatic sediments. This study aimed to analyze the content of heavy metals in green mussels and crabs in the coastal area of Karawang - West Java which is suspected to often receive a variety of pollutants from potential industrial activities resulting in heavy metal contamination. In addition, the two types of benthic biota are often consumed by the community so that the feasibility or safety based on heavy metal content is also important to elaborate. Sampling was focused on 2 locations that often experienced a drastic increase in the abundance of green mussels, namely Sungaibuntu and Cemarajaya Villages. The results of sample analysis showed that Cadmium (Cd), Lead (Pb), and Tin (Sn) were below the detection limit for all samples. Arsenic (As) content was relatively higher in shellfish samples, while Mercury (Hg) levels were higher in crab samples. If viewed from the location of live shells in the water column (with the help of artificial substrate) and crabs in the bottom of waters, the metal content in both samples indicated that Hg accumulated more quickly in the bottom waters whilst As can lasted longer in the water column. When viewed from the viewpoint of consumption eligibility, all heavy metal content in the samples of shells and crabs in the study site still meets the requirements for consumption eligibility based on SNI 7387: 2009 [1].

Index Terms: Accumulation, crabs, detection limit, green mussels.

1 INTRODUCTION

KARAWANG waters are one of Indonesian waters that have a lot of fishing activities. In addition, the fish catchment in the Coastal Area of Karawang waters is sent to the nearest area, namely Jakarta and the surrounding areas. Nowadays, many human activities contribute to pollution in Karawang waters, such as waste disposal from the community, diverse industrial process, sea transportation, and oil spills [1], [2]. These activities have high potential to release waste containing heavy metals so that marine pollution might occur. Heavy metals in the waters will undergo a process of deposition and accumulate in sediments, then accumulate in the bodies of marine life in the waters either through the gills or through the food chain and eventually reach humans [3], [4]. Consumption of fish with high level of heavy metal contamination might bring up a serious consequence for human health [5]. The assessment of aquatic environment by water quality sampling mighty not clearly show the thoroughly condition of heavy metal content on the coastal area. Hence, the presence of heavy metals in aquatic biota and sediment needs to be elaborated. Benthic biota such as green mussels and crabs in Karawang waters can be used as good indicators because they are slow movement in a certain habitat [6]. Mussels have the potential to accumulate heavy metal content in waters due to its filter feeders [7], [8], whilst crabs have sensitivity to metal pollution because of their living in the bottom sediments where chemical contaminants are mainly stored [9]. This research aimed to analyse heavy metal content in green mussels and crabs in order to assess the water pollution in Coastal Water of Karawang Regency, and categorize them in consumption eligibility of Indonesian standard rules [10].

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2 MATERIALS AND METHODS

The samples was collected in Karawang Regency at two locations (Sungaibuntu and Cemarajaya Villages) (Fig 1). Details of biota collection are shown in Table 1. The sampling was carried out in November 2019. Green mussels and crabs were wrapped and stored frozen until analysis was undertaken. Analysis of heavy metal content was done at Laboratory of testing, calibration and certification services, IPB University using Atomic Absorption Spectrophotometry (AAS) method. Species of green mussels and crabs sampled in this research were Perna viridis, Charybdis feriata, and Thalamita sp. (Table 1).

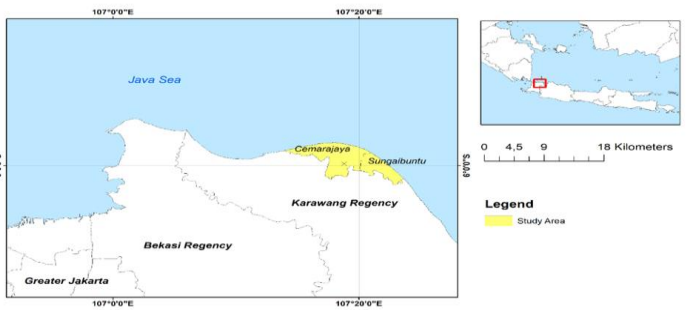

***Fig. 1**. Study area (Cemarajaya and Sungaibuntu)*

TABLE 1
ECOLOGICAL CHARACTERISTICS OF GREEN MUSSELS AND CRABS'S SAMPLE

Location	English name	Scientific name	Habitat	Length (cm)
Sungaibuntu	Green Mussel	Perna viridis	Attached to the substrat in estuary with bissal thread	2
Cemarajaya	Green Mussel	Perna viridis	Attached to the substrat in estuary with bissal thread	2
	Cancer Sexdentatus	Charybdis sp	Seashore and rocks	8
	Stone Crab	Thalamita sp.	Seashore, rocks, coral reef, seagrass	11

The results of heavy metal content analysis were compared with consumption eligibility of Indonesian standard rules [10] concerning Metal Content in Food (Table 2), to assess the feasibility of benthic biota. The heavy metal content analyzed were Arsenic (As), Cadmium (Cd), Mercury (Hg), Tin (Sn), and Lead (Pb).

TABLE 2
MAXIMUM LIMIT OF As, Cd, Hg, Pb CONTAMINATION IN FOOD (SNI 7387: 2009)

Food Category	Maximum limit (mg/kg)			
	As	Cd	Hg	Pb
Fish and fishery products include molluscas, crustaceans and echinoderms as well as amphibians and reptiles				
Fish and other processed products	1.0	0.1	0.5	0.3
Predatory fish such as shark, tuna, marlin, and others	-*)	0.5	1.0	0.4
Shellfish (bivalve), molluscas and sea cucumbers	1.0	1.0	1.0	1.5
Shrimp and other crustaceans	1.0	1.0	1.0	0.5

*) There is no quality standard requirement

3 RESULT AND DISCUSSION

The concentrations of five heavy metals (As, Cd, Hg, Sn, and Pb) of green mussels and crabs in coastal area of Karawang are listed in Table 3. The results showed that Cadmium (Cd), Lead (Pb), and Tin (Sn) were below the detection limit for all samples. Arsenic (As) content was relatively higher in Green mussels' samples, while Mercury (Hg) levels were higher in crab samples. The ranges of concentration of heavy metal content are as follows: 0.053 – 0.092 mg/kg for As, <0.005 (under detection limit) for Cd, 0.010 – 0.027 mg/kg for Hg, <0.4 (under detection limit) for Sn, and <0.5 (under detection limit) for Pb. The order of species according to the heavy metal accumulation as follows: Green Mussel's Cemarajaya > Green Mussel's Sungaibuntu > Cancer Sexdentatus's Cemarajaya > Stone Crab's Cemarajaya for As, and Cancer Sexdentatus's Cemarajaya > Stone Crab's Cemarajaya > Green Mussel's Cemarajaya > Green Mussel's Sungaibuntu for Hg.

TABLE 3
HEAVY METAL CONCENTRATION (mg/kg) IN DIFFERENT SELECTED MUSSELS AND CRABS SPECIES

Location	Biota	mg/kg				
		As	Cd	Hg	Sn	Pb
Sungai buntu	Green Mussel	0.091	<0.05	0.008	<0.4	<0.5
Cemara jaya	Green Mussel	0.092	<0.05	0.010	<0.4	<0.5
	Cancer Sexdentatus	0.064	<0.05	0.027	<0.4	<0.5
	Stone Crab	0.053	<0.05	0.013	<0.4	<0.5
SNI 7387:2009[a]		1.0	1.0	1.0	-	1.5

[a]) Consumption eligibility of Indonesian standard rules SNI 7387: 2009 concerning Metal Content in Food

If viewed from the location of shells habitat in the water column (with the help of artificial substrate) and crabs in the bottom waters, the metal content in both samples indicated that Hg accumulated more quickly in the bottom waters whilst As can lasted longer in the water column. Naturally, heavy metal Hg has the property of easily depositing in sediments in the form of particulates [11], so that the Hg that is deposited in the sediment will quickly enter the bodies of marine benthic animals, such as mussels, crabs, and then accumulate in their bodies. Heavy metal As has the highest concentration compared to other heavy metals in all analyzed aquatic biota, followed by heavy metal Hg. It can be an indication that the sea waters of Sungaibuntu and Cemarajaya, Karawang have the potential to be contaminated with heavy metals As and Hg. Heavy metal As that found in marine waters can come from agricultural waste such as disposal of pesticides, insecticides, herbicides, algaecides, rodenticides, and fertilizers [12]. Considering that the agricultural activities in Karawang Regency community are very large, it is possible that heavy metal As that enters the sea waters, settles, and accumulates in the sediment comes from the discharges of pesticides and fertilizers containing As from agricultural activities. Likewise, heavy metal Hg can enter marine waters from pesticide application discharges which are carried by the river into the Karawang Sea. For green mussels, based on the sample size of green mussels which is still small, about 2 cm or the stage of juveniles [13] and the west wind currents at the time of sampling, it is strongly suspected that the green mussels caught in the coastal waters of Karawang originate from green mussel cultivation area in Jakarta Bay [14]. Therefore, there is a chance that the heavy metal content of As and Hg in the green mussel sample is affected by the high level of heavy metal pollution in Jakarta Bay [15], [16]. The detection of As and Hg heavy metals in green mussels and crabs in Karawang seawaters further strengthens the results of previous studies which have reported that heavy metal content is detected in marine biota on the north coast of Java, especially aquatic biota that live at the bottom (benthic biota) [14], [17], [18], [19]. When viewed from the viewpoint of consumption eligibility, all heavy metal content in the samples of shells and crabs in the study site still meets the requirements for consumption eligibility based on SNI 7387: 2009. Although it is still safe for consumption, but if we often consume green mussels or crabs or other marine benthic animals, so heavy metals, such as Hg and As, will accumulate in the body, and it is dangerous and high risk for our healthy. Based on its physical and chemical characters, Hg has the highest order of toxicity among other heavy metals. Heavy metals As and Hg are groups of non-

essential heavy metals that are very dangerous and can cause poisoning (toxic) in humans who consume them [20]. Moreover, the green mussel samples analyzed were small size or juveniles, so with their accumulation characters, the concentration of heavy metals As and Hg in adult-sized green mussels would potentially be much higher. As a biota filter feeder, green mussels can accumulate more heavy metal contaminants compared to other aquatic animals so that it is very risky to human health who consume them [21], [22], [23], [24]. Therefore, community must apply the precautionary principle if they want to consume green mussels, especially from north coastal of Java.

4 CONCLUSIONS

The results showed that Cadmium (Cd), Lead (Pb), and Tin (Sn) were below the detection limit for all samples. Arsenic (As) content was relatively higher in Green mussels' samples, while Mercury (Hg) levels were higher in crab samples. Therefore, all heavy metal content in green mussels and crabs' sample in the study site still meets the requirements for consumption eligibility based on SNI 7387: 2009 by applying the precautionary principle, both in quantity and frequency.

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