Analysis of cadmium (Cd) heavy metal content in Mangrove Crab (*Scylla olivacea*) meat at Lake Siombak

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Abstract. The presence of heavy metals in the aquatic environment must be monitored for their presence. This study aims to determine the content of heavy metals cadmium (Cd) in water and mangrove crabs (*Scylla olivacea*). Water and crab samples were taken in June-July 2019. The Cd content in water has exceeded the quality standard of Kepmen LH of 2004, Cd content in crabs is still below the quality standard of BPOMRI of 2018. It can be concluded, that the content of heavy metal Cd in water has exceeded the quality standard and crabs are still below the quality standard.

1. Introduction
The lake is a pool of water all year long. The lake is also a basin that serves to hold water and store water that comes from rain water, ground water, spring water or river water. Lake is characterized by a slow current or even no current at all. The residence time of water in a lake can last a long time. Currents in lake waters can move in various directions [5]. Siombak Lake was formed because of the dredging of land carried out for the construction of the Belmera toll road (Belawan Medan Tanjung Morawa). Before becoming a lake, the location of Siombak lake used to be land owned by local residents that was used for toll roads. The land is dredged and filled with rainwater and river water to form Lake Siombak [13].

Other heavy metals that are often found in industrial waste are heavy metals Cadmium (Cd). Harmful heavy metals that accumulate in marine biota are absorbed through the gills and digestive tract. The heavy metal Cd which is buried in tissues and bound to proteins is called metalotonein (MTN), is rather permanent and has a fairly long half-life. Cd is a heavy metal that has high toxicity after Hg. The maximum level of Cd in permissible wastewater based on the Decree of the State Minister for the Environment Number: KEP-51 / MENLH / 10/1995 concerning Liquid Waste Quality Standards for Industrial Activities is 0.05 ppm [9].

Aquatic biota which has the highest role in the absorption of heavy metals in waters are crustaceans such as crabs, shellfish and several types of shrimp. Crab is an aquatic biota in its habitat that has good survival. Crabs are often used as aquatic bioindicators because they are able to accumulate heavy metals which are quite high compared to other biota. Heavy metals are generally toxic to living things, although some of them are needed in small quantities. Heavy metals can be distributed to parts of the human body and some will be accumulated through various intermediaries such as air, food and water that is polluted by heavy metals. If the situation lasts continuously for a long time it can reach a large amount, then it will endanger human health [6].
Therefore, this study aims to determine the concentration of cadmium (Cd) heavy metals in mangrove crabs (*Scylla olivacea*) in Siombak Lake and to determine the level of pollution of cadmium (Cd) heavy metals according to the standard predetermined quality standards.

2. Materials and methods

2.1. Study site
This research was conducted in June - July 2019 which included water, substrate and mangrove crab (*Scylla olivacea*) sampling in the waters of Lake Siombak Kelurahan Paya Pasir Medan Marelan, Medan City. Sampling was carried out at 3 stations. Map of the research location can be seen in Figure 1.

2.2. Tools and materials
The tools used in this study are Bubu, Secchi disk, global positioning system (GPS), vandorn water sampling, stationery, knife, water sample bottle, callipers, refractometer, pH meter, DO meter, thermometer, cool box, porcelain cup, hot plate, furnace, test tubes, measuring cups, analytical scales, erlenmeyer, beaker glass, pipet volumetric, measuring flask, glass funnel, filter paper, stirrer and Atomic Absorption Spectrophotometer (AAS).

The ingredients used are mangrove crabs (*Scylla olivacea*) water and substrate samples, hydrochloric acid (HCl) solution, concentrated Nitric acid (HNO₃), chloric acid (HClO₄), distilled water (used in the dilution process), standard Cd solutions, label paper and tissue.

2.3. Sampling
Water sampling is carried out directly in the field as much as 1500 ml where there are 3 water sampling points, then put into water sample bottles and placed in a coolbox. Sampling of mangrove crabs (*Scylla olivacea*) is carried out directly in the field of 6 mangrove crabs (*Scylla olivacea*) with a minimum body weight of 150 gr, where there are 3 sampling points of mangrove crabs (*Scylla olivacea*). Mangrove crabs (*Scylla olivacea*) are then cleaned of mud that sticks and then put into the coolbox.
2.4. Data analysis
Analysis of cadmium (Cd) heavy metal content in water and mangrove crab (*Scylla olivacea*) samples was analysed at the Medan Regional Health Laboratory using the Atomic Absorption Spectrophotometer (AAS) method. The results of the analysis are presented in tabulations and analysed descriptively.

3. Results and discussion

3.1. Heavy metal content
Based on the results of the study the average values of water physical and chemical parameters can be seen in Table 1 below.

| Table 1. Average values of Water Physics and Chemical parameters in Lake Siombak waters |
|--------------------------------------------|
| Parameter       | Unit | Station | Quality standard |
|-----------------|------|---------|------------------|
|                 |      | I       | II    | III   |                   |
| Physics         |      |         |       |       |                   |
| Temperature     | °C   | 30.3    | 31.5  | 30.5  | 28 – 32 (c) *     |
| Salinity        | (%)  | 7       | 8     | 8     | 6 - 34 (c) *      |
| Water clarity   | Cm   | 60      | 50    | 80    | -                 |
| Chemistry       |      |         |       |       |                   |
| pH              | -    | 7.33    | 7.5   | 7.43  | 7 – 8.5 (d) *     |
| DO              | mg/L | 1.13    | 1.85  | 2.13  | > 5 *             |
| Cd              | mg/L | 0.0095  | 0.0195| 0.059 | 0.001 *           |

Source: Primary Data
Information:
*) KepMen LH No 51 Year 2004 [10]

Based on the analysis of cadmium (Cd) in the water contained in the waters of Lake Siombak at each station has varying values ie the average ranges between 0.0095 - 0.059 mg / L with the lowest average value found at station I which is 0.0095 mg / L and the highest is at station III which is 0.059 mg / L (Table 2). Thus, based on Ministerial Decree and Environment No. 51 of 2004 Lake Siombak waters have exceeded the threshold of cadmium (Cd) which is ≥ 0.001 mg / L and included in the polluted category. According to [1] said that heavy pollution if DO levels between 0.1-2 mg / L, the low dissolved oxygen is thought to be used by bacteria to decompose the pollutants so that waste material in water can be oxidized through chemical reactions, so it will have an impact on decreased levels of dissolved oxygen.

The heavy metal content of Cd in the water columns from the three stations has shown above sea water quality standards. This is because heavy metals that enter the aquatic environment will experience dilution due to the effects of tides, adsorption and absorption by aquatic organisms [3]. However, if observed from the three stations, stations II and III have higher Cd heavy metal contents compared to other locations. The high content in stations II and III is caused by the metal content that comes from several sources, i.e. apart from land, it also comes from human activities that occur on land, namely the presence of household waste containing, industrial waste deposits and corrosion of pipes water pipes containing ferrous metals carried by the river to the station. This can also be related to the condition of the waters at the time of the study, based on the results of water quality measurements of dissolved oxygen content (DO) in the waters of Lake Siombak classified as low, ranging between 1.13 - 2.13 mg/l. This indicates that in the waters of Lake Siombak there has been waste pollution, one of them is Cd metal.

Besides that, the water temperature will also support the high solubility of Cd in water. High temperatures cause decreased levels of dissolved oxygen (DO) in water. An increase in water temperature can describe the degree of mineral solubility so that the solubility of Cd in high water.
Heavy metal solubility is also influenced by DO conditions in water. According to [12] low DO concentrations cause low solubility of heavy metals making it easy to settle to the bottom of the sediment. It is known that DO in the waters of Lake Siombak 1.13 - 2.13 mg/L.

**Table 2.** Results of average analysis of Cd heavy metal content in water and mangrove crab (*Scylla olivacea*) samples in Lake Siombak waters

| Location   | Cadmium Heavy Metal (Cd) | Water (mg/L) | Crab (mg/kg) |
|------------|--------------------------|--------------|--------------|
| Station I  |                          | 0.01         | 0.0020       |
|            |                          | 0.009        | 0.0018       |
| Average    |                          | 0.0095       | 0.0019       |
| Station II |                          | 0.019        | 0.0019       |
|            |                          | 0.02         | 0.0020       |
| Average    |                          | 0.0195       | 0.00195      |
| Station III|                          | 0.058        | 0.0020       |
|            |                          | 0.06         | 0.01         |
| Average    |                          | 0.059        | 0.006        |
| Quality standard |                    | 0.001*      | 0.1**        |

Source: Primary Data
Information:
*) KepMen LH N0 51 Year 2004 [10]
**) BPOM RI No 5 Year 2018 [2]

Cadmium metal content in mangrove crabs (*Scylla olivacea*) at each station in the waters of Lake Siombak have values ranging from 0.0019 - 0.006 mg / kg with the lowest average value found at station I which is 0.0019 mg/kg and the highest is at station III which is 0.006 mg / kg. Based on the quality standard of the Food and Drug Supervisory Agency (BPOM) no 5 of 2018 which is equal to ≤0.1 mg/kg, thus the cadmium content in mangrove crabs (*Scylla olivacea*) found in the waters of Siombak Lake is stated to be still below the permitted threshold.

The content of heavy metals in mangrove crabs is also influenced by water conditions. The higher the temperature, the level of accumulation of heavy metals in the sediment will be higher. According to [7] that rising temperatures will cause bioaccumulation rates to be high. Strengthened by the opinion of [4] that the higher the water temperature in a waters, the toxicity power increases, so that the heavy metal content of Cd is more easily absorbed by mangrove crabs so that the heavy metal content of Cd in the body increases, and vice versa the lower the temperature water, the toxicity decreases. Rising temperatures in the waters will accelerate the reaction in the formation of heavy metal ions.

The difference in the value of the concentration of cadmium heavy metal content in crabs is also influenced by differences in each crab's body size. In accordance with research conducted by [11] the results of the average value of the concentration of cadmium heavy metal content in mangrove crabs (*Scylla serrata*) which were studied based on size obtained different results, where mangrove crabs measuring 100 gr obtained 0.11 results while crabs measuring 150 gr got the result ≤ 0.003.
3.2. Bioconcentration factor values
Based on the calculation of cadmium bioconcentration factor values in crabs with water in the waters of Lake Siombak from the three stations it was found that BCF ranged from 0.1 to 0.1947. The lowest cadmium bioconcentration is at station II, which is 0.1 and the highest is at station I, which is 0.1947 (Table 3).

| Station  | Average Concentration Value | BCF   |
|----------|-----------------------------|-------|
|          | Crab (mg/kg) | Water (mg/L) |       |
| Station I | 0.00185         | 0.0095         | 0.1947 |
| Station II | 0.00195        | 0.0195         | 0.1   |
| Station III | 0.006          | 0.059          | 0.1017 |

Thus, it can be concluded that mangrove crabs (Scylla olivacea) have the ability to accumulate heavy metals cadmium (Cd) in crabs with water in the waters of Lake Siombak classified as low accumulation ability, namely BCF <100 ppm [8].

4. Conclusion
The content of heavy metal Cd in water in Siombak Lake waters has been indicated to be contaminated with Cd metal because it is above the quality standard, which ranges from 0.0095 to 0.059 mg/L. While the content of heavy metals Cd in mangrove crabs (Scylla olivacea) in Lake Siombak waters have not been contaminated with Cd metals because they are still below the quality standard, which ranges from 0.0019 to 0.006 mg/kg. The value of crab bioconcentration factor to water is still relatively low, namely BCF value ≤ 100.

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