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Accumulation Heavy Metal on Shrimp White *(Litopenaeus Vannamei)* at the River Mouth of Ketahun, North Bengkulu

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ABSTRACT

Heavy metals are poisonous materials capable of causing damage to the normal aquatic organisms in the community around the Ketahun River estuary. The entry of heavy metals into the waters of the Ketahun River estuary is allegedly from various activities such as bathing, washing, toilet use, palm oil plantations, coal mining, and the disposal of gold mine waste. This is the background for conducting research to analyze the content of Hg, Cd, Pb, and As in Litopenaeus vannamei in the Ketahun River estuary. The determination of sampling locations was done using a purposive method, and the samples were tested using Inductively Coupled Plasma Mass Spectrometry (ICP-MS). The ecology of the river estuary was measured using a thermometer, pH meter, Dissolved Oxygen Meter, and Total Dissolved Solid Meter. The research results were analyzed using a descriptive qualitative method. According to the findings of the study, the metal content in Litopenaeus vannamei exceeds the quality standard with an analysis result of 0.2328 mg/kg, while the quality standard is 0.20 mg/kg, which has health implications. For sediment, the heavy metal that exceeds the quality standard is mercury at 0.5921 mg/kg, while the quality standard is 0.15 mg/kg. The ecology of the river estuary continues to be an ideal environment for living biota.

Keywords : Heavy metal , Ketahun River , Bengkulu, *Litopenaeus vannamei*, ICP-MS

INTRODUCTION

The river is a freshwater ecosystem that serves as a habitat for various organisms. (Rahmi et al ., 2016). Sumatra Island has numerous rivers, one of which is the Ketahun River located in North Bengkulu. (Arief, 2015). The largest river in Bengkulu is the Ketahun River, covering an area of 2,405.45 km2. It consists of seven sub-watersheds: Ketahun Hulu, Ketahun Tengah, Ketahun Hilir, Lelangi Hulu, Lelangi Tengah, Lelangi Hilir, Suwoh, and Santan. (BPDASHL, 2016). Humans often rely on rivers for livelihood, recreational activities, and food sources. Local communities engage in various activities along the river. However, agricultural and mining activities contribute to environmental issues such as water pollution, health risks, and sedimentation downstream. (Kamalia & Sudarti, 2022). Waste from agricultural, mining, bathing, washing, and toilet activities that is disposed of in waterways can accumulate and lead to environmental pollution, requiring immediate attention. (Putri et al. , 2021).

Metals found in nature can be obtained from various sources, such as the upwelling process, volcanism, tectonics, and atmospheric input. Metals are naturally present in water, albeit in trace amounts. (Puspasari, 2006). In cases where heavy metal pollution in the

Ketahun estuary river is alleged to have consequences, high community activities such as agriculture, mining, bathing, washing, and using toilets can trigger the accumulation of heavy metals. Heavy metals are metallic elements with high atomic masses that can originate from anthropogenic activities. (Suharjo et al., 2022). The presence of heavy metals in water and the ability of aquatic organisms to accumulate these metals can have a significant impact on their survival and overall health. (Priatna et al ., 2016). Metals such as mercury (Hg), cadmium (Cd), lead (Pb), arsenic (As), nickel (Ni), and chromium (Cr) are hazardous and often contaminate the environment. These metals can accumulate in organisms, persist in the body for extended periods, and become toxic over time. (Silitonga et al ., 2015). Budiastuti et al. (2016) highlighted that aquatic biota, such as fish, shrimp, and shellfish, can become contaminated with high levels of heavy metals present in sediment, posing health risks if consumed. It is crucial for the public to be informed about the sources of heavy metals and methods to prevent their accumulation, as the presence of these metals in the environment can have adverse effects on human health. (Hananingtyas, 2017).

Heavy metal pollution in water can disrupt various aquatic organisms, including gastropods, decapods, and fish. The research conducted by Pratiwi (2020) revealed that heavy metals have a detrimental impact on aquatic organisms and human health. Tests were conducted to measure the levels of heavy metals, specifically Hg, Cd, Pb, and As, in white shrimp (Litopenaeus vannamei), a species commonly consumed by the local community.

MATERIALS AND METHODS

Sampling was conducted in November 2023 at Muara Sungai Ketahun, North Bengkulu Regency. The sampling location was determined using the purposive sampling method, which involves selecting samples based on specific criteria. The researcher's consideration is to determine the sampling location based on accessibility.
Samples were collected from tidal areas on the left and right banks downstream of the river, divided into four points as shown in Figure 1.

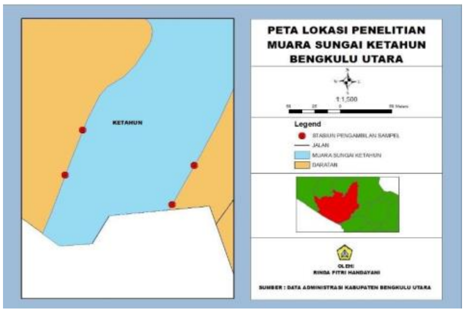

Figure 1. Research Sites (Sourch: Archgis)

The station transect size was 20 m, divided into four plots each measuring 5 m. Sample shrimp were collected using two methods: 1) spreading nets on the plot, and 2) sifting samples from the bottom of the water. Sediment samples were collected using a corer at a depth of 50-100 cm below the water surface. Shrimp samples were obtained, preserved in 40% formalin, and stored in zip-lock plastic bags. The sediment was separated from gravel, filtered through a sieve, and stored in a labeled bottle.

Testing for heavy metal content in 250g samples of shrimp and sediment using Inductively Coupled Plasma Mass Spectrometry (ICP-MS) method. The procedure for heavy metal analysis using ICP-MS is illustrated in Figure 2.

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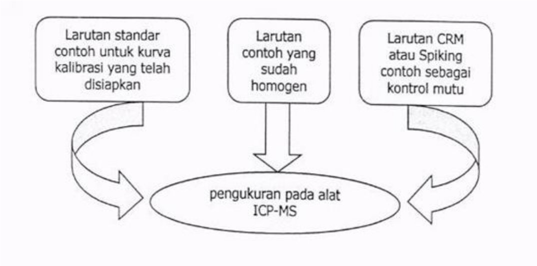

Figure 2. Procedur ICP-MS (Sourch : UPT. PMP2KP Banyuwangi)

The parameters of the ecology environment can be measured using temperature, pH meters, DO meters, and TDS meters.

RESULT AND DISCUSSION

In the research conducted at four stations, only samples from station 2 met the minimum weight requirement for testing heavy metal content. The results of heavy metal testing on *Litopenaeus vannamei* from station 2 are presented in Table 1. The table 1 below presents the results of heavy metal testing on Litopenaeus vannamei from station 2.

Table 1 Results test metal heavy on *Litopenaeus vannamei*

Number	Test Parameters	Results Testing	Raw Quality BPOM (2018)	Information
1	Mercury (Hg)	0.2049 mg/kg	0.50 mg/kg	In lower threshold limit
2	Cadmium (CD)	0.0232 mg/kg	0.10 mg/kg	In lower threshold limit
3	Lead (Pb)	0.2328 mg/kg	0.20 mg/kg	Go beyond threshold limit
4	Arsen (US)	0.1929 mg/kg	0.25 mg/kg	In lower threshold limit

The tabulation results in Table 1 show that one type of heavy metal, Pb, exceeded the threshold limit. According to BPOM regulations number 5 of 2018, the accumulation of Pb at 0.2328 mg/kg is categorized as exceeding the threshold. *Litopenaeus vannamei* found in the Ketahun river estuary may pose a health risk if consumed over a long period. (Veronika et al., 2022). The activity of enzymes involved in the formation of hemoglobin can be inhibited by the presence of lead (Pb) in the human body. Lead toxicity can lead to spontaneous abortion in women, disruption of nervous and gastrointestinal functions, memory impairment, infertility in men, and kidney problems. (Indirawati, 2017).

Shrimp bodies accumulate heavy metals from the food chain. According to Yusni & Setiani (2019), shrimp collect heavy metals as they are small benthic-eating demersal animals that reside at the bottom of water bodies. Pb can be absorbed into a shrimp's body through various means, such as ingestion, direct absorption from water, and diffusion through the carapace. After entering the shrimp's metabolic system, lead (Pb) will circulate through the bloodstream, spreading and concentrating in the shrimp's body. The carapace section facilitates the accumulation of substances through osmoregulation and diffusion across the skin. (Pong-Masak & Rachmansyah, 2017).

Content metal heavy sediment in estuary river

The table in Table 2 shows the accumulation of sedimentary heavy metals at the mouth of the Ketahun River.

Table 2. Results metal test heavy on sediment

Number	Parameter	Test result	ANZECC Quality Standards & ARMCANZ (2000)	Information
1	Mercury (Hg)	0.5921 mg/kg	0.15 mg/kg	Go beyond threshold limit
2	Cadmium (CD)	0.0738 mg/kg	1.5 mg/kg	In lower threshold limit
3	Plumbum (Pb)	9.4732 mg/kg	50 mg/kg	In lower threshold limit
4	Arsen (US)	7.0816 mg/kg	20 mg/kg	In lower threshold limit

Based on the heavy metal analysis results presented in Table 2, it is evident that the mercury content in the sediments exceeds the quality standard, with a concentration of 0.5921 mg/kg. The sediment has the highest concentration of Pb at 9.4732 mg/kg, according to the Australian and New Zealand Environment and Conservation Council (ANZECC) and the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) Water Quality Guidelines (2000). Heavy metal contamination in sediment can persist long after the pollution source is removed, resulting in higher metal concentrations in sediment compared to biota (Putri et al., 2014).

Community activities can contribute to the accumulation of heavy metals in sediment. Even seemingly harmless activities like using toilets can impact the levels of heavy metals in sediment. The Ketahun river area is also affected by coal mining, palm oil plantations, and the disposal of waste from gold mines. (Silviani et al., 2022). Lebong Regency is rich in mineral resources, particularly gold mines. (Sari et al., 2023). Mining activities generate waste containing heavy metals like mercury, which can contaminate water sources and harm aquatic life (Bernadus et al., 2021). Mercury is a toxic liquid metal found in the environment. It is the most toxic non-radioactive element. (Sari et al., 2023). In the environment, cadmium (Cd) can be released from public activities such as household waste and market waste. (Aja et al., 2020). According to Nurfadhilla et al In the estuary of the Ketahun River, there are numerous boats passing by, and along the riverbanks, there are several locations that serve as boat docks. Nurfadhilla et al. (year) conducted a study to assess the impact of boat traffic on the water quality of the estuary. One factor that can lead to river water pollution by lead (Pb) is the transportation activities of fishermen using boats.

Accumulation occurs from agricultural application products such as herbicides, insecticides, algicides, and fungicides. (Hertika dan Putra, 2019). Communities can utilize phytoremediation with aquatic plants to reduce the accumulation of heavy metals in water bodies. Examples of aquatic plants effective in removing heavy metals include *Eichhornia crassipes* and *Hydrocotyle umbellata* (Irhamni et al., 2017).

Comparison content metal heavy between *L. vannamei* with the sediment

The content of the comparison shows high levels of metal and sediment, as well as shrimp. This comparison is illustrated in Figure 2.

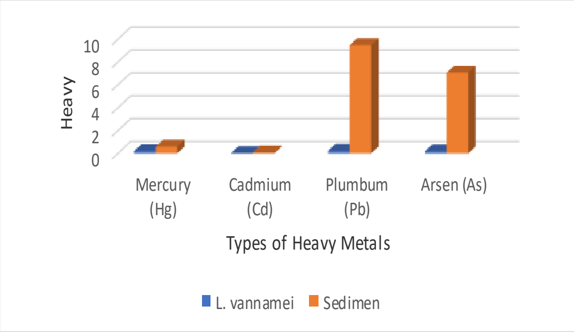

Figure 2. Comparison diagram of heavy metal content

Table 1 and Table 2 show variations in the heavy metal content present in Litopenaes vannamei and sediment. The comparison of heavy metal test results is illustrated in Figure 2, highlighting significant differences in Pb and As levels between L. vannamei and sediment. L. vannamei has a relatively short life cycle of around 90 days. After 90 days, L. vannamei shrimp may no longer be able to grow and develop optimally, or they may have already died. (Rahmawati, 2023). Heavy metals suspended in sediment will persist for a longer period, resulting in higher concentrations of heavy metals in sediment compared to biota.

Parameter Ecology estuary River Ketahun

Parameter environment which used on moment study between other form temperature, water pH, DO, TDS. Results measurement environment based on parameter Which used shown in Table 3.

The study focused on various environmental parameters such as temperature, water pH, dissolved oxygen (DO), and total dissolved solids (TDS). The results of the measurements based on these parameters are presented in Table 3.

Table 3. Data Environment

Parameter	Mark	Raw quality	Information
Temperature	24 °C	10 °C - 25 °C	Normal
pH	8.5	6.5 – 8.5	Normal
DO	9.1 mg/L	>5 mg/L	Normal
TDS	99 ppm	500ppm	Normal

The ideal temperature range for aquatic organisms is between 10°C and 25°C. Current measurements indicate that the water temperature is within the normal range at 24°C. Temperature plays a significant role in the distribution of heavy metals in water and sediment. Lower temperatures lead to heavy metals settling in sediment, while higher temperatures can cause heavy metal compounds to dissolve in water (Ramadhan, 2021). The pH measurement yielded a value of 8.5. The normal pH range for water, according to the WHO, is between 6.5 and 8.5 during both the dry and rainy seasons. Different types of waste can affect the pH levels of polluted water. (Naillah et al., 2021). This indicates that the pH level did not exceed the limit.

Dissolved oxygen (DO) levels in the Ketahun River estuary at station 2 were measured at 9.1 mg/L, which meets the optimal water quality standard for supporting biota life (>5 mg/L) as per the Decree of the Minister of Environment No. 51 of 2004. Organic material in water consumes dissolved oxygen, so higher levels of organic material result in lower dissolved oxygen levels. (Simbolon, 2016). TDS measurements showed results as high as 99 ppm, which is well below the maximum permitted level of 500 ppm according to Minister of Health Regulation No. 492 of 2010. Water TDS levels are influenced by soil runoff, coal weathering, and human activities. (Suharjono, 2021).

The ecological condition of the estuary of the Ketahun River is assessed using four parameters: temperature, water pH, dissolved oxygen (DO), and total dissolved solids (TDS). These parameters are compared to established quality standards to determine the water quality at the river mouth. The tabulated values show that the water conditions meet the quality standards and are suitable for aquatic biota. The optimal environmental conditions at the mouth of the Ketahun River indicate that it can still support aquatic life.

CONCLUSION

From the study results, it can be concluded that the heavy metal content in L. vannamei exceeds the threshold limit, particularly for Pb. Additionally, the sediment analysis indicates elevated levels of mercury above the threshold. The presence of high levels of heavy metals in sediments may be attributed to anthropogenic activities. Despite this, the ecological parameters measured in accordance with quality standards remain below the threshold, indicating a relatively stable environment.

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