Konsentrasi Timbal (Pb) pada Kerang Kepah (*Geloina expansa*), Air, dan Sedimen Mangrove Desa Peniti Kabupaten Mempawah Kalimantan Barat

The Concentration of Lead (Pb) in Kepah (*Geloina expansa*), Water, and Sediment of Mangrove Peniti Village Mempawah Regency West Kalimantan

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ABSTRAK

Pencemaran logam berat dan bahaya yang ditimbulkannya merupakan isu global dan perlu mendapat perhatian yang tepat. Logam berat bersifat racun bagi lingkungan dan organisme akuatik. Sebagai *filter feeder*, kerang Kepah mampu menyerap dan mengakumulasi logam berat dari lingkungan ke dalam tubuhnya. Kepah merupakan bivalvia yang banyak dikonsumsi karena memiliki kandungan gizi tinggi. Oleh karena itu, efek biotoksik terhadap manusia sangat diperhatikan. Sungai Peniti memiliki peran penting bagi masyarakat pesisir, khususnya di Kabupaten Mempawah. Kawasan ini telah dikembangkan untuk berbagai aktivitas dimana kegiatan tersebut sangat mempengaruhi kondisi perairan dan dianggap sebagai sumber pencemaran, termasuk logam berat. Penelitian ini bertujuan untuk menganalisis kandungan Pb pada daging Kepah, air, dan sedimen dari kawasan ekosistem mangrove Desa Peniti. Pengambilan sampel dan pengukuran parameter lingkungan dilakukan di dua stasiun berdasarkan keberadaan kerang Kepah. Teknik standar digunakan untuk mengukur tingkat Pb dalam sampel. Analisis kandungan Pb dilakukan dengan menggunakan Spektrofotometer Serapan Atom (SSA). Konsentrasi Pb dalam sampel air (0.139 - 0.147 mg/L) dan sedimen (0.046 - 0.047 mg/L) berada di atas ambang batas. Sedangkan kandungan logam Pb pada daging Kepah masih di bawah batas maksimum yang telah ditentukan. Oleh karena itu, Kepah dari ekosistem mangrove Desa Peniti Kabupaten Mempawah masih layak untuk dikonsumsi.

Kata kunci: Logam Berat, Timbal (Pb), Kepah, *Geloina expansa*, Sedimen

ABSTRACT

Heavy metal pollution and its hazards are global issues that need proper attention. Heavy metals are toxic to the environment and aquatic organisms. As a filter feeder, Kepah are able to absorb and accumulate heavy metal from the environment into their body. Kepah is edible bivalve that widely consumed because its potential nutritional value, so that the biotoxic effect in human are great concern. Peniti River has important roles for the coastal community, especially in Mempawah Regency. This area has been developed for various uses. These activities greatly influenced water condition and were considered as sources of pollution, including heavy metals. The aim of this study was to evaluate the Pb content in Kepah flesh, water, and sediment collected from the mangrove ecosystem area of Peniti Village. The sample collection and measurement of environmental parameters were carried out at two stations based on the presence of Kepah. The standard technique was used to quantify the Pb level in the samples. The analysis of Pb content was performed using an Atomic Absorption Spectrophotometer (AAS). The concentrations of Pb in the water and sediment samples were above the threshold. Meanwhile, the metal *content of Pb in Kepah flesh was still below the maximum limit that had been determined. Therefore, Kepah from the mangrove ecosystem of Peniti Village, Mempawah Regency, were still good for consumption.*

Keywords: *Heavy Metals, Lead (Pb), Kepah, Geloina expansa, Sediment*

INTRODUCTION

Heavy metal pollution and its hazards are global issue (Shah *et al*., 2021) and requires proper attention from various parties. Heavy metals are toxic to the environment and living biota and cannot be decomposed by microorganisms (Lata *et al*., 2013). The main source of heavy metal pollution is the entry of industrial and agricultural waste, mining of metals, transportation via shipping traffic (Hadia-e-Fatima and Ahmed, 2018; Masindi *et al*., 2021). In addition, in an aquatic environment, heavy metal will be accumulated in water and sediments, and can be absorbed by organisms. Benthic biota, including shellfish, have a low rate of movement so they are very potential to be contaminated (Tabari *et al*., 2010; Mendil *et al*., 2010; Vieira *et al*., 2011). According to previous studies, shellfish as filter feeder have a high ability to accumulate heavy metals from the environment (Alyani *et al*., 2017; Dharmadewi, 2020). The accumulation of heavy metals in shellfish can be transferred to humans who consume (Ismahene and El-Hadi, 2012).

The mud clam *Geloina expansa* ("Kepah" in West Kalimantan) belongs to the family Cyrenidae is an edible bivalve that buried in the soft sediment around the roots of the mangrove ecosystem (Bayen *et al*., 2005). Kepah has been reported to be found abundantly and widely distributed in Indonesian waters. In West Kalimantan, Kepah found in Peniti (Deni *et al*., 2020; Jannati *et al*., 2022), Sungai Nibung (Safitri *et al*., 2023), Sungai Bakau Kecil (Surtadi *et al*., 2018), and Pemangkat (Amin, 2009). This species is able to use as bioindicator of water quality (Jeena and Abbas, 2010; Monica *et al*., 2016), particularly related to heavy metal pollution. Lead (Pb) was classified as toxic metal (Sari *et al*., 2014; Lomolino *et al*., 2016) and can be accumulated in the body of biota (Saputra, 2018) in habitats that contaminated heavy metal pollution. Prasetya (2007) showed the Pb contamination in Kepah from Segara Anakan was 0.0061 ppm, while the Pb concentration in the water (< 0.0001 ppm) and sediment (11.228 ppm). In addition, the Pb concentration in Kepah collected around the industrial and port area Cilacap had greatly exceeded the threshold with the average of daily safe consumption rate was 0,00369 kg/day (Ristanti *et al*., 2013). The Pb contamination also occurs in the Mahakam Delta with concentrations in sediments (34.455 mg/kg) and shellfish flesh (5.557 mg/kg) (Rizal *et al*., 2012).

Peniti River is located in Mempawah Regency, West Kalimantan which has important roles for the coastal community. Moreover, this area has been developed for various uses, such as habitation, ecotourism, and fisheries activity. The existence of these activities greatly influenced water condition and considered as source of pollution, including heavy metal pollution. Around the Peniti River, we discovered mangrove ecosystem with potential of *G. expansa*. This species is widely consumed because they contain high nutritional value, such as fatty acid (7.98%) (Leiwakabessy *et al*., 2019), protein (7.06-16.87%), fat (0.40-2.47%), carbohydrates (2.36-4.95%), and provide energy of 69-88 kcal/100g of meat (Amin, 2009). Furthermore, *G. expansa* has an important economic value with selling price ranging from Rp. 5.500 – Rp. 6.000 per kg in Peniti Village. This price increases after being processed (Supriyantini *et al*., 2012) as Kepah satay, Kepah sauce and various other cooking products. According to the potential application of Kepah as an alternative food ingredient with high nutritional value, it is important to conduct study on the metal content of Pb. The aim of this study was to evaluate the Pb content in Kepah flesh, water, and sediment collected from the mangrove ecosystem area of Peniti Village, Mempawah Regency, West Kalimantan.

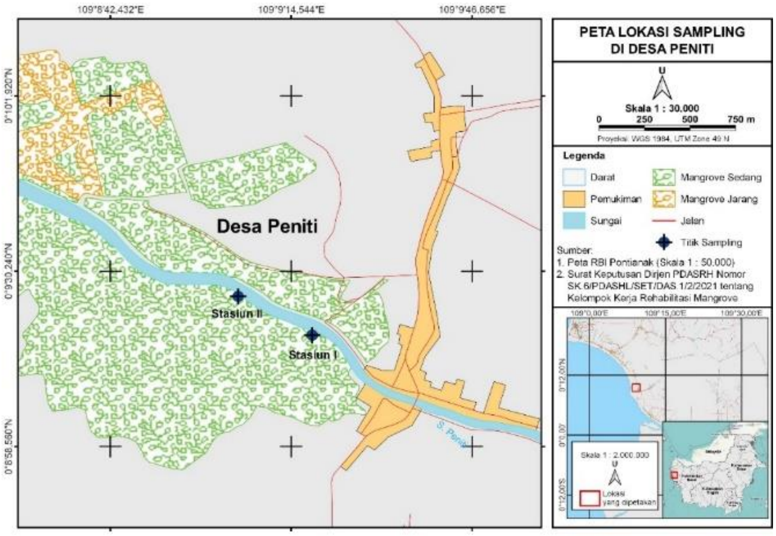

Figure 1. Sampling location in mangrove area of Peniti Village Mempawah Regency West Kalimantan

METHODS

This research was conducted on January 2022 in mangrove area of Peniti River, Mempawah Regency, West Kalimantan (Figure 1). The samples collection of water, sediment, Kepah flesh, and measurement of environmental parameters were carried out in-situ at two stations. The determination of study area was conducted using purposive sampling method based on the presence of Kepah. Station I was close to the settlements and jetty (00º 09'18.8" N and 109º 09'18.29" E), while station II was slightly out of the Peniti River (00º 09' 26.21" N and 109º 09' 05.30" E). Data collection of each parameter was carried out in two replications. The determination of the Pb concentration was conducted in the laboratory of PT. Sucofindo Persero Pontianak, West Kalimantan.

Samples collection and preparation

Kepah were taken directly at the sampling stations, the sediment was collected using a shovel at a depth of 10 cm then stored in a polyethylene bag, while the surface water sample was collected and stored in polyethylene bottles for subsequent preparation and analyses in the laboratory. Sample preparation was carried out before determining the concentration of Pb metal. Kepah samples were separated the flesh and the shell part. Flesh was cleaned with running water then drained. After that, sample was grounded into a fine powder using a blender. Sediment samples were also separated from others objects, such as plastic, leaves and other materials. The analysis of Pb content was performed using Atomic Adsorption Spectrophotometer (Shimadzu, Japan) model AA-7000.

Figure 2. Kepah from the mangrove area Peniti Village West Kalimantan

Determination of Pb level in water, sediment, and Kepah

The standard technique was used to quantify the Pb metal level in the samples according to *Association of Officiating Analytical Chemists* (AOAC) method (2016). For the measurement of Pb concentration in the water sample, as much as 5 mL of nitric acid (HNO_3) was added to the 100 mL of the test material. After that, it was heated until the solution was completely mixed. Sample was put into a 100 mL volumetric flask, then diluted with distilled water. In the laboratory, digestion of Pb in Kepah flesh and sediment samples was carried out before quantifying the metal concentration. One gram of homogenized Kepah fine powder sample was put into a 250 mL beaker glass, then added as much as 10 mL of reagent combination containing 70% of HNO_3 (pro-analysis), 70% of $HClO_4$ (pro-analysis), and 98% of H_2O_2 in 5:2:1 ratio. The procedure of mineralization was carried out using hotplate at 50°C until the sample was dry. As much as 10 mL of 2N HCl was added and destruction process was continued for 30 minutes. For the next step, the solution was filtered using Whatman No.1 filter paper, then pipet of 1 mL solution and added of distilled water up to 25 mL final volume. Then, sample kept at room temperature for further examination.

Data analysis

The concentration of Pb in water, sediment, and Kepah was determined by the following formula (AOAC, 2016):

$$\text{Pb } (\mu g/kg) = \frac{(D - E) \text{ x Fp x V}}{W}$$

Where D is the concentration of sample (µg/kg), E is the concentration of blank sample (µg/kg), Fp is dilution factor, V is final volume of sample solution (L), and W is weight of sample (kg).

RESULT AND DISCUSSION

Identification and Characteristics of Kepah

According to He and Zhuang (2013, the classification of Kepah is as follows:

Kingdom : Animalia
Phylum : Moluska
Class : Bivalvia
Order : Venerida
Family : Cyrenidae
Genus : *Geloina*
Species : *Geloina expansa* (Mousson, 1849)

In this study, we observed the morphological characteristics of Kepah. Samples have bilaterally symmetrical shell, hard, and dark brown. In addition, the morphometric measurements were also conducted, including length, width, thickness of the shell, and total weight (Figure 3).

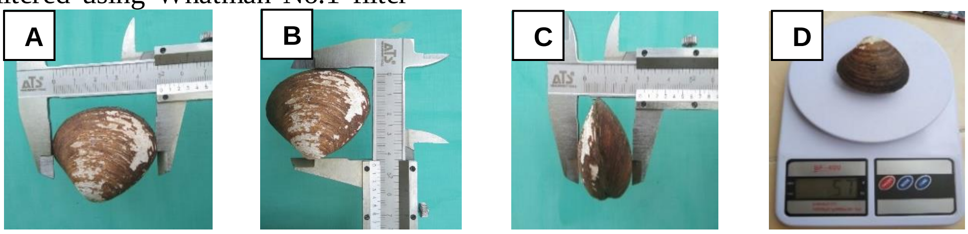

Figure 3. Morphometric characteristics of Kepah (A) length (B) width (C) thickness (D) total weight

In each mangrove ecosystem, Kepah shells vary in size due to the type of mangrove vegetation. The mangrove ecosystem in Peniti river was dominated by *Avicennia marina* species. This was in line with the result of Kuncoro *et al*. (2019). The result showed the average value of morphometric measurements of Kepah shells, such as length (50.4 mm), width (45.6 mm), thickness (25.9 mm), and total weight (40.9 g). Our result had a larger size compared to previous studies, that Kepah live in mangrove dominated *Avicennia marina* (41.3 mm length and 34.7 mm width) and *Rhizophora apiculata* (41.31 mm length and 34.46 mm width) (Kadarsah and Susilawati, 2019). Environmental parameters influence the growth and the development of shellfish, such as temperature, salinity, pH, and dissolved oxygen. Mud clams grow optimally in tidal area and muddy substrate with high organic matter content. The coastal area of West Kalimantan has many estuaries flows which strongly support the growth and development of mud clams.

Water Quality Parameters

The water condition of Peniti River can be observed based on physio-chemical parameters (Table 1). These environmental parameters play an important role in supporting growth and development, distribution of shellfish, and affect the rate of metal absorption from the water.

Table 1. Physio-chemical parameters condition in the Mangrove area of Peniti Village

Parameters	Station I	Station II
Temperature (^oC)	27.93	28.03
Salinity (‰)	26.07	27.23
Dissolved Oxygen (ppm)	4.37	4.40
pH	7.67	7.70

In this research, water temperature in the mangrove ecosystem of Peniti ranging from 26.8 to 29.3 ^oC. The results of previous studies stated that the temperature value at the same location was 26–28.5 ºC (Deni *et al*., 2020). This value was still following the optimal temperature range for the growth of shellfish which was 20-30 ºC, while the temperature above 30 ^oC stimulate female mussels to mature gonads. Water temperature is one of the limiting factors that plays an important role and influence the growth and development of species (Kusumaningtyas *et al*., 2014). In addition, temperature also affects the presence and distribution of a biota (Brahmana, 2014; Ainuddin *et al*., 2017). Increasing temperature will increase metabolic and respiratory activity, as well as oxygen consumption in the waters (Brahmana, 2014; Rangkuti *et al*., 2017).

The measurement of salinity was 25.2–28.5 ‰ and in line with previous study (Deni *et al*., 2020) that reported the average value ranging from 27.3 to 28.0 ‰. This condition was still in the optimal range for the habitat and growth of shellfish of 25-35 ‰ (Widasari, 2013; Supono, 2014; Rajab *et al*., 2016). Variation in salinity values is influenced by the mixing of fresh water and sea water. Salinity affects the growth, distribution, and productivity of biota (Wisudyawati, 2014). In the present investigation, the average of Dissolved Oxygen (DO) was 4.37-4.40 ppm and it was still in the optimal range for the growth of organisms, including shellfish. Pratama (2015), reported that bivalves in general can live in poor conditions of oxygen in mangrove ecosystems. According to the Decree of the Minister of the Environment Number 51 of 2004, the DO value that can support the life of aquatic biota is >5 mg/L. Meanwhile, the DO value <2 mg/L cause the death of the organisms (Effendi, 2003). DO concentration in waters was influenced by several factors, such as diffusion from the atmosphere, photosynthesis, respiration, oxidation of organic matter, temperature, and salinity (Effendi, 2003; Brahmana, 2014).

For monitoring water conditions, pH plays an important role as chemical parameters (Simanjuntak, 2009). The pH value in mangrove vegetation exhibited normal to alkaline condition, ranged between 7.1 to 8.2. Previous study also conducted in mangrove vegetation of Peniti Village and found the pH value of 8.2–8.4. The magnitude of the optimal pH value of 6-9 support the growth of bivalves (Suwondo, 2012). In addition, Junaidi *et al*. (2010) also stated that the value of 9 < pH < 5 was not suitable for the life of macrozoobenthos. Variations in pH values influence the community structure of biota (Rangkuti *et al*., 2017). In general, aquatic organisms are very sensitive to changes in pH and have optimal growth in the pH range of 7–8.5 (Effendi, 2003; Minister of Environment Decree No. 51 of 2004).

The Concentration of Lead (Pb) in Kepah Flesh, Water, and Sediment

The metal content of lead (Pb) in samples of water, sediment and Kepah flesh in the mangrove ecosystem of Peniti Village, Mempawah Regency can be seen in Table 2.

Table 2. The Concentration of Lead (Pb) in Kepah Flesh, Water, and Sediment

Sample	Station I	Station II	Standard
Kepah flesh	0.104 (mg/kg)	0.137 (mg/kg)	1.5 (mg/kg) (SNI 7387:2009)
Water	0.147 (mg/L)	0.139 (mg/L)	0.005 (mg/L)
Sediment	0.046 (mg/L)	0.047 (mg/L)	(PP No. 22 Year 2021)

The Pb content in Kepah sample collected from the mangrove area of Peniti Village, Mempawah Regency was below the threshold for foodstuffs. Based on SNI 7387:2009 in respect of the maximum limit of heavy metal contamination in food, it established that the maximum limit of Pb contamination in bivalves is 1.5 mg/kg. Our results indicated that Kepah from the mangrove ecosystem in Peniti are still suitable for consumption. Kepah as filter feeder can accumulate Pb in their body. Furthermore, Pb classified as toxic metal, both for the aquatic environment and for biota (Darmono, 2001; Rajeshkumar and Li, 2018). Consumption of shellfish products contaminated with heavy metals that exceeds the threshold can cause various types of diseases (SNI 7387:2009; Islam *et al.*, 2015). Several studies on heavy metal pollution in the environment and shellfish products has been carried out. Handayani *et al*. (2020) reported the contamination of Pb in Kepah flesh from East Kalimantan waters as much as 0.020 mg/L.

The concentration of Pb contained in the water and sediment samples in the mangrove area of Peniti Village, Mempawah Regency was above the threshold at both stations. According to PP No. 22 Year 2021 concerning the implementation of environmental protection and management that established that the maximum limits for Pb metal contamination in the environment was 0.005 mg/L. Furthermore, the content of Pb in the sediment sample had a higher value compared to the water sample. This was due to the presence of metallic bonds with organic compounds present in the sediment. Particles absorbed by sediment are more dominant because metals have a tendency to bind to hydroxides and organic matter in sediments (Suryono, 2016). In addition, there will also be bonds between inorganic compounds to form stable compounds (Leiwakabessy, 2005). The characteristics and size of the substrate/sediment also play an important role in the accumulation of metals. Fine and small sediment particles have a larger surface area with a more stable ion density to bind heavy metals (Amin, 2002; Sahara, 2009). Another factor is that heavy metals will be deposited within a certain period and accumulated in sediments. Deposition occurs due to the density of the metal is higher than the density of water (Amin *et al*., 2011).

The Pb content in the water sample had a lower value than the concentration in sediment. This is due to the water will mobile or move, allowing metal ions to be carried away by the current. Previous study by Ma'rifah *et al*. (2016), surface currents affect the accumulation of heavy metals in sediments. The concentration of heavy metals in water also varies greatly, depends on the season. In the rainy season, heavy metals either in dissolved form or in sediment are carried to the sea through rivers (Bana, 2015). Another source of heavy metal pollution, especially Pb, is thought to have come from the spill/leakage of boat fuel around the study area. Transport of Pb emissions in the environment through rivers has a greater impact than air (Permanawati *et al.*, 2013).

CONCLUSION

It could be concluded that the concentrations of Pb in the water and sediment samples were above the threshold. Meanwhile, the metal content of Pb in Kepah flesh was still below the maximum limit that had been determined. Therefore, Kepah from the mangrove ecosystem of Peniti Village, Mempawah Regency were still good for consumption.

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