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Feasibility Study: Kapah Clam (Meretrix lyrata) Consumption Based on the Amount of Heavy Metal Lead (Pb) in Pulau Labu, Deli Serdang Regency

Sofyanurrazaq Sinuraya[1*], Mukhlis[2], Delvian

[1]*Natural Resources and Environmental Management Study Program, Postgraduate School, Universitas Sumatera Utara, Medan, 20155, Indonesia*
[2]*Department of Agrotechnology, Faculty of Agriculture, Universitas Sumatera Utara, Medan, 20155, Indonesia*
[3]*Faculty of Forestry, Universitas Sumatera Utara, Medan, 20155, Indonesia*

*Corresponding Author: sofyansinuraya@gmail.com

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ABSTRACT

The hazardous heavy metal lead (Pb) can infiltrate the human body through the food chain. This study aimed to determine the maximum allowed amount of lead (Pb) and the lead heavy metal content in the meat of kapah clams (Meretrix lyrata) from Pantai Labu, Deli Serdang Regency, North Sumatra Province. This study used stratified random sampling in three locations: Bagan Beach, Muara Serdang, and Putra Deli. Heavy metal lead (Pb) measurements were conducted using the Parkin Elmer Atomic Absorption Spectrophotometry (AAS) method with an Atomic Absorption Spectrophotometer. Maximum Tolerable Intake (MTI) or Maximum Weekly Intake (MWI) is divided by the amount of heavy metal lead (Pb) in Kapah Clam meat (Meretrix lyrata) to determine the permissible consumption limit. This research shows that exceeding the MTI limit can lead to toxicity in human body.

Keywords: feasibility study, heavy lead metal (Pb), kapah clam (meretrix lyrata), maximum tolerable intake

1. Introduction

Pollution is one of the major problems facing the world today. Human activities or natural processes can cause pollution. The entry of waste into water can result in a decrease in water quality both physically and chemically. Some cases of marine pollution that often occur include oil spills due to tanker accidents, port activities, tank cleaning, and deliberate waste disposal, which can cause environmental damage and reduce the quality of coastal and marine resources. The existence of industry, tourism, and population activities in coastal areas that dispose of waste into rivers that flow into the sea makes the problem of marine pollution even more complex.

The process of accumulation and deposition of heavy metals in water bodies will undergo the process in sediments, then accumulate in the body of marine biota in the waters (including clams that are sessile and as bioindicators) either through the gills or through the food chain and will eventually reach humans. This phenomenon is known as bioaccumulation and biomagnification. Heavy metals such as Pb, Cu, and Fe are harmful and can enter the body through the respiratory and digestive tracts [1].

Monitoring pollution in the aquatic environment can be done by analyzing the content of heavy metals accumulated in the body of aquatic biota. Aquatic biota that can be used as bioindicators are clams because clams have a wide distribution, slow movement, sedentary nature, tolerant of environmental changes, tolerance of pollutants, low metabolic rate of enzyme activity, and large and stable populations. They have a long-life span and can survive for research in the laboratory and field [2].

The kapah clam is one type of clam that is prospective to be developed because of its rapid growth and can be utilized throughout the year, has a high tolerance to environmental changes so that it is economically profitable, and has a lot of protein content, so that people often consume it. The kapah clam is one of the bioindicators of heavy metal pollution such as Lead (Pb). [3]

This research will be conducted in Pantai Labu, Deli Serdang Regency. This location has the potential for large amounts of kapah clam. At Labu Beach, Deli Serdang Regency, several activities are sources of heavy metals, such as fishing and residential areas. This is thought to be one of the sources of heavy metal Lead (Pb) that accumulates in the meat of kapah clams.

A similar study was conducted by [4] on metal concentrations and potential health risks in clam tissue (Meretrix lyrata Sowerby 1851) from the East Java coast of Indonesia. The study results showed that the value of heavy metal content in clam tissue for the north coast, East Java, is more polluted than the south coast, East Java. This is because the north coast of Java Island is more densely populated and has more fishing activities compared to the south coast as the many rivers flow into the north coast of Java Island through factories that discharge heavy metal waste into the river body, resulting in the accumulation of these heavy metals.

2. Method

2.1. Sample Analysis

Determination of sample points using the Stratified Random Sampling method. The location was Bagan Beach, Muara Serdang Beach, and Putra Deli Beach. Bagan Beach is the closest beach to the Fish Auction Place (TPI), crowded with fishing boats that want to sell fish at the TPI. Muara Serdang Beach is located above Bagan Beach and remains quite crowded with tourists during the holiday season; Putra Deli Beach is in the Estuary and becomes a fisherman traffic from TPI to the sea. The beach is a beach visited by fishermen to take Kapah clam.

Sampling of kapah clam was carried out at three stations at the research site using the 50x50 plot method. Sampling of kapah clam using hand sorting technique or direct collection by hand. The clams were taken of the same size and then put into a ziplock and an ice box. Sampling of kapah clam was conducted again two weeks later at the same station in the study site.

2.2. Heavy Metal Analysis

Analysis of kapah clam begins with separating the meat from the clam; the meat that has been separated from the clam is weighed as much as 100g. The meat is then mashed and heated in an oven at 70°C for 12 hours until all the water evaporates and becomes dry. The dried clam meat sample was then mashed using a mortar, and then the clam sample was taken, weighed □5g, and put into a beaker glass. The sample is then added 25 ml of concentrated HCl and 5 ml of HNO3; the addition of HCl serves to dissolve heavy metals, and the addition of HNO3 serves to increase the valence of metals to stabilize. Then, the sample is dissolved while heated at 900□C for 1 hour [4].

The heated sample was allowed to stand at room temperature and then put into a 100 ml volumetric flask quantitatively by adding distilled water until the red line mark. The kapah clam samples were then allowed to stand overnight to separate the fat so that it would not be destroyed during the wet digestion process. The digested samples were stored in polyethylene bottles and tested for Pb heavy metal content at Shafera Enviro Laboratory in Medan City.

This test is a Parkin Elmer Atomic Absorption Spectrophotometry (AAS) testing stage using an atomic absorption spectrophotometer with a wavelength of 283.3 nm for Lead (Pb) [5].

The Parkin Elmer Lambde Atomic Absorption Spectrophotometer (AAS) is used to measure Pb metal content. The reading on the AAS is an absorbance reading, which is then calculated to obtain the actual Pb heavy metal content of the kapah clam meat sample based on [5] as follows:

$$\textbf{Heavy Metal Content} = \frac{(\textbf{A x B})}{\textbf{C}}$$

Description:
Heavy metal content = actual content of the sample (mg/kg)
A = content measured by AAS (µg/ml)
B = final volume of sample solution (ml)
C = sample weight (g)

The maximum concentration of food contaminated with heavy metals per week uses the threshold figures published by the World Health Organization (WHO) and Food and Agriculture Organization (FAO) (2010). Calculation of Maximum Weekly Intake using the equation:

$$\textbf{Estimated intake per day = N x average intake}$$

Description:
N = heavy metal concentration (mg/kg)
Average intake = 0.14 (kg) [13]

To find out the weekly intake of Kapah clams, use the following equation:

$$\textbf{Estimated intake week} = \frac{\textbf{Estimated intake week x 7}}{\textbf{BB}}$$

Description:
BB = 60 kg (average adult weight) [13]

To find out the amount of consumption of Kapah clam, the following equation can be used:

$$\textbf{MWI = body Weight x PTWI}$$

Description:
MWI = Maximum Weekly Intake (mg/week)
PTWI = Provisional Tolerable Weekly Intake

Then, the Maximum Tolerable Intake (MTI) value is calculated with the formula:

$$\textbf{MTI} = \frac{\textbf{MWI}}{\textbf{Ct}}$$

Description:
MTI = Maximum Tolerable Intake (kg/week)
Ct = Concentration of Heavy Metals found in soft tissue

3. Result and Discussion

3.1. Pb (Lead) Heavy Metal Content in Kapah Clam (Meretrix lyrata)

The results of testing the heavy metal content of Pb in the meat of kapah clam in the waters of Pantai Labu Subdistrict, Deli Serdang Regency, were carried out at the Shafera Enviro Laboratory Medan using the Atomic Absorption Spectrophotometry (AAS) method, the laboratory results showed the accumulation of heavy metal content of Pb in kapah clam.

Data on the content of heavy metal Pb in the meat of kapah clam in the waters of Pantai Labu District, Deli Serdang Regency, can be seen in Table 1.

Table 1. Data of Pb metal content in kapah clam meat in Pantai Labu, Deli Serdang Regency

Station	Average (week 1 and 2) (mg/kg)	Total Average	Standard
PL 1	4,74		
PL 2	3,89	**4,345**	1,5
PL 3	4,41		

Description
PL: Pantai Labu
*: Maximum quality standard for heavy metal contamination in food by the National Standardization Agency (BSN) in 2009: Indonesian National Standard (SNI) No. 7387. [3]

Based on Table 1, the average value of heavy metal Pb in the meat of kapah clam in the waters of Pantai Labu, Deli Serdang Regency, is 4.345 mg/kg. The average value exceeds the quality standard of Pb heavy metal in clam, which is 2 mg/kg.

The presence of heavy metal Pb in the waters of Pantai Labu Subdistrict, Deli Serdang Regency, is due to the location being a dense area with human activities and the fishing industry [4]. The source of Pb heavy metal entry is due to the high activity of fishermen who dispose of waste in the form of Tetra Ethyl Lead (TEL), which comes from fuel oil combustion into the waters without prior management. This is supported by the high value of heavy metal Pb at PL 1 Station, which is close to TPI (Fish Auction Place). Activities that occur at TPI cause heavy metal waste, especially Pb, due to the many activities of fishermen, such as fuel oil spills and fuel waste from these fishermen [8].

3.2. Feasibility of Consuming Kapah clam Meat (Meretrix lyrata) Against Heavy Metal Pb

Kapah clam are one of the widely consumed animals and are in great demand by the public because they contain protein, vitamins, iron, and high nutritional value. The calculation of the estimated intake value of kapah clam per day is the heavy metal content multiplied by the assumption that the average seafood intake per day is 0.14 kg. Furthermore, PTWI (Provisional Tolerable Weekly Intake) was calculated per week on individuals with an average body weight of 60 kg.

Based on the calculation of kapah clam intake per week, they compared it to the PTWI (Provisional Tolerable Weekly Intake) quality standard. The results of the calculation of the feasibility of consumption of kapah clam meat for heavy metal Pb in the waters of Pantai Labu, Deli Serdang Regency, can be seen in Table 2.

Table 2. Calculation of Feasibility of Consumption of Heavy Metal Pb in kapah clam in Pantai Labu, Deli Serdang Regency.

Station	Metal Content Pb (mg/kg)	Estimated intake of heavy metals per day (mg/hari)	Estimated intake of heavy metals per week (PTWI) (mg/kg)	PTWI Standar* (mg/kg)
PL 1	4,74	0,6636	0,077	
PL 2	3,89	0,5446	0,063	**0,025**
PL 3	4,41	0,6174	0,072	
X	**4,35**	**0,6085**	**0,071**	

Description:
PL: Pantai Labu
X: Average
*WHO/FAO (2010)

Table 2 shows that the calculation of the average intake of heavy metals Pb in the meat of kapah clam in the waters of Pantai Labu, Deli Serdang Regency in one week in adults (body weight 60 kg) is 0.071 mg/kg. Table 2 shows that the calculation of the average intake of heavy metal Pb in kapah clam meat in the waters of Pantai Labu, Deli Serdang Regency in one week in adults (60 kg body weight) is 0.071 mg/kg. It shows that the weekly intake of heavy metal Pb in kapah clam in Pantai Labu waters is above the PTWI standard set by WHO/FAO in 2010. consumption feasibility limits serve to determine the limits of consumption of kapah clam, which contain heavy metal Pb, so that they are more careful and do not endanger the health of the body.

To determine the amount of kapah clam that can be consumed, calculate the Maximum Tolerable Intake (MTI), namely by dividing MWI (Maximum Weekly Intake) by Ct (Metal Concentration in Biota). From the above calculation, the amount of kapah clam based on the heavy metal content of Lead (Pb) that can be consumed is 0.344 kg/week.

The presence of Pb in the water can accumulate in the body of kapah clam through the food chain until it is consumed by humans, which will eventually endanger human health, commonly referred to as biomagnification. The food chain system shows that humans are the highest collectors of heavy metals in their bodies due to their role as high-level consumers.

Motor vehicles such as ships generally use premium gasoline or diesel fuel containing Tetra Ethyl Lead (TEL) or Tetra Methyl Lead (TML) to increase the octane number so the engine does not experience knocking. Through combustion, 98% of TEL will be converted into lead bromide, which will be released in the form of vapor containing heavy metal lead, which will cause environmental pollution and the risk of lead accumulation in the human body. [6]

The function of lead in a mixture of gasoline or diesel fuel is to increase lubricity and improve combustion efficiency. It can increase the performance of motorized vehicles. This chemical, along with gasoline and diesel, is burned in the engine, and the remaining 70% comes out with exhaust emissions from combustion. Lead coming out of the exhaust is one of the environmental pollutants [6].

Lead (Pb) is a heavy metal that is very dangerous for living things because it is carcinogenic (causes cancer). The danger of Pb accumulation generally affects the nervous system, especially in infants and children whose nervous systems are still developing. Lead toxicity can occur through oral route, food, drink, inhalation, skin contact, parenteral contact, or body tissues [9].

4. Conclusion

From this research, it can be concluded that the average content of heavy metal Pb in kapah clam in the waters of Pantai Labu is 4.345 mg/kg. This heavy metal content is above the quality standard of 1.5 mg/kg.

The maximum amount of kapah clam meat that can be consumed by the community based on the content of heavy metal Pb is 0.344 kg/week, and if more than the consumption limit obtained from this study, it can cause poisoning to the body.

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