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Health Risk Assessment Via the Consumption of Clam (*Corbicula largillierti)* Accumulated Heavy Metals (Pb) and Coliform Bacteria at Kapuas River, West Borneo

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Abstract

As population activity is increasing and the Kapuas River is still a means of transportation, causing *Corbicula largillierti* to accumulate heavy metals (Pb) and Coliform bacteria in their bodies. This makes it dangerous to be consumed by humans. Thus, this research has two main aims. First, to find out the concentration of Pb and Coliform inside *C. largillierti* that lives at Kapuas River, Pontianak and the river's water. Second, to analyze the health risk of consuming the clams. Furthermore, the Atomic Absorption Spectrophotometer (AAS) is used to analyze the Pb sample and the Most Probable Number (MPN) method is used to analyze the Coliform. The result of this research shows that concentrations of Pb and Coliform from the Kapuas River have exceeded the limits designated for aquatic biota based on the Decree of the State Minister for the Environment No. 51 of 2004. In addition, the health risk is measured using Estimated Daily Intake (EDI), Target Hazard Quotient (THQ), and Target Carcinogenic Risk (TR) with scores for each >10 times the RfD, >1, and 10^{-3}. This result shows that based on the clam *C. largillierti* consumption for 70 years life span of 60 kg body weight, had a high and negative effect on health risk problems and had a cancer risk for consumers. However, the health risk problem might increase much worse due to the long and continual period of consumption exceeding the estimated daily intake.

INTRODUCTION

Kapuas River is located in West Borneo where the province itself is widely known as a province of thousands of rivers. People in Pontianak already utilize the flow of the Kapuas River to do a lot of activities such as fishery and the main source of water for daily needs i.e., drinking water. On the other hand, most people in the city of Pontianak often throw industrial waste and trash into the river (Febrianti, 2014). The river itself is one of the longest rivers in Indonesia with 1,086 km total in length, of which 942 km of it can be sailed.

Kusnoto and Purmintasari (2018) stated that the river is still being used as a transportation medium between several regions. The daily transportation using a boat and the fact that there are roads near the flow area of the river make it contaminated with heavy metals such as lead

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(Pb). Moreover, people who live near the bank of the river give more residential waste to Kapuas. Khotimah (2013) explained that residential waste from people who live near the river through gutters is causing Coliform bacteria which are categorized as a pathogen to grow exponentially in Kapuas.

Various aquatic organisms live in Kapuas. One of them is *C. largillierti* which is known by the people of Pontianak as remis. According to Suwignyo *et al.* (2005), *Corbicula* is a limnetic clam that has an economic value. These limnetic clams can be consumed as a source of protein and can be used as feed ingredients for an animal.

The clam commodity is one of the preferred commodities so it has high demand. Based on the data Statistic Indonesian Fisheries which was reported by the Indonesian Statistics of the Ministry of Marine Affairs and Fisheries (2012) shows that the production volume of clams was increasing significantly with an average of 94.50% per year or approximately 700 tons per year. Moreover, as many as 2 tons of clams were produced from the West Borneo region which equals 10 million production value per year. It was supplied from Sambas, Bengkayang, Pontianak, Ketapang, Kayong Utara, Kubu Raya, Pontianak City, and Singkawang City.

According to Putri and Kurnia (2018), the presence of pathogenic bacteria, namely Coliform, can cause diarrhea if the amount exceeds the threshold. Furthermore, Pontianak Health Office data in 2017 shows cases of diarrhea reaching 214 per 1,000 population. In 1995, there were 280 sufferers of diarrhea per 1,000 population. In 2000, there were 300 sufferers, and every toddler at this time at least had diarrhea on average 1.3 times per year. This shows that the problem of polluted water was increasing because of the Coliform in domestic waste and the unhealthy behavior of the people around Kapuas River. Moreover, lead is a toxic compound that can cause anemia and is known as an indicator in identifying lead poisoning. According to Purnomo (2015), 16 people were found to have Pb in their blood; those people were employees of Pontianak City Transportation Service.

Corbiculid clams are filter feeders that obtain food by filtering water from the surrounding environment (Al-Mamun and Khan, 2011). The nature of the filter feeder of Corbiculidae clams is the cause of this commodity to have the potential to accumulate pollutants, both heavy metals such as Pb and microbes. Through this filter feeder system, heavy metals Pb and Coliform pathogenic bacteria can enter the body tissue of the clams (Retyoadhi *et al.*, 2005). This is also the cause of *C. largillierti* to be a dangerous food when consumed because it has a risk of poisoning and causing disease. Thus, this research has two main aims. The first is to find out the concentration of Pb and Coliform inside *C. largillierti* that lives at Kapuas River, Pontianak, and the river's water. The second is to analyze whether or not human health is affected by consuming the clams.

METHODOLOGY

Place and Time

This study took a sample of the water and clam in June 2020 and August 2022, the water quality measured it in place. Kapuas River, Pontianak, West Borneo is chosen to be the research area because *C. largilierti* which are known as remis by people of Pontianak can be easily found living in the river. Every day, people who live near the river are trying to capture the clams to be consumed. The point of sampling location can be seen in Figure 1.

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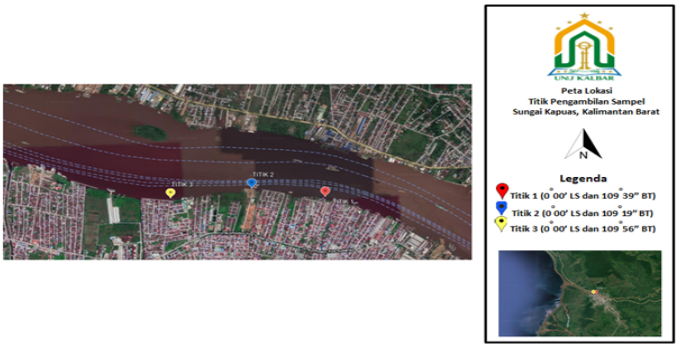

Figure 1. Research area (Kapuas River, Pontianak, West Borneo) (Google Earth, 2022).

Research Materials

Measurement of heavy metal levels of Pb in *C. largillierti* shellfish using the Atomic Absorption Spectrophotometry (AAS) method based on the Indonesian National Standard (SNI) (No. 2354. 5: 2011). Measurement of Coliform bacteria *C. largillierti* using the MPN (Most Probable Number) method based on the Indonesian National Standard (SNI) (01-2332.1-2006). Measurement of dissolved oxygen and temperature meters (type PDO-520). pH meter using pH meters (Atc Pen type pH 009).

Research Design

Sampling of shellfish was carried out at the bottom of a muddy river because the shells were at that location. Sampling was carried out at 3 points with an interval of ± 100 m between point 1 to another point. *C. largillierti* clams live submerged in muddy riverbeds so in taking these organisms they need to soak while groping. The water depth at low tide is ± 50 cm and the current velocity is 0.06 m/s. The sample after being obtained from the mud is then put into the tub.

Work Procedure

The test animal used in this study was the clam Corbicula largillierti measuring 3-4 cm because this size is a measure of public consumption. Meanwhile, the sample of shellfish needed was 10 gr for the Pb metal content and 25 gr for the Coliform content. Sampling of shellfish was carried out at three points (as 3 replicates). Moreover, the measurement of water quality was focused on temperature, pH, and Dissolved Oxygen (DO) using DO meter and pH meter tools. In addition to that, the descriptive method with a quantitative approach is employed to analyze the quality of the water. Then, the water sample and the flesh sample of the clams were analyzed in FMIPA Laboratory of Tanjungpura University, Pontianak to measure the concentration of Pb using the AAS as well as the concentration of Coliform using the MPN method.

Data Analysis

Estimated Daily Intake of Metal

The Estimated daily intake of metals (EDI)represents the estimated daily intake of metal through the consumption of clam by an adult. The EDI was measured according to Liu *et al.* (2018):

$$EDI = \frac{EF \times ED \times IR \times Cm}{WAB \times TA}$$

Where:

EDI = estimated daily intake (mg/kg/day)
EF = exposure frequency (365 days/year)
ED = exposure duration (70 years)
IR = food ingestion rate (9.80 g/day) (Rantetampang and Mallongi, 2014)
Cm = metal concentration in clam (ppm)
WAB = average adult body weight (60 kg)
TA = average lifetime (70 years x 365 days/year)

Target Hazard Quotients

Target Hazard Quotients aim to assess the adverse health effects caused by metal in this case. The THQ score is known as a useful parameter in assessing human health risks from metal contamination in

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clams (Yap *et al.*, 2016). Moreover, the formula is shown below:

$$THQ = \frac{EDI}{RfD}$$

Where:
THQ = target hazard quotients
EDI = estimated daily intake (mg/kg/day)
RfD = oral reference dose (Pb = 0.0036 mg/kg/day) (Yabanli and Alparsla, 2015)

Carcinogenic Risk

Target cancer risk is used to indicate the carcinogenic risk. The method which is used to estimate TR was calculated by the following equation (Hidayati *et al.*, 2020):

$$TR = EDI \times CSF$$

Where:
TR = target cancer risk
EDI = estimated daily intake (mg/kg/day)
CSF = oral carcinogenic slope factor (Pb = 0.0085 mg/kg/day)

RESULTS AND DISCUSSION

Water quality data were collected at the Kapuas River. Then, the water quality was measured in place. Table 1 shows the result of the water quality measurement.

Table 1. The result of water quality in the Kapuas River.

Point	Temperature (°C)	pH	Dissolved Oxygen (mg/L)
1	28.7	6.01	6.8
2	28.5	6.01	6.4
3	28.3	6.07	6.3
Mean	28.5	6.03	6.5
Standard	28-30	6.5 – 8.5	>5

The characteristic of the station was that it is a densely populated area and is a transportation route from Pontianak to Tanjung Periok and Pontianak to Semarang. Based on the results of measuring the water quality parameters at the observation station, it showed that in general, the pH measurement results have a score of 6.03. The pH in this location was in the normal range. The temperature score was measured at 28.5 °C. Meanwhile, the DO results obtained were in the optimal range for clams to grow. The DO ranges above indicate that the waters were safe for marine life. Where the pH, temperature and DO score based on water quality for aquatic biota were still within the optimum limit (KEPMENLH, 2004).

Table 2. Pb concentration and Coliform in the water and the clams.

Point	Parameter			
	Pb (ppm)		Coliform ($^{MPN}/_{100ml}$)	
	Water	Clam	Water	Clam
1	0.0021	1.74	24000	5000
2	0.0021	1.69	24000	5000
3	0.0021	1.79	24000	5000
Mean	0.0021	1.74	24000	5000
Standard	0.0010*	1.5**	1000*	<3**

* KEPMEN LH No.5 of 2004
**BPOM No. HK.00.06.1.52.4011 of 200

Table 2 shows that the heavy metals Pb and Coliform in the waters of the Kapuas River in the city of Pontianak shows that the Pb contamination in the Kapuas River water is 0.0021 ppm and the total Coliform is 24000 $^{MPN}/_{100ml}$. The standard quality of Pb contamination for aquatic biota is 0.0010 ppm and Coliform is 1000 $^{MPN}/_{100ml}$ (KEPMENLH, 2004). It shows that the heavy metals Pb and Coliform in the Kapuas River have exceeded the limits designated for aquatic biota. The results of the test also showed that the heavy metal content of Pb in *C. largillierti*

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clams was 1.74 ppm with total Coliform in the clams was 5000 $^{MPN}/_{100ml}$. Based on the Regulation Of The Head Of The Agency Of Drug And Food Control No. HK.00.06.1.52.4011 of 2009 states that the quality standards for heavy metal Pb and Coliform for fishery products are 1,5 ppm and <3 $^{MPN}/_{100ml}$, respectively. Thus, it can be seen that the *C. largillierti* clams taken from the Kapuas River in the city of Pontianak have exceeded the maximum limits of microbial and chemical contaminations in food.

Coliform bacteria was an indicator of water quality because its existence shows that clean water has been contaminated by human feces (Santy *et al.,* 2017). According to Putri and Kurnia (2018), if the amount exceeds the threshold, the presence of pathogenic bacteria, namely Coliform, can make food poisonous and cause diseases such as diarrhea. Moreover, lead poisoning was a toxic compound, and the effects of lead exposure can occur without obvious symptoms. The effects of exposure are chronic, so the longer a person is exposed, the cumulative dose increases progressively (Laila and Shofwati, 2013).

Table 3. Health risk appraisal of EDI, THQ, and TR.

Heavy	Parameter	Unit	Result
Pb	EDI	mg/kg/day	0.2842
	THQ	-	78.94
	TR	-	2.42 x 10^{-3}

Based on the EDI assessment results in Table 3, it is known that the Pb metal in *C. largillierti* clams has exceeded the tolerance value of the oral reference dose. In which the *C. largillierti* Pb is contaminated, the EDI score for consumers is 0.2842 mg/kg/day. The EDI score is more than the RfD of Pb metal consumed by humans which is 0.0036 mg/kg/day. If the result of the EDI score exceeds the RfD, then it is a warning about the detrimental health effects that may be caused by heavy metals contained in consumed clams. Excessive consumption of clams can have an impact on health because they contain heavy metals that exceed the tolerance limit for daily clams intake (Rayyan *et al.,* 2019). According to the NYSDOH (2007), if the ratio of EDI of heavy metal to its RfD was equal to or less than the RfD then the risk will be minimal. But if it is >1–5 times the RfD then risk will be low, if >5–10 times the RfD then risk will be moderate, however, if >10 times the RfD then the risk will be high. Thus, it can be concluded that the consumption of *C. largillierti* clams has a high risk of health problems for consumers.

It can be seen in Table 3 for the THQ score of Pb in *C. latgillierti* has been above 1. THQ of Pb metals was scored at 78,94. Moreover, according to Javed and Usmani (2016), THQ values of < 1 indicate that adverse health effects were unlikely to occur and THQ values of > 1 indicate that the consumer population has potential health risks. Also, if the THQ >1, then it was an alarm for public health concerns (Zodape, 2014). It can be concluded that the Pb concentration in the *C. largillierti* clams at Kapuas River is harmful to the people who consumed it.

Based on the results of the TR assessment of Pb metal in *C. largillierti* clams, it showed a moderate cancer risk of 2,42 x 10^{-3}. According to the NYSDOH (2007), the threshold TR values for categorizing risk are as follows: TR ≤ 10^{-5} low risk, 10^{-4} to 10^{-3} moderate risk, 10^{-3} to 10^{-1} high risk, and ≥ 10^{-1} very high risk. Based on the clam *C. largillierti* consumption for a 70 years life span of 60 kg body weight, it indicated that people who consumed clams from Kapuas River had a high and negative effect on health risk problems and had cancer risk for consumers.

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CONCLUSION

The results of the analysis of the Pb concentration in the clams was 1,74 ppm and the total Coliform was 5000 $^{MPN}/_{100ml.}$ In addition, the concentrations of Pb and Coliform in *Corbicula largillierti* clams from the Kapuas River, Pontianak, West Borneo based has exceeded the maximum limits of microbial and chemical contaminations in food. For health risk assessment using EDI, the results were 0.2842 mg/kg/day. For the THQ value, the result is 78,94. For the TR value, the result is 2.42 x 10^{-3}. These results indicate that this health risk assessment shows a high risk because each value results in EDI >10 times the RfD, THQ >1, and TR to 10^{-3}. However, the health risk problem might increase much worse due to the long and continual period of consumption. Therefore, effort required a way to reduce pollutants, toxic substances, and bacteria in bivalves through depuration.

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