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.
(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 Suwigyro 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 Kapua 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. largillierti 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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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) (Yabanli and Alparsla, 2015)

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>
<thead>
<tr>
<th>Point</th>
<th>Temperature (℃)</th>
<th>pH</th>
<th>Dissolved Oxygen (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>28.7</td>
<td>6.01</td>
<td>6.8</td>
</tr>
<tr>
<td>2</td>
<td>28.5</td>
<td>6.01</td>
<td>6.4</td>
</tr>
<tr>
<td>3</td>
<td>28.3</td>
<td>6.07</td>
<td>6.3</td>
</tr>
<tr>
<td>Mean</td>
<td>28.5</td>
<td>6.03</td>
<td>6.5</td>
</tr>
<tr>
<td>Standard</td>
<td>28-30</td>
<td>6.5 – 8.5</td>
<td>&gt;5</td>
</tr>
</tbody>
</table>

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 ℃. 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>
<thead>
<tr>
<th>Point</th>
<th>Pb (ppm)</th>
<th>Coliform (MPN/100ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Water</td>
<td>Clam</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0.0021</td>
<td>1.74</td>
</tr>
<tr>
<td>2</td>
<td>0.0021</td>
<td>1.69</td>
</tr>
<tr>
<td>3</td>
<td>0.0021</td>
<td>1.79</td>
</tr>
<tr>
<td>Mean</td>
<td>0.0021</td>
<td>1.74</td>
</tr>
<tr>
<td>Standard</td>
<td>0.0010*</td>
<td>1.5**</td>
</tr>
</tbody>
</table>

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 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)


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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 (San ty 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.

<table>
<thead>
<tr>
<th>Heavy Parameter</th>
<th>Unit</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pb</td>
<td>EDI</td>
<td>0.2842</td>
</tr>
<tr>
<td></td>
<td>THQ</td>
<td>78.94</td>
</tr>
<tr>
<td></td>
<td>TR</td>
<td>2.42 x 10^{-3}</td>
</tr>
</tbody>
</table>

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 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^{-5} 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.
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 $2.42 \times 10^{-3}$. 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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