

Safe Concentration of Lead in Community Drinking Water in the Tapak River Area, Tugu City District, Semarang

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ABSTRACT

Lead (Pb) is one type of heavy metal that has a low melting point, is easily formed, and has active chemical properties. Lead is usually used to coat the metal to prevent rusting. It is highly dangerous for living things as it has carcinogenic properties, can cause mutations, and relatively takes long time to decay and its toxicity does not change for long time period. This study aimed to determine the safe concentration of lead in the water that consumed by people in Tugurejo Village, Tugu Kota Subdistrict, Semarang City, Central Java Province. This study was an observational study with non reactive research using reference dose (RfD) calculation and LOAEL. The sample was 35 people from the Tugurejo Village, Tugu Kota Subdistrict, Semarang City, Central Java Province.

The measurement results show that the concentration of Lead (Pb) is 0.003 mg/L. This concentration is the same as the quality standard of 0.003 mg/L according to Government Regulation No. 82 of 2001 concerning Management of Water Quality and Water Pollution Control. This means that the concentration of lead in river water is still relatively safe. The manual calculation of safe concentration of lead in Tapak river water for drinking water produced a result of 0,00055 mg/L. It is below the maximum Pb limit for drinking water as stated in the Republic of Indonesia Minister of Health Regulation Number 492/MENKES/PER/IV/2010 of 0.01 mg/L. This calculation can be used to predict safe concentrations of toxins in water for the manufacture of safe drinking water for the people of Tugurejo Village, Tugu City, Semarang, Central Java Province. Therefore, the environmental conditions of the Tapak river must be maintained so that the Lead (Pb) levels in the Tapak river water will not increase.

Keywords: Lead (Pb), safe concentration, Tapak river water

Introduction

Lead (Pb) is one type of heavy metal that has a low melting point, is easily formed, and has active chemical properties. Lead is usually used to coat the metal to prevent rusting. It is a bluish gray soft metal and has a +2 oxidation number (Sunarya, 2007).¹

It is highly dangerous for living things as it has carcinogenic properties, can cause mutations, and relatively takes long time to decay and its toxicity does not change for long time period (Brass, 1981).² According to Palar (1994), Pb can pollute air, water, soil,

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plants, animals and even humans. Pb can enter the body through food either from plants or animals.³

Lead (Pb) is one of the environmental pollutants. The pollution of the Pb has increased in recent years. The environmental impact has also increased, especially regarding water pollution. The pollution became serious threats to water quality in Indonesia. Most of them came from waste from both industrial and human activities. Basically, the river is one of the water sources commonly used by humans for various activities in their daily life. It has a very important role in human life and all of living things, so that river will affect and be affected by other conditions or components.⁴

Rivers provide many benefits for humans through irrigation, drinking water, agriculture and industry. One of the areas where its river has polluted water by Pb is Java. This is due to the concentration of industry in the area of these rivers. The Tapak River is one of the rivers polluted by Lead (Pb). Geographically, the Tapak River is located in Tugurejo Village, Tugu District, Semarang City, Central Java Province, more precisely on the west side of Semarang City, which is around 12 km from the city center.⁵

Tugu Sub-district is one of the sub-districts in Semarang City. This sub-district is the place where large number of industries situated, from small, medium and large industries. Lead (Pb), the source of pollutants in the Tapak River, comes from residential areas and industrial areas. Most of wastes disposed in the Tapak river are waste from the Tambakaji Industrial Zone and other industries around the Tugu District near the Tapak River.⁵

In terms of water quality requirements, water must comply with the provisions contained in several regulations, one of which is Government Regulation No. 82 of 2001 which stated that Lead content in drinking water should not exceed the standard of 0.03 mg/L.⁶ This is slightly different with other regulation. Regulation of the Head of Drug and Food Control Agency (BPOM) of the Republic of Indonesia Number 23 of 2017 concerning the maximum limit of heavy metal contamination in processed food stated that the maximum limit of Pb for the natural mineral water category and its source is 0.01 mg/kg.⁷ This maximum limit is the same as the limit stated in the Regulation of the Minister of Health of the Republic of Indonesia Number 492/MENKES/PER/IV/2010, which is equal to 0.01 mg/L.⁸

According to the results of the Puspito Raharjo's study (2018), it was found that lead content was 4.462 mg/L in Tapak river water and 0.623 mg/kg in mangrove oyster meat. A preliminary survey of 20 people in the area found that they consumed 250 gr mangrove oysters per day with a frequency of 2-3 times/week. It also found that the average concentration of lead in river water at each station was 0.03 mg/L. Based on the explanation above, it is necessary to measure the safe concentration of Lead in water for consumption by the people of Tugurejo Village, Tugu City, Semarang, Central Java Province.

Materials and Method

This study aimed to determine the safe concentration of lead in the water that consumed by people in Tugurejo Village, Tugu Kota Subdistrict, Semarang City, Central Java Province. This study was an observational study with non reactive research using safe concentration (c safe) calculation and LOAEL. The sample was 35 people from the Tugurejo Village, precisely in RW 4. The sample of water was taken from 4 different stations in the Tapak River, 2 liters for each station.

This study began by conducting a literature study on the calculation formula of Dose Reference (RfD) and safe concentration (c safe). The variables of this study were Lowest Observed Adverse Effect Level (LOAEL) of Pb dan Reference Dose (RfD). This study used manual quantitative data analysis to determine the safe concentration (c safe) of Pb.

In Saridewi and Tualeka (2017)⁹, it is shown that the calculation of safe (C safe) concentration can be calculated using a formula obtained from William (1985), Davis (1991) and Soemirat (2003) as follows:

$$C \text{ safe} = \frac{RfD \times Wb}{\alpha \times R}$$

Annotation:

C safe: safe concentration (mg/L)

RfD: Reference Dose

Wb body weight

α : % substance absorbed by ingestion

Result

A. Lowest Observed Adverse Effect Level (LOAEL) of Lead: Before determining the safe limits of concentrating chemicals, it is necessary

to determine the Lowest Observed Adverse Effect Level (LOAEL). The process to achieve the safe threshold limit value begins by determine the Lowest dose at which there was an observed toxic or adverse effect (LOAEL)¹⁰. So the Lowest Observed Adverse Effect Level (LOAEL) value must be known in advance way of literatur study by searching the literatur that has been available on the internet, books or other scientific source. However, the literature used must be reliable and there is evidence of scientific studies. Below is Lowest Observed Adverse Effect Level (LOAEL) value based on ATSDR 1990 in Chemical Safety Information from Intergovernmental Organizations, the value of the Lowest Observed Adverse Effect Level (LOAEL) of Lead (Pb) is 3.2 µg/m³.¹¹ So that:

$$\text{LOAEL} = \frac{n \times \text{molecular weight}}{24,45} \times 1000$$

$$3.2 \mu\text{g}/\text{m}^3 = \frac{n \times 207.2}{24,45} \times 1000$$

$$n = 0,00038 \text{ mg}/\text{kg}/\text{day}$$

Based on the above calculations it was found that the value of Lowest Observed Adverse Effect Level (LOAEL) of Lead (Pb) was 0.00038 mg/kg/day.

B. Reference Dose (RfD) of Lead (Pb): Tualeka (2013) states that the Reference Dose (RfD) of a toxin exposure can be calculated using the following formula¹²:

$$\text{RfD} = \frac{\text{LOAEL}}{100}$$

Using the above formula, the obtained Reference Dose (RfD) for Lead (Pb) was 0,0000038mg/kg.

$$\begin{aligned} \text{RfD} &= \frac{0,00038}{100} \\ &= 0,0000038 \text{ mg}/\text{kg} \end{aligned}$$

Based on the above calculations it was found that the value Reference Dose (RfD) of Lead (Pb) was 0,0000038 mg/kg.

C. Safe concentration (c safe) of Lead (Pb) in Drinking Water: To determine the safe concentration of Lead in drinking water, the following formula (Tualeka, 2013) was used.

$$\text{C Safe} = \frac{\text{RfD} \times \text{Wb}}{\alpha \times \text{R}}$$

Using the above formula and the ingestion absorption percentage of 20% (ATSDR, 2010)¹³, the safe concentration of Lead in water in Tapak River was 0,00055 mg/L. The calculation is shown below:

$$\begin{aligned} \text{C Safe} &= \frac{0,0000038 \times 58}{20\% \times 2} \\ &= 0,00055 \text{ mg}/\text{L} \end{aligned}$$

The result of the calculation above is still below the threshold limit value (TLV) of Pb in drinking water as stated in the Regulation of the Minister of Health of the Republic of Indonesia Number 492/MENKES/PER/IV/2010 of 0.01 mg/L. Thus, this result can be used to predict toxins in water for the manufacture of drinking water for the people of Tugurejo Sub-District, Tugu District, Semarang, Central Java Province. It can also be used as a comparison value for the TLV set by various institutions such as the Ministry of Manpower and Transmigration, the National Standardization Agency, OSHA and so on.

Discussion

Measurements of Lead (Pb) concentration in Tapak river water in Tugurejo Village, Tugu District, Semarang City, Central Java Province, were carried out in 4 different stations and 2 liters of samples were taken from each stations.

The measurement results show that the concentration of Lead (Pb) is 0.003 mg/L. This concentration is the same as the quality standard of 0.003 mg/L set by Government Regulation No. 82 of 2001 concerning Management of Water Quality and Water Pollution Control. It means that the concentration of Lead in Tapak river water is still relatively safe.

The manual calculation of safe concentration in the water of the Tapak River, Tugurejo Village produced a figure of 0,00055 mg/L. It is below the threshold limit value of Pb for drinking water as stated in the Regulation of the Minister of Health of the Republic of Indonesia Number 492/MENKES/PER/IV/2010 of 0.01 mg/L. Thus, the calculation can be used to predict toxins in water for the manufacture of drinking water for the people of Tugurejo Village, Tugu City, Semarang, Central Java Province. The calculation of safe concentration of Lead

(Pb) in drinking water is based on the calculation of the Reference (RfD) and the Lowest Observed Adverse Effect Level (LOAEL). To calculate LOAEL, testing used experimental animals. The calculation result of the Lowest Observed Adverse Effect Level (LOAEL) for Lead (Pb) is 0.00038 mg/kg/day.

Reference Dose (RfD) is obtained from the LOAEL value calculation. The calculation result of the Reference Reference (RfD) was 0.0000038 mg/kg. The safe concentration of Lead (Pb) is obtained from the calculation of the Reference Dose (RfD), the average body weight, Lead (Pb) absorption through ingestion, consumption rate and time. The safe concentration (c safe) result was 0.00055 mg/L. This value is above is still below the threshold limit value (TLV) set in the Regulation of the Minister of Health of the Republic of Indonesia Number 492/MENKES/PER/IV/2010 of 0.01 mg/L. Thus, this concentration value can be used as an additional reference to measure the next safe concentration.

Conclusion

The measurement results of the average concentration of Lead (Pb) in the waters in the Tapak River, Tugurejo Village, Tugu District, Semarang, Central Java Province, was 0.03 mg/L. This value is equal to the quality standard of 0.03 mg/L according to Government Regulation No. 8 of 2001 concerning Management of Water Quality and Water Pollution Control. The result of the manual calculation for safe concentration of Lead in drinking water was equal to 0.00055 mg/L. This is below the TLV set in the Regulation of the Minister of Health of the Republic of Indonesia Number 492/MENKES/PER/IV/2010 of 0.01 mg/L. Therefore, it can be concluded that the water in the Tapak River is still safe to consume.

However, the effort to maintain the concentration is need to be carried out. Some of them are to always control Lead concentration by regular laboratory check and dissemination to the community around Tugu River not to consume river water. In addition, all communities together with the government must participate in maintaining and supervising all human activities that can increase concentration of heavy metals in river water. This is aimed to conserve the river water, so that it is free of harmful heavy metals and the community can use river water for their daily needs without worrying of the negative effects of using the river water.¹⁴

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