Analysis Of Lead (Pb) Level In Tofu In Nangewer Village, Garut Regency, Indonesia

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Tofu is a type of food made from soybean staples that is often consumed by the public. However, the production process uses water near the polluted Citarum river to allow exposure. This study aims to determine the levels of heavy metal lead (Pb) in tofu using the Atomic Absorption Spectrophotometry (AAS) method. This research uses descriptive method to describe the exposure of Pb to tofu production in the village of Nangewer, Garut regency, Indonesia. The results showed that the concentration of lead metal in heavy tofu obtained an average of 0.762 mg / kg and with the highest concentration of 0.823 mg / kg. The results of this study indicate that it is still below the threshold determined by SNI No.7387: 2009 which is 2.0 mg / kg so that it is still fit for consumption by the public.

Keywords: *Tofu, Heavy Metals, Lead (Pb), Atomic Absorption Spectrophotometry.*

Introduction

Food is an important part of human health. This is because the food consumed by the human body gets the required intake such as carbohydrates, proteins, fats and vitamins. Many diseases are caused by poor food quality. According to the Law of the Republic of Indonesia No. 18 of 2012 Concerning Food, food security is a condition and effort needed to prevent food from possible biological, chemical and other contaminants that can interfere, harm and endanger human health (BPOM, 2017). Processed food is food or drinks that are processed by a particular method, processed food can be divided into processed food that is prepared and not served.

One food product that is not ready to serve is tofu. Tofu is a product made from soy protein clumps. Due to the high protein and fat content, tofu is a product that can rot quickly. At room temperature and without packaging, the shelf life of tofu is only 1-2 days. More than that time the taste becomes sour, then gradually becomes rotten. To overcome this, the method of boiling and then soaking can be done to extend the shelf life of tofu 3-4 days. Meanwhile, cooling can maintain the shelf life of tofu for 5 days (Sarwono, 2001). In trade, there are 2 types

of tofu, namely ordinary tofu and Chinese tofu. These two types of tofu differ in their shape and manner of manufacture. In making Chinese tofu, soybeans are boiled first before soaking and usually have a larger size (Purwarningsih, 2007). Tofu is known to the public as a daily food which is generally very popular and has a high digestibility. Basically, the process of making tofu consists of 2 parts, namely making soymilk and clotting its protein. As a clotting agent, traditionally usually used prickly, which is liquid that comes out during pressing and has been acidified overnight. As a substitute, orange juice, vinegar, lactic acid solution, CaCl2 or CaSO4 solution can be used. Several factors that influence the protein marinade and the quality of tofu are the way of milling or extraction of raw material selection, clotting material, and the sanitation condition of processing in general (Purwarningsih, 2007).

Sanitation is a health effort by maintaining and protecting environmental cleanliness. Republic of Indonesia Law No. 36 of 2009 concerning health states that the increase and stabilization of health efforts are carried out through 15 kinds of activities, one of which is food and beverage security. Water sanitation is the most important element for good food processing. Water is very important in the kitchen because it is not only used for cleaning and sanitation purposes, but also is needed during product handling and processing. Water is a good solvent, various substances can be easily dissolved in water, so that chemical elements, such as iron, lime, mineral salts.

In the village of Nangewer Sari there is a tofu industrial site adjacent to the Citarum River where conditions of water quality are very poor, around 1,320 L / s / day or equivalent to 270 tons / day Industrial waste entering the Citarum River contains heavy lead (Pb) metals (Budiman, Dhahiyat and Rustikawati, 2012; Andina, 2018; Oendakni, Agunwamba, and Ugwu, 2014; Metcalf & Eddy, 1991). According to PP. RI No. 82 of 2001 concerning water quality with a lead concentration (Pb) threshold of 0.03 mg / L. Based on research conducted by Budiman, Dhahiyat and Rustikawati (2012), the concentration of lead heavy metals (Pb) in the Citarum River exceeded the threshold, which reached 0.13 mg / L. While for food, the threshold value based on SNI No.7387: 2009 is 2.0 mg / kg of food.

Lead (Pb) is a type of heavy metal that is soft, blackish brown in color, and easily purified (Palar, 2008). It is estimated that almost 90% of lead (Pb) that enters the human body comes from food (Alsuhendra and Ridawati, 2013; Adhani and Husaini, 2017). Lead (Pb) is a highly toxic heavy metal (Flora, 2015; Henretig, 2015; Abdi and Kazemi, 2015; Baehaki, Rudibyani, Aeni, Perdana, and Aqmarina, 2020; Nawrot and Staessen, 2006; Loukidou, Zouboulis, Karapantsios, and Matis, 2004), especially for children, because children's muscles are more sensitive and lead (Pb) is easily absorbed in developing bodies. Lead can cause a decrease in intelligence in children. Lead poisoning (Pb) can occur when lead (Pb) levels reach three times the normal limit. This decrease in intelligence is caused by abnormalities in brain function because lead (Pb) competitively replaces the role of minerals in regulating the function of the central nervous system (Alsuhendra, Ridawati, 2013; Palar, 2008).

In 2013, the World Health Organization (WHO) estimated lead poisoning resulted in 143,000 deaths, and 600,000 cases of intellectual disability in children each year (Dart et al., 2015). Lead poisoning (Pb) can cause symptoms that vary according to toxicity, age, individual and duration of exposure. The symptoms of lead poisoning (Pb) include abdominal pain, convulsions, headaches, fatigue, insomnia, nausea, weak muscles, difficulty concentrating, anemia, kidney damage, coma and death (Lichtfouse and Schwarzbauer, 2012). Acute poisoning shows neurological signs, vomiting, vomiting, diarrhea and constipation (Bruton, 2007). Palar (2008) explains that red blood cells are a complex form of chelate formed by Fe (iron) metal with haeme and globin groups. The synthesis of the complex involves two kinds of enzymes, namely the ALAD enzyme (Amino Levulinic Acid Dehydrase) or the amino acid levulinat

dehydrase and the ferrochhelase enzyme. ALAD enzyme is a cytoplasmic type enzyme. This enzyme will react actively in the early stages of synthesis and during the red blood cell circulation takes place. The ferrochhelase enzyme is meant in the group of mitochondrial enzymes. This enzyme ferrokhelatase will function actively in the final process of synthesis, which catalyzes the formation of chelate hemoglobin complexes.

Cases of lead poisoning can be prevented mainly by avoiding and preventing lead exposure. Individual prevention can be done by increasing the frequency to wash hands and consume iron, calcium and avoid materials containing lead (Pb) in the home such as the replacement of lead pipes (Dantje and Sembel, 2015). The Ministry of Health of the Republic of Indonesia limits the maximum consumption of lead (Pb) in food 4 ppm / day (Alsuhendra and Ridawati, 2013).

There are three sources of food contamination to lead (Pb), which are kitchen utensils, packaging and non-packaging paper, and water and air pollution. Previous researchers (Budiman, Dhahiyat and Rustikawati, 2012) said that lead (Pb) in the Citarum River exceeded the PP threshold. RI. No. 82 of 2001. This has led to a suspicion that lead heavy metals can contaminate community water. Water is a natural resource which has a very important function for the life of the people of Nangewer Village, including in tofu production activities. Based on observations, there is a tofu processing industry located near the Citarum River.

Atomic Absorption Spectrometry (AAS) is a method of analysis that can be used to determine the elements or metals in a sample (Suherman, 2011). The basic principle of the Atomic Absorption Spectrometry (AAS) technique is that electrons in an atom absorb light energy at certain wavelengths and convert to higher energy (excited). The number of atoms that light passes through and is excited is directly proportional to the amount of energy absorbed by measuring the amount of light energy absorbed so that it can determine the number or concentration of atoms of the element tested in the sample (Suherman, 2011).

Research Method

This type of research conducted by researchers is a descriptive analysis method that aims to determine the levels of lead heavy metals (Pb) in tofu samples. Descriptive analysis research is a method that functions to describe or give an overview of the object under study through data or samples that have been collected as they are without analyzing and making conclusions that are applicable to the public (Sugiyono, 2016). The population used in this study is tofu found in Nangewer Sari Village Industry. The sample is part of the population that is expected to represent or represent the population (Riyanto, 2013). The use of samples is 10% - 20% with a large population. The sample used in this study was 12 tofu samples from one industry around the Citarum River. Pb content testing in samples refers to BNS (2004), Ainna (2013), and Perkin (1996) about Pb testing using atomic absorption spectrophotometers.

Tools and Materials

The tools used in this study were atomic absorption spectrophotometers, funnels, porcelain cups, 100 ml beakers, hot plates, filter paper, Erlenmayer flasks, measuring flasks, Analytical balance. While the materials used are aquadest, HNO3 solution, tofu samples, and crystal Pb $(NO_3)_2$

Sample preparation

Mashed tofu sample, then weighed as much as 5 grams in porcelain with known weight. Then the tofu sample is put into a 100 mL beaker. HNO_3 solution is put into a beaker as much as 10 mL and heated on a hot plate at a temperature of 110 ^{0}C until the sample is homogeneous. After homogeneity, the solution is allowed to stand for a moment, then filtered with filter paper in a 100 mL volumetric flask and added with distilled water to mark the mark.

Making a stock solution of Pb $(NO_3)_2$ 1000 ppm (Stock A)

A solution which has a 1000 ppm lead metal content is used to make a standard solution with a lower content. This solution is made by dissolving 0.1 gram of $Pb(NO_3)_2$ into 100 ml of distilled water.

Make a solution of Pb $(NO_3)_2$ 100 ppm (Stock B)

This solution is made by diluting stock solution A. Stock solution A is pipetted as much as 10 mL and put into a 100 mL volumetric flask. Then add distilled water to the boundary mark.

Preparation of a standard solution of Pb $(NO_3)_2$

Series of standard solutions were made with concentrations of 1 ppm, 2 ppm, 3 ppm, 4 ppm and 5 ppm. The solution was made from the dilution of stock solution B. The five solutions were then measured for absorbance at a wavelength of 283.3 nm.

Measurement of Pb levels in tofu samples

The prepared sample was measured for its absorbance using an atomic absorption spectrophotometer at a wavelength of 283.3 nm.

Results and Discussion

Standard Curves

The results of measurements of the absorbance of a series of standard solutions are presented in tabular form (see Table 1). From Table 1 it can be seen that the higher the concentration the higher.

Table 1. Absorbance Value of Pb Standard Solution

Concentration of Pb (ppm)	Absorbance
1	0,730
2	1,943
3	2,862
4	4,055
5	5,068

Then the data in Table 1 is processed to produce a standard curve (see Figure 1). From Figure 1 we get the linear line equation y = 1.0788x - 0.3048, where y is the absorbance value and x is the concentration. In the linearity test the determination of regression R2 from the

calibration curve standard, the correlation coefficient is obtained. Correlation coefficient values indicate a strong relationship between the concentration of the solution (x-axis) and absorbance (the y-axis). The regression coefficient value obtained is $R^2 = 0.9985$, this means that the value of R^2 is close to ideal so that the curve can be used as a standard curve for determining the Pb content in tofu samples in Nangewer Village around the Citarum River in Garut Regency, Indonesia.

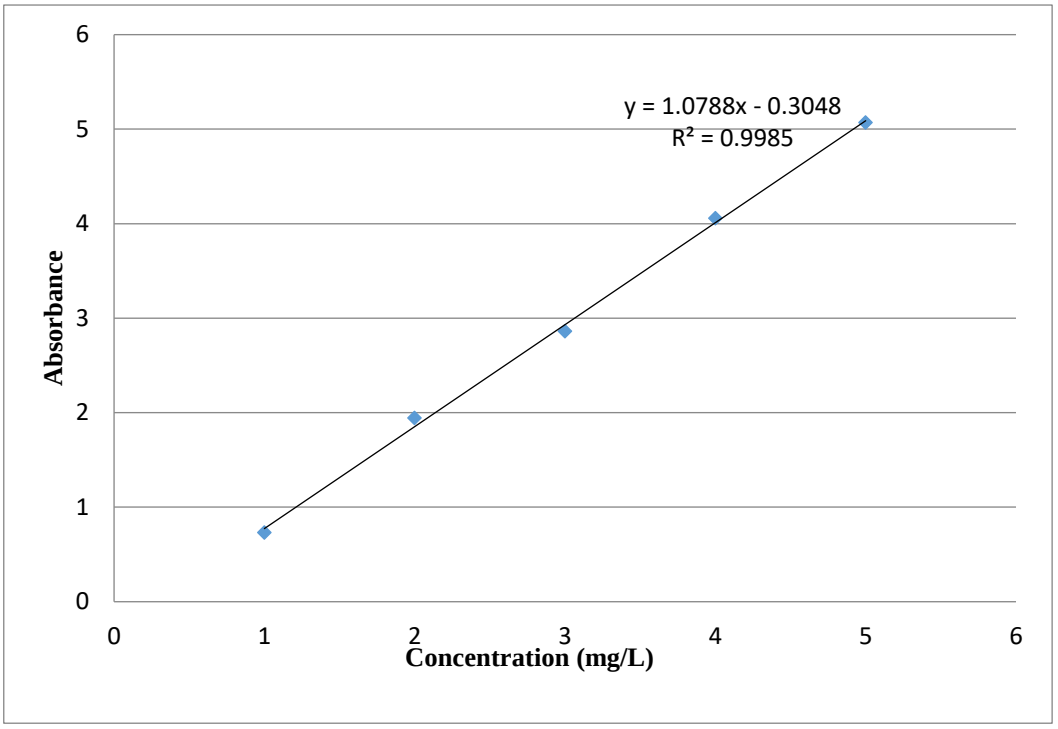

Figure 1 Standard Curve of $Pb(NO_3)_2$ Solution

Measurement of Pb Concentration in Samples

The results of measurements of Pb concentration in tofu are generally below the threshold determined by the government, which is 2.0 mg / kg of food. The mean Pb level in the sample was 0.762 mg / Kg. Even for the highest levels, namely in sample 11, it was at 0.837 mg / kg. This shows that the Pb exposure at the time of tofu production is very small. The water used for the production process is also good, although the location is close to the Citarum river.

The low Pb content can be attributed to the good filtering capacity of the soil. Lead metal dissolved in water bodies at certain levels will change its function to become a source of poison for aquatic life. This situation can certainly destroy an order of aquatic ecosystems (Palar, 2008). Water will seep in the soil and combine to form a layer of soil called an aquifer, a layer that is easily traversed by water is called a permeable layer, such as a layer found in sand or gravel while a layer that is difficult to pass through by water is called an impermeble layer. When infiltration into the soil, surface water comes into contact with minerals contained in the soil and dissolves it, so that the water quality changes due to chemical reactions (Dantje and Sembel, 2015).

Table 2 Data on Measurement of Absorbance and Concentration of Heavy Metal Pb in Tofu

Sample	Absorbance	Concentration (mg/Kg)
Sample 01	0.403	0.656
Sample 02	0.499	0.745
Sample 03	0.466	0.714
Sample 04	0.428	0.679
Sample 05	0.488	0.734
Sample 06	0.584	0.823
Sample 07	0.541	0.784
Sample 08	0.538	0.781
Sample 09	0.568	0.809
Sample 10	0.549	0.791
Sample 11	0.599	0.837
Sample 12	0.553	0.795
Average	0.518	0.762
Maximum	0.599	0.837
Minimum	0.403	0.656
SD		0.057

Although the measured Pb level is below the threshold, it is often considered whether or not to consume this tofu. This relates to the length of time that Pb stays in the body so if too much consumption of tofu produced here will cause accumulation of Pb in the body. If Pb has accumulated in the body in large amounts, it is not impossible that symptoms of poisoning will still occur. This is because Pb is toxic in that it is characterized as an inhibitor in the formation of red blood cells so that it can cause symptoms of anemia, headaches, organ damage, and can even disrupt the nervous system (Dart et al., 2015; Palar, 2008; Bruton, 2007).

Conclusion

Based on the research that has been done, it can be concluded that the average lead (Pb) content contained in the Tofu Sample in Nangewer Village is 0.762 mg/Kg. This number is still suitable for public consumption because it is still below the threshold established by SNI No.7387: 2009 regarding the maximum value of lead metal contamination in tofu which is 2.0 mg/Kg.

Acknowledgements

The researcher would like to thank Lembaga Pengelola Dana Pendidikan (LPDP) Indonesian endowment fund for education, Finance ministry of Indonesia for supporting this research.

References

Abdi, O. and Kazemi, M. (2015). A riview study of biosorption of heavy metals and comparison between different biosorbents. *J. Mater. Environ. Sci*, 6(5): 1386-1399.

Adhani, R. and Husaini. (2017). Logam Berat Sekitar Manusia. Lembaga Mangkurat University Press: Banjarmasin.

Ainna, R. N. (2013). Kadar Logam Berat Timbal(Pb) Dalam Air Sungai Dengan Metode Spekrofotometri Serapan Atom (SSA). [Thesis]. Makassar: Universitas Islam Negeri Alaudin

Alsuhendra dan Ridawati (2015). Bahan Toksik Dalam Makanan. Bandung : PT Rosdakarya.

Andina, S. (2018). Begini kehidupan di bantaran sungai Citarum, Sungai terkotor di Dunia. [Online]. [cited 2019 Jan 12]; Available from: URL:https://www.google.com/amp/jabar/tribunnews.com/amp/2018/03/04/begini-kehidupan-di-bantaran-sungai-citarum-sungai-terkotor-di-dunia

Baehaki, F., Rudibyani, R. B., Aeni, S. R. N., Perdana, R., and Aqmarina, S. N. (2020). Utilization of *Salacca zalacca* Seeds As Chromium(VI) Adsorbents. *Tche Quimica*, 17(34).

BNS (2004). Standar Nasional Indonesia, Cara Uji Timbal (Pb) Dengan Spektrofotometri Serapan Atom. SNI = 06-69898-2004.

BPOM (2017). Batas Maksimum Cemaran Logam Berat Dalam Pangan Olahan. Jakarta : BPOM.

Bruton L, *et al*. (2015). Principles of Toxicology. Yogyakarta: Andi Offset.

Budiman, B. T. P., Dhahiyat, Y., dan Rustikawati, I. (2012). Bioakumulasi Logam Berat Pb (Timbal) dan Cd (Kadium) Pada Daging Ikan Yang Tertangkap Di Sungai Citarum Hulu. *Jurnal Perikanan dan Kelautan*, 3(*4*).

Dantje, T., dan Sembel, B. A. (2015). *Toksikologi Lingkungan*. Yogyakarta: Andi Offset.

Dart, R. C. (2015). *Medical Toxikologi*. Yogyakarta: Andi Offset.

Flora, S. J. (2015). *Heavy Metal Induced Oksidative Stress & Its Possible Reversai By Chelation Therapy*. Yogyakarta: Andi Offset.

Henretig F. M. (2015). *Principles of Toxicology*. Yogyakarta: Andi Offset.

Lichtfouse, E. and Schwarzbauer, J. (2012) *Environmental Chemistry For A Sustainable World Volume 1: Nanotechnology And Health Risk*. New York: Springer.

Loukidou, M. X., Zouboulis, A.I., Karapantsios, T.D., and Matis, K.A. (2004). Equilibrium And Kinetic Modeling Of Cr(VI) Biosorption By Aeromonas Caviae *Colloids And Surfaces A: Physicochem. Eng. Aspects*, 242: 93-104.

Metcalf & Eddy, Inc. (1991). Wastewater Engineering: *Treatment, Disposal, Reuse, 3rd Ed*. (Revised By: G. Tchobanoglous And F.L Burton). New York: McGraw Hill, Inc.

Olukanni, D. O., Agunwamba, J. C., and Ugwu, E. C. (2014). Biosorption of Heavy Metals In Industrial Wastewater Using Microorganisms (*Pseudomonas Aeruginosa*) *American Journal Of Scientific And Industrial Research*, 5(*2*): 81 – 87.

Palar, H. (2008). *Pencemaran Dan Toksikologi Logam Berat*. Jakarta: Rineka Cipta.

Peraturan Pemerintah Republik Indonesia No. 82 Tahun 2001 Tentang kualitas air.

Perkin, E. (1996). Analytical Methods for Atomic Absorption Spectroscopy. USA: Perkin-ElmerCo..

Purwaningsih, E. (2007). *Cara Pembuatan Tahu Dan Manfaat Kedelai*. Jakarta: Ganeca Exact.

Riyanto (2013). *Statistik Deskriptif*. Yogyakarta: Nuha Medika.

Sarwono, B. dan Saragih, P. (2001). *Membuat Aneka Tahu*. Jakarta: Rineka Cipta.

Sugiyono (2016). Metode Penelitian Kuantitatif, Kualitatif, dan R&D. Bandung: Alfabeta.
Suherman, R. (2011). Uji Kadar Logam Pb,Cd, dan Fe Pada Air Situ Cileduk Pamulang. [Thesis]. Jakarta: Universitas Islam Negeri Syarif Hidayatullah.