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The CConcentration of Heavy Metals Cd, Hg, Pb in Processed Food Products Based on *Pterygoplichthys pardalis* (Castelnau, 1855) from Ciliwung River Jakarta Region

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Abstract

Background: Heavy metal that pollutes the river area affects living organisms that reside in it. Contamination of heavy metal in the Ciliwung River leads to the presence of heavy metal elements (Cd, Hg, and Pb) inside the body of the plecos (Pterygoplichtys Pardalis), which inhabits that area. Hence, using plecos flesh and bones as a raw material in processed food products (e.g. shredded fish, shumai, and fish flour) might harm humans. An accumulated load of heavy metals in the human body would likely trigger health problems. Insufficient data on heavy metal concentration in Ciliwung River plecos-based food products underlies this research to calculate the concentration of heavy metal Cd, Hg, and Pb on the previously mentioned plecos-based shredded fish shumai and flour. **Methods:** Heavy metal Cd, Hg, and Pb concentration analysis using X-Ray Fluorescence (XRF) methods conducted on PAIR Batan. **Results:** Value of Cd on shredded fish <0.5 mg/kg, shumai 0,7 mg/kg, head+tailbone and body skeleton flour <0.3 mg/kg. Value of Hg on shredded fish and shumai <0.7 mg/kg, head+tailbone flour 0.3 mg/kg, body skeleton flour 0.4 mg/kg. Value of Pb on shredded fish 1.3 mg/kg, shumai 0.8 mg/kg, head+tailbone flour 2.3 mg/kg, body skeleton flour 1.6 mg/kg. **Conclusions:** Heavy metal concentration on Ciliwung River plecos-based processed food products (shredded fish, shumai, and flour) has exceeded the maximum limit of Cd, Hg, and Pb determined by SNI, BPOM, and FAO.

Keywords: Ciliwung River plecos; fish flour; heavy metal; shredded fish; shumai

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Introduction

Heavy metals are one polluting waste in the Ciliwung River in Jakarta. Based on research conducted by Elfidasari et al., (2019), the waters of the Ciliwung River Jakarta contain heavy metals such as Pb, Hg, Cd, Cu, Mn, and Zn with high concentrations. The source of heavy metal spruce in the Ciliwung River is suspected to come from waste produced by various industries along the Ciliwung River and discharged directly into the Ciliwung River (Elfidasari et al., 2018). This condition results in the Ciliwung River being currently included in heavily polluted rivers (Ministry of Environment, 2010).

Heavy metals are toxic and not easily degraded, making them harmful to humans and the surrounding environment (Opasola et al. 2019). Heavy metals accumulate in the suspension of particles and sediments (Jonge et al., 2012), potentially endangering human health and ecosystems through the food chain (Eslami et al., 2011; Abubakar & Adeshina, 2019). According to Simionov et al. (2016), heavy metals enter the body of fish through three pathways, namely gills, digestive tract, and body surface. The part of the fish's body that experiences the most accumulation of heavy metals in the gills, and the lowest collection is on the body's surface. Heavy metals absorbed into fish's bodies are transported through the bloodstream and accumulate into organs and tissues (Authman et al., 2015). Ecological conditions influence the absorption and accumulation of heavy metals in fish, physics-chemical-biological waters, types of polluting elements, and aquatic physiology (Oryan et al., 2011). Heavy metals are harmful to marine ecosystems and humans. The accumulation of heavy metals in humans leads to impaired functioning of the brain, liver, kidneys, lungs, and muscles (Arantes et al., 2016).

Heavy metal pollution in the Ciliwung River directly impacts the fish population in the river. One type of fish that dominates the waters in the Ciliwung River Jakarta is the pleco with the species Pterygoplichthys pardalis (Yudo & Said, 2018; Hadiaty, 2011). Heavy metal spruce in the Ciliwung River impacts the metal content of P. pardalis pleco meat, increasing from year to year (Table 1). The concentration of heavy metals has exceeded the safe consumption limit of meat products. This causes P. pardalis pleco meat is not safe for consumption (Elfidasari et al., 2020). However, the meat of the pleco is still widely used by the people around the Ciliwung River as a source of livelihood and economy.

Table 1. The concentration of heavy metals on P. pardalis meat from the Ciliwung River

Heavy Metal	Metal concentration (ppm)				
	Ratmini (2009)	Alfisyahrin (2013)	Elfidasari *et al.* (2018)	SNI Meat	SNI Fisheries Products
Cd	0,003	<0,005	0,5±0,2	0,3	0,1
Hg	0,02	2,99±1,93	2,7±0,3	1	0,3
Pb	0,0005	0,001	0,8±0,3	0,03	0,5

The use of pleco as a basic ingredient in making processed food products for most communities around the Ciliwung River is because the fish is found in abundant quantities and is economically valuable (Aksari et al., 2015). In addition, from the results of previous studies obtained information that the protein content in Ciliwung River pleco is quite high, almost equivalent to marine fish protein (Elfidasari et al., 2019). People around the Ciliwung River use P meat. pardalis as a raw material for various processed food products peddled by traders such as siomai, batagor, fish meatballs, and brains (Munandar & Eurika, 2016) while the bones can be used as raw materials for making a fish meal and oil (Bechtel et al., 2019).

Given the increasing use of pleco meat as the basic ingredients of processed food products and the unavailability of metal content data on shredded, siomai and fish meal causes, this research is an urgency to be carried out. This study aims to analyze the content of heavy metals in processed food products based on pleco that are commonly consumed by the community, such as shredded, siomai, and fishbone meal. The study results are expected to be a source of information on heavy metals Cd, Hg and Pb in the three processed food products.

Methods

This research is a descriptive study by conducting laboratory analysis of the heavy metal content of Cd, Hg, and Pb in processed food products in the form of shreds, siomai, and bone meal made from Ciliwung River pleco. Conducted at the National Atomic Energy Batan Radiation Application and Isotope Center (PAIR BATAN).

Collection of samples of pleco

The pleco used as the basic ingredients of processed food products come from pleco catchers who look for fish along the Ciliwung River flow in the Jakarta area, ranging from Pasar Minggu to Cawang.

Tools and materials.

Tools used in the manufacture of shreds and siomai pleco include oil pressing devices, blenders, containers, frying pans, stirrers, steaming pans, stoves and gas. Tools used in the manufacture of the bone meal are dissmill, multmill and cabinet dryer. The tools used for the XRF test include plastic cups, ovens, and XRF tools.

The ingredients used in this study were meat and bones of pleco (head, body, tail), lime, onion, garlic, ginger, lemongrass, galangal, turmeric, bay leaf, orange leaf, coconut milk, wheat flour, leek stems, eggs, pepper powder, oil, salt, granulated sugar, tissue, and plastic Millar.

Making fish shreds

The meat of 1 kg of pleco that has been profiled is washed thoroughly, then boiled for approximately 20 minutes until cooked. The meat of the cooked fish is shredded until smooth. Make seasonings, such as 14 cloves of shallots as much as possible, seven cloves of garlic, turmeric, ginger, lemongrass, galangal mashed using a blander. Coconut milk as much as 500 ml, is put in the frying pan, add seasonings that have been mashed, bay leaves and orange leaves to taste, and then cooked to boil. Shredded meat is put in the pan and stirred evenly, then added salt as much as two tablespoons and stirred again for up to two hours. Sugar is added as much as two tablespoons and stirred again until the shreds turn brownish (Anwar et al., 2018).

Making siomai of pleco

The meat of 500 g of pleco is cleaned, chopped until smooth. The spices are pureed, namely 10 cloves of shallots, 10 cloves of garlic, two tsp salt, and two tsp pepper powder. A large basin is prepared, added wheat flour as much as 1 kg, minced meat, fine seasoning, two eggs, and five onions that have been mixed. The siomai dough is kneaded until evenly distributed, then the siomai dough is rounded. The pan for steaming is smeared with oil, so that the dough does not stick when steamed. The pot is heated until the water boils. The formed dough is put in a steaming pan, the pan is covered and the siomai is cooked for ± 30 minutes.

Making fish bone meal brooms

Flour making is carried out at Seafast IPB Bogor. Making flour begins with soaking the bones of pleco frozen in water for a while, then drying under the hot sun for two days. The bones of the pleco that have been dried are then reduced in size with a multimill to speed up the drying process. Fishbones are dried with a cabinet dryer (oven cabinet) with a temperature of 60 °C for 6 hours. The bones of the pleco are then mashed with a 40 mesh dismill tool. The pleco bones that have been smoothed using dismill produce bone meal with a smoothness of 40 mesh.

Analysis of metal content

Analysis of metal content is carried out using the XRF method. In this method, samples in shreds, siomai and bone meal of pleco are made into cup samples. Cup samples are made by weighing the sample as much as 5 g and dioven for 1 hour and then put in the cup. The sample in the cup is coated with 3 strands of tissue and tightly covered with plastic, then the sample is inserted into the X-Ray Fluoresence (XRF) (Manggara & Shofi, 2018) tool.

Data analysis

Data from the XRF metal content test was recorded in the form of the heavy metal content of Cd, Hg and Pb in shredded food products, siomai, and bone meal pleco processed with the help of Microsoft Excel was then delivered descriptively in the form of tables.

Sample or Participant

This section describes the description of the sample of participants in the study. The author can also explain how the sample was involved and ethical statements about the recruitment of participants. For scientific research, the author can write research materials and how a complete description of the material is obtained. General tools and materials do not need to be written down.

Instrument

For educational research or classroom action research, clearly describe the instrument that was built and its use. The author must be able to explain how the instrument is given. For Science research, the author can replace the subheadings according to need such as Extraction, Isolation Method, and Test Sample.

Result

Characteristics of shredded and siomai of fish meat, as well as bone meal of pleco

Shreds produced from the meat of pleco are browned, have a fibrous texture and smell a mixture of spices and fish (Figure 1). Siomai made from pleco meat has physical characteristics that resemble mackerel siomai, the difference is that pleco siomai has a strong fish aroma (Figure 1).

Figure 1. Processed food products made from pleco from Ciliwung River A) Abon, B) Siomai, C) Head +tail bone flour, D) Body bone flour.
(Source: Personal documentation).

Heavy metal content in shredded pleco

The results of the analysis of metals contained in the shredded pleco identified the presence of heavy metals types, namely cadmium (Cd), mercury (Hg) and lead (Pb). Each of the heavy metal content obtained is Cd < 0.5 mg / kg, Hg < 0.7 mg / kg and Pb 1.3 mg / kg (Table 2). The content of heavy metals Cd, Hg and Pb in shredded pleco exceeds the threshold value of safe to be suitable for consumption based on SNI 7690.1: 2013 on the quality and safety requirements of shredded food and SNI 7387: 2009 on the maximum limit of metal contamination in food. So that the Ciliwung River pleco shredded products are declared not yet eligible for consumption.

Table 2. Concentration of heavy metals Cd, Hg, Pb on shredded pleco from the Ciliwung River

Elements	Shredded Plecoticks mg/kg	Elfidasari (2018) mg/kg	SNI 7690.1 2013 mg/kg	SNI 7387 : 2009 mg/kg
Cd	< 0.5	0.6	0.1	0.3
Hg	< 0.7	1.4	0.5	0.3
Pb	1.3	3.6	0.3	0.3

Heavy metal content in pleco siomai

The results of the analysis of the concentration of heavy metals Cd, Hg and Pb in processed food products siomai pleco showed that the concentration of Cd in non-frozen siomai 2.4 mg / kg and frozen siomai 0.7 mg / kg; Hg concentration in siomai of < 0.7 mg/kg; and pb concentrations in non-frozen siomai 0.9 mg/kg and frozen siomai 0.8 mg/kg (Table 3). This result shows a high number when compared to the value of SNI 7756: 2013 on the quality and safety requirements of processed food products in the form of fish siomai and SNI 7387: 2009 on the maximum limit of metal spruce in food. Therefore, the siomai of the Ciliwung River pleco is included in the category of not meeting food safety requirements (Table 3). If the concentration of metal Cd, Hg and Pb in processed food products siomai fish is compared with the results of Elfidasari et al (2018) the decrease in heavy metal concentrations is found in Hg and Pb. Heavy metals Cd concentration has not decreased and are still relatively high numbers (Table 3).

Table 3. Concentration of heavy metals Cd, Hg, Pb in siomai pleco from the Ciliwung River

Elements	Nonfreeze Siomai mg/kg	Frozen Siomai mg/kg	Elfidasari (2018) mg/kg	SNI 7756: 2013 mg/kg	SNI 7387: 2009 mg/kg
Cd	2,4	0,7	0,6	0,1	
Hg	< 0,7	< 0,7	1,4	0,5	0,3
Pb	0,9	0,8	3,6	0,3	

Heavy metal content in the bone meal of pleco

The concentration of heavy metals in the bone meal of pleco is distinguished by the bone parts of the pleco that are processed into flour, namely in head and tail bone meal (TKE), body meal (TTB) and head, tail, body bone meal (TKEB). The results of the analysis of the cd heavy metal content in TKE amounted to < 0.3 ± 0 mg / kg, TTB of 0.3 ± 0 mg / kg, and TKEB of <0.3 ± 0 mg / kg. Cd heavy metal concentrations of all three types of bone meal show the same concentration and have values exceeding the maximum SNI limit of 0.1 mg/kg and BPOM) of 0.1. However, the concentration of heavy metal Cd in all three bone meals showed a lower value than fao's provision of 0.5 (Table 4).

The concentration of heavy metal Hg in pleco bone meal showed that TKE was 0.3 ± 0.3 mg/kg, TTB was 0.4 ± 0.4 mg/kg, and TKEB was < 0.7 ± 0 mg/kg (Table 4). When compared to the maximum limit value of SNI, the concentration of heavy metals Hg in TKE and TBD indicates a lower concentration. In comparison, TKEB flour has a higher concentration than the maximum limit of SNI. Compared to bpom and FAO values, the concentration of heavy metals Hg in all three fish meals showed a higher number (table 4).

The concentration of Pb metal in TKE is 2.3 ± 0.3 mg / kg, TTB is 1.6 ± 0.3 mg / kg, and TKEB is 2.8 ± 0.3 mg / kg. The highest concentrations of heavy metals Pb are found in

TKEB, This result shows that the concentration of heavy metals Pb in all three types of flour is much higher than the maximum limit of SNI 7387: 2009, BPOM and FAO (Table 4).

Table 4. Concentration of heavy metals Cd, Hg and Pb on fish meal brooms from the Ciliwung River

Elements	TKE mg/kg	TTB mg/kg	TKEB mg/kg	SNI mg/kg	BPOM mg/kg	FAO mg/kg
Cd	< 0.3±0	< 0.3±0	< 0.3±0		0.1	0.5
Hg	0.3±0.3	0.4±0.4	< 0.7±0	0.3	0,06	0.1
Pb	2.3±0.3	1.6±0.3	2.8±0.3		0,10	0.3

SNI: Quality limits of SNI metal spruce food products (SNI 2009)
FAO: International Standard for the Limit of Metal Contamination in Food (FAO 2003)
BPOM: Maximum limit for heavy metal contamination in food (PerBPOM 2018)

In general, the concentration of heavy metals in all three types of fish bone meal showed a higher number when compared to the provisions of metal contamination quality limits in processed food products according to SNI, BPOM and FAO.

Discussion

Ciliwiung River pleco shreds are good because they have a soft texture, good taste, distinctive aroma of fish, and long shelf life (Anwar et al., 2018). For fish siomai and using the basic ingredients of pleco, meat also produces a siomai character similar to mackerel ingredients. It has a savory taste, a chewy and tight texture, and a strong aroma (Supriatin et al., 2019). The character of fishbone meal brooms does not yet have a feeling that matches the character of a good fishbone meal. Pleco bone meal is divided into three types, namely head and tail bone meal (TKE), body bone meal (TBD) and head, tail, and body bone meal (TKEB). The three flours made from the head, body, and tail bones have a rough texture with a smoothness level of 40 mesh, color to gray, characteristically scented fish, and many found lumps in the flour.

This is not following the statement (Orlan et al., 2019), which states that quality fish meal has a texture with fine grains, is uniform, free from fish eyes, clean, bright colors, and has a fishy aroma typical of fish. However, the bone meal of pleco has different physical characteristics. The smoothness of the bone meal of pleco is 40 mesh because there are obstacles when making flour. The obstacle that occurs is when using a multimill with a sieve measuring 60 mesh samples of fish bones stick and inhibit the process of making flour. Samples of fish bones attached to the tool are caused by the oil content that comes out of the fish bones. The oil can cause the smoothed fish bones to clump and close the multimill holes used to produce flour. The level of oil contained in fish meal depends on the process of making fish meal (Lase et al., 2014). Therefore, to reduce oil levels it is necessary to do meth Although there is a decrease in the concentration of heavy metals Hg and Pb in processed food products siomai pleco compared to the concentration of heavy metals in fish meat, but the concentration of the two heavy metals is still higher when compared to SNI maximum limit of metal spruce in food. and SNI quality requirements for processed food products in the form of siomai. Different flour making odes. The low level of smoothness of fish bone meal brooms causes the bone meal of pleco does not meet the characteristics of good flour for consumption.

The analysis of metal content in fish food product sweeps of the Ciliwung River, showed the heavy metal content of Cd, Hg and Pb that exceeded the provisions of quality standards for the safety of processed food products. For processed products, the metal content has exceeded the limits of food safety provisions for shredded products (SNI

7690.1: 2013) and the maximum limit of metal spruce in food (SNI 7387: 2009). The high concentration of metals in shredded and fish siomai is caused because raw materials in the form of pleco meat from the Ciliwung River already contain heavy metals with high concentrations. Based on Elfidasari et al (2018), the value of the basic material heavy metal content in the form of pleco meat was obtained, namely Cd 0.6 mg / kg, Hg 1.4 mg / kg and Pb 3.6 mg / kg. The high content of heavy metals in the meat of Ciliwung River pleco is caused because the waters of the Ciliwung River have been polluted with dangerous heavy metals in high concentrations (Elfidasari et al., 2020). Most heavy metals can enter the body of aquatic organisms through the food chain and through tissues such as gills and skin.

Heavy metals that are dissolved in the water and settle in sediment will enter the body of aquatic biota like fish. This will make heavy metals accumulate in the fish's body (Cahyani et al., 2016). Heavy metals that enter the body of pleco are caused because the metal is a nondegradable hazardous waste (Agustina, 2014). As a result, heavy metals will accumulate into the body of organisms that are in the environment, and can even enter the human body. One of the entry of heavy metals into the human body is through food. Foods with heavy metals such as Cd, Hg, and Pb that enter the body excessively can increase the risk of negative health in humans.

In addition to shreds and siomai from pleco meat, high concentrations of heavy metals Cd, Hg and Pb are also found in fish meal derived from bone raw materials both derived from the head bone, body bones, tailbones and a mixture of head, body and tail bones (Table 4). The high concentration of metal in fishbone meal proves that heavy metals in the Ciliwung River have accumulated not only in the meat of pleco but also stored in the bones both in the bones of the head, body and tail. The accumulation of heavy metals in fish bones is due to the high concentration of heavy metals in the waters that are the habitat of the fish as well as the length of time of contamination of metals from the waters into the body of the fish (Yousif et al. 2021; Will et al. 2012; Christopher et al. 2009; Staniskiene et al. 2006)

Processed fish ingredients can be dangerous to consume if the fish body contains heavy metal levels that exceed the limits specified in the decree. Director-General of POM Ministry of Health of the Republic of Indonesia regarding the maximum limit of metal spruce in food No. 03725 / B / SK / 1989. Consumption with a maximum Pb value of 1000 ppb, a maximum Cd value of 2000 ppb and SNI 7389: 2009 concerning the maximum limit of metal spruce in food with a Pb 300 ppb and Cd 100 ppb. Heavy metals are generally toxic to living things, although some are needed in small amounts. Heavy metals are bioaccumulated which if consumed continuously for a long time can have a detrimental impact on health (Budiman et al., 2012).

Heavy metals have a density of 5 g.cm-3 or more, are difficult to degrade, and can enter the environment even adsorbed in the body of organisms (Forstner & Whitmann 1983). Heavy metals are generally toxic. If absorbed will be excreted by the body through detoxification mechanisms. The number of heavy metals that exceed the threshold and cannot be detoxified will accumulate in various organs. Heavy metals affect the activity of metalloenzymes and subcellular organelles by eviction of important metal cofactors from enzymes or disrupting the structure of subcellular organelles (Lu, 2006).

Cd heavy metals are widely used in various industries, including battery raw materials, plastic pigments, ceramics, glassware, steel and metal coatings, polyvinyl chloride (PVC) stabilizers, and fertilizer constituents (Faroon et al. 2012). C.D.s accumulated in the body will affect kidney function and bones and result in cardiovascular disease, type two diabetes, and cancer (Chunhabundit, 2016). The kidneys are human organs that are very sensitive to cadmium toxicity, as they result in tubular dysfunction and kidney damage over time. Due to bone demineralization, Cd metal toxicity also disrupts the skeletal system (Schaefer et al., 2020). Cd accumulation can cause cancer such as kidney, prostate, breast, and endometrial cancer because it is carcinogenic (Mcelroy & Hunter, 2019). According to Bishak et al. (2015), carcinogenesis is caused by various factors, namely suppression of gene expression, inhibition of DNA damage repair and apoptosis, induction of oxidative stress, endocrine disorders, cell proliferation, and the formation of reactive oxygen (ROS).

Hg heavy metals scattered in the aquatic environment of the Ciliwung River come from industrial activities around the Ciliwung River that contribute to hg polluting waste (Aksari et al., 2015). The accumulation of mercury-heavy metals in aquatic environments through the food chain can result in high pollution levels in aquatic organisms, even at very low concentrations. This is done because fish is the main source of methyl mercury in the human diet. Observations of several types of marine and freshwater species indicate that bioaccumulation of total mercury concentrations in fish body tissues increases with the fish body's life, weight, and length (Purbonegoro, 2014).

The accumulation of mercury in the human body is due to consuming fishery products exposed to mercury (Kimáková et al., 2018). Hg organic compounds are called methylmercury which is easily absorbed and accumulates in the human body. Methylmercury has high toxicity to the nervous system, kidneys, and human immune system. Some of the symptoms caused by methylmercury include kidney damage, brain function, DNA and chromosomes, sperm, nervous system disorders, allergies, miscarriages and defects in infants (Pandey et al., 2012). According to Rice et al. (2014), mercury metal has provided toxicological effects on several human organ systems. Including cellular, cardiovascular, hematological, pulmonary, kidney, immunological, neurological, endocrine, reproductive, and embryonic development systems.

Pb is also one type of heavy metal widely used in the industrial field and is toxic and difficult to degrade naturally in nature (Hezbullah et al., 2016). The accumulation of Pb in the human body is bad for the circulatory system, cardiovascular, kidneys, endocrine, gastrointestinal, immune, and reproductive systems (Yingliang et al., 2014). Pb metal is neurotoxic and can spread throughout the organs of the human body and cause damage. Pb toxicity is due to substituting itself with divalent cations that affect cell function and free radical formation (Rodríguez et al., 2015). According to Iyanda & Adekunle (2012), Pb metal can imitate and inhibit calcium which plays a role in the body's metabolism.

Heavy metals that enter the body and accumulate in the organs of the human body can block the work of enzymes to interfere with the body's metabolism, causing allergies, mutagens, teratogens or carcinogens for humans (Ginting, 2009). In 1970, Cd poisoning in Toyama City, Japan, reported as itai-itai disease, a symptom of complaints of back pain for several years and causes osteomalacia or bone softening and spinal fractures sufferers (Hananingtyas, 2017).

Suppose the results of this study are compared with the results of research conducted by Elfidasari et al. (2018). In that case, there is a decrease in the concentration of Cd, Hg and Pb metals in all three types of processed food products compared to the heavy metal content contained in fish meat. This can be due to several treatments in processing food products that can reduce the level of heavy metals such as the use of lime and boiling. Making shredded pleco begins with cleaning the fish meat, giving lime then boiling. The use of lime in processing food based on fish can eliminate the fishy smell in fish meat. In addition, lime also can reduce metal content (Nurmalasari & Zaenab, 2015). This is because lime contains citric acid that can bind metal ions so that it can remove metal ions accumulated in meat. The boiling process at a certain period without using lime also causes a decrease in metal content but is not significant (Sari et al. 2014). This condition provides information that there is a decrease in the metal content of fish meat brooms processed into shreds that can be thickened due to giving lime and boiling.

In making siomai will be done steaming for 30 minutes after the siomai formed roundly. The process of food processing through boiling and steaming within this certain period can lead to a decrease in the concentration of heavy metals in processed food products from both plants and animals (Dwiloka & Atmomarsono 2012; Rachmawati et al. 2013; Sari et al. 2014; Widowati et al. 2017). Based on Dwiloka & Atmomarsono (2012) research, the metal levels of Fe, Cs, Rb, Co, Zn, Cd and Sc in the breast and thighs of broiler chickens decreased after boiling and steaming. Likewise, food products from dara shells and green mussels that experience a decrease in heavy metal levels after going through the boiling process (Rachmawati et al. 2013; Alyani et al. 2017; Mayholida et al. 2020). In addition to animal food products, a number of heavy metals contained in long bean vegetables and Moringa leaves also experienced a decrease in concentration after steaming and boiling (Widowati et al. 2017; Manggara & Shofi 2018). This shows that processed food products based on Ciliwung River pleco meat such as shreds, siomai and fish meal are not safe.

Conclusions

P. pardalis pleco food products from the Ciliwung River contain heavy metals Cd, Hg, and Pb with concentrations exceeding food safety thresholds and not meeting Indonesian national standards (SNI).

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Declaration statement

The authors reported no potential conflict of interest

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