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ACCUMULATION OF HEAVY METALS IN WATER BODIES AND FISH IN RESERVOIR RIVER FLOW AREA OF CITARUM AND IMPACT ON HUMAN HEALTH MINI REVIEW

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Abstract

The aim of this review article 1) to explain the types of heavy metal contamination found in water bodies from reservoirs in the river flow area of Citarum. 2) to identify the types of fish that are cultivated and the exposure to heavy metals in these fish and 3 to explain the health effects of heavy metals in human consumption. Based on the results, it can be concluded that the types of heavy metals that pollute the waters in the river over flow Cirata (Saguling, Cirata and Jatiluhur are lead (Pb), Zeng (Zn), Cadmium (Cd) and Cromium (Cr). The concentration of the presence in these water bodies is still below the quality standard set by BPOM Indonesia. The types of fish cultivated in the river over flow Cirata Reservoir (Saguling, Cirata and Jatiluhur are goldfish, tilapia, catfish, and hard-lipped barb fish. All types of the fish are fish for consumtion. The types of heavy metals found in these fish are Pb, Cd and Cr. It is present at concentrations below the exposure limits by BPOM Indonesia. Humans exposed to heavy metals can have an impact on their health and can even cause death.

Keywords : Quality standards, copper, dangerous, toxic, fish for consumption

INTRODUCTION

Reservoirs are river flow dams that can be used by the local community as irrigation, hydropower, raw water sources, and flood control (Kartini and Permana 2016). Reservoirs also have potential in the field of fisheries such as for fish cultivation activities with floating net cages and places for fishing (Mulyadi and Atmaja 2016; Selmi et al. 2019) so that the quality of reservoir waters must be in accordance with water quality standards so that fish

cultivation activities can be continue to run and there is a guarantee of the safety of the fish produced for human consumption.

Reservoirs can become aquatic ecosystems that are more susceptible to pollution such as chemical with types, Hazardous and toxic materials. If the reservoir location is close to residential, agricultural, or industrial environments that use chemicals because the waste from these activities will be discharged into the river and can contaminate the reservoir because the river is one of the sources of reservoir water (Sutrisno et al. 2007). One type of hazardous chemical is a class of heavy metals such as cadmium (Cd), chromium (Cr), lead (Pb), copper (Cu), zinc (Zn) which can be toxic to the aquatic environment. Reservoir contaminated with heavy metals can cause the quality of the reservoir waters to decline (Priyanto et al. 2008). Heavy metals in waters can come from nature such as volcanic dust, erosion of rocks and and from human activities, namely domestic waste and industrial waste (Maddusa et al. 2017). According to Komarawidjaja (2017) heavy metals can come from textile industry waste which uses heavy metals in the dying process. According to Istarani and Pandebesie (2014), in addition to the textile industry, heavy metals can come from the alloy industry, pesticides and others.

Fish can be contaminated because heavy metals cause biotransformation and bioaccumulation processes in living organisms. In the body of aquatic biota, the amount of accumulated metal will continue to increase through food, gills and digestive tracts and then accumulate in body tissues such as liver and kidney (Nur 2013). The content of heavy metals in the body of fish and where the fish comes from is important to know because fish is part of the human diet. Heavy metals in fish meat can be distributed and accumulate in the human body who eat these fish and in the long term can cause human health problems (Yulaipi and Aunurohim 2013). Therefore, the aim of this review article 1) to explain what heavy metal contaminants are found in the reservoir waters in the river over flow Citarum. 2) to identify the types of farmed fish and their exposure to heavy metals and 3 to explain the health effects of heavy metals if consumed by humans.

Heavy Metal Contamination in Reservoir Waters

The Citarum River is the longest river in West Java - Indonesia. In the river flow area Citarum, there are three reservoirs, from upstream to downstream are Saguling, Cirata and Jatiluhur. These three reservoirs are used, among others, for fish farming and hydroelectric power plants.

According to Pratiwi et al. (2011) there are several problems that occur in reservoir waters such as in the waters of the Jatiluhur reservoir. These problems are experiencing a decrease in water quality, a decrease in fish production, and an increase in corrosion and

weathering in hydropower construction. The problem is due to the increase in nutrients or metals from the leftover feed (fish meal) or fish metabolism residue in the marine cage maintenance that enters the reservoir waters.

According to Riani (2010) Cirata Reservoir experienced an increase in heavy metal inorganic waste as a result of industrial activities by dumping the waste into the Citarum River which then entered the Cirata Reservoir. The inorganic waste is toxic and can accumulate in living organisms. According to Sutrisno et al. (2007) and Wicaksono et al. (2016) heavy metals are elements that are harmful to the aquatic environment and can cause ecological disturbances in the reservoir ecosystem. According to Wicaksono et al. (2016) in the Cirata Reservoir sediments there are heavy metal concentrations ranging from 0.29 to 5.32 mg / kg, the lead content is thought to have come from fish feed for floating net cage cultivation which has been contaminated with lead.

According to Adani et al. (2018) based on research results, the concentration of heavy metal Zn in the waters of the Saguling Reservoir ranges from 0.1441 mg / L - 0.5976 mg / L and there are two out of 10 locations that exceed 0.50 mg / L, as the quality standard limit of PP No. 82, Tahun 2001, namely the inlet area or the place where the river flows into the reservoir. The high of Zn concentration is due to the fact that there are many industrial activities that use chemical materials for product refinement and fiber preservation. According to Paramita et al. (2017) the highest concentration of Cd in the Saguling reservoir was 0.0015 mg / L while the highest Cr concentration was 0.02 mg / L, the two heavy metals were still below the quality standard. However, regardless of the concentration of cadmium metal in a per day, it must be considered because heavy metals can accumulate in fish body tissues through the process of metabolic activity or bio-absorption (Çoban et al. 2013).

Reservoir waters that are polluted by industrial or domestic waste can be toxic and have the potential to produce products such as fish which are also polluted because pollutants such as heavy metals can enter the body's tissues through food or respiration organs (gills) (Murtini and Rachmawati 2007). The high pollution of heavy metals in waters and sediments will cause the concentration of heavy metals in fish meat to increase due to the accumulation process (Cahyani et al. 2016).

The fish that cultivated in the reservoir

River flows that are dammed into reservoirs can change to form a new ecosystem that is different from river ecosystems because not all fish can adapt to reservoir waters. The types of fish that can adapt to reservoir waters are usually fish that dominate and can grow and reproduce well compared to fish that cannot adapt so that they can disappear over a long period of time (Purnamaningtyas and Hedianto 2012). The types of fish cultivated in the

Jatiluhur Reservoir in the floating net cages are ornamental carp kumpay (*Carassius auratus*), carp (*Cyprinus carpio*) and tilapia (*Oreochromis niloticus*). These types are economically valuable consumption fish (Purnamaningtyas and Hedianto 2012). In addition, Hard-lipped barb fish (*Osteochilus hasselti* C.V) is also one of the consumption fish cultivated in the Jatiluhur reservoir (Pratiwi et al. 2011). The dominant types of fish cultivated in Jatiluhur reservoir are goldfish, tilapia, and catfish (Karunia 2015).

Tilapia and goldfish are also common fish cultivated in Cirata reservoir using floating net cages with an intensive cultivation pattern, namely fish stocking is carried out at high density and using commercial feed during the enlargement process (Ardi 2013).

Based on the research results, koi ornamental fish and pomfret fish can be cultivated in the Cirata reservoir by diversifying the cultivated fish because the two fish can grow well and in accordance with the characteristics of the reservoir waters. Diversification is an aquaculture activity by adding the types of fish that are cultivated so that it can increase the income of floating net cage farmers (Gandhy 2017).

Accumulation of Heavy Metals in Cultivated Fish in the river over flow Citarum Reservoir

Fish can be used as bioindicators of chemical pollution in waters which can be shown by abnormal growth and death in fish. Based on the research results of Priyanto et al. (2008) fish originating from Cirata reservoir contains heavy metal Hg of 0.25 - 151.6 ppb, Pb of 2 - 65 ppb, Cd of 0 - 34 ppb, and Cu of 1< - 154 ppb. All concentrations of heavy metals are still below the threshold set by the Indonesian Food and Drug Administration (BPOM), namely Hg at 500 ppb, Pb at 2,000 ppb, Cd at 1,000 ppb, and Cu at 20,000 ppb. However, the concentration of heavy metals in the body of fish must still be watched out because it can have an impact on health if consumed.

According to Suprian and Salami (2011) bioaccumulation of heavy metal Hg in fish cultivated in the Jatiluhur reservoir, namely Goldfish, Tilapia, and Red Devil respectively is 1.38.10-6; 1,74.10-6; 3,61.10-6 mg / kg. The accumulation of heavy metals is still below the threshold set by the Indonesian Food and Drug Administration (BPOM), which is 0.5 mg / kg, but this concentration must be monitored due to the nature of Hg metal which is difficult to eliminate.

The concentration of heavy metal Pb found in catfish cultivated in floating net cages in Saguling reservoir is based on research by Mutiara et al. (2013), namely the gills (0.01-120 ppm), liver (0.01-160 ppm) and meat (0.01-130 ppm). In other studies, it was informed that the concentration of Pb in catfish with a body length of 20 cm, namely the gills of 24.88 ppm, liver 25.89 ppm and meat of 34.17 ppm and this concentration had exceeded the threshold set

by the Food and Drug Administration. (BPOM) Indonesia (Indonesian National Standard no. 7387: 2009). The highest concentration is found in catfish meat which can be caused by the production of mucus on the skin. Heath (1987) in Mutiara et al. (2013) explained that the production of mucus on the skin will make it difficult to exchange substances from the environment into the body or vice versa so that heavy metals that stick to the mucus will accumulate and be absorbed by fish meat. Meanwhile, the highest concentration of Cd heavy metal was found in catfish with a size of 30 and 40 cm, namely in the liver at 5.65 ppm and 13.99 ppm. The accumulation of heavy metals in the liver is due to the strong binding of sulfur and nitrogen so that enzyme activity and the immune system are inhibited due to the accumulation of heavy metals.

Not only in fish, heavy metal concentrations can also accumulate in aquatic biota whose habitat is in sediments, such as macrobenthos. Based on the results of Wicaksono's research (2016), the concentration of heavy metal lead in macrozoobenthos in Cirata Reservoir is 0.78 - 3.19 mg / kg. Whereas in sediments, the concentration of lead metal is higher, which is between 0.29 - 5.04 mg / kg, so it can be said that the concentration of heavy metals in aquatic sediments can affect the concentration of heavy metals in macrozoobenthos.

Impact of Heavy Metals If Consumed by Humans

Fish is one of the aquatic biota that can be used as a bioindicator to determine the concentration of heavy metals in waters because heavy metals can accumulate in body tissues. Fish, which is a source of protein for humans, will be dangerous to consume if the fish contains heavy metals, because these heavy metals will move and accumulate in the human body (Cahyani et al. 2016). As a result, it can interfere with human health such as sore throat, headaches, dermatitis, allergies, anemia, kidney failure, pneumonia, and other diseases (Effendi et al., 2012 in Pratiwi 2020). Heavy metals are also substances that are toxic and have both casinogenic (cancer-forming substances) and teratogenic (changes in the shape of organs, cells, body tissues) (Agustina and Teknik 2014).

According to Pratiwi (2020) the work of enzymes in humans will be hindered because there are heavy metals and the body's metabolism can be disrupted. Some heavy metals that can be harmful to humans are lead (Pb), copper, mercury, cadmium, and chromium. According to Baloch et al. (2020) humans exposed to high Pb concentrations may experience nervous system damage. kidneys, liver, reproductive system, bones, teeth and immunity, besides Pb which is found in the blood of children can permanently damage the brain. Cadmium contamination can cause itai-itai disease which was first discovered in Japan, namely bending and cracking, showing symptoms of nephropathy and osteomalacia and causing death (Istarani and Pandebesie 2014).

CONCLUSION

Based on the results of the above study, it can be collected 1) Types of heavy metals that pollute the waters in the river over flow Cirata (Saguling, Cirata and Jatiluhur are lead (Pb), Zeng (Zn), Cadmium (Cd) and Cromium (Cr). these waters are still below the quality standards set by BPOM Indonesia. 2) The types of fish that are cultivated in the Cirata reservoir (Saguling, Cirata and Jatiluhur are goldfish, tilapia, catfish, and hard-lipped barb fish. consumption Types of heavy metals found in these fish are Pb, Cd and Cr. Their presence is at concentrations below the threshold allowed by BPOM Indonesia 3) Humans exposed to heavy metals can have an impact on their health and can even cause death.

REFERENCES

Adani, Julia Putri, E K A Wardhani, and Kancitra Pharmawati. 2018. Identification of Lead (Pb) and Zinc (Zn) Heavy Metal Pollution in Surface Water and Sediment in Saguling Reservoir, West Java Province. *Jurnal Reka Lingkungan* 6(2): 1–12.

Agustina, Titin, and Fakultas Teknik. 2014. Heavy Metal Contamination In Food And Its Impact On Health. *TEKNOBUGA* 1(1): 53–65.

Ardi, Idil. 2013. Fish Cultivation System of Floating Net Cages to Maintain the Environmental Sustainability of Cirata Reservoir. *Media Akuakultur* 8(1): 23–29.

Baloch, Shahnawaz et al. 2020. Occupational Exposure of Lead and Cadmium on Adolescent and Adult Workers of Battery Recycling and Welding Workshops : Adverse Impact on Health. *Science of the Total Environment* 720: 1–8. https://doi.org/10.1016/j.scitotenv.2020.137549.

Cahyani, Nica, Djamar T. F Lumban Batu, and Sulistiono. 2016. WEIGHT METAL CONTAINS OF Pb, Hg, Cd, and Cu in REJUNG FISH (*Sillago Sihama*) IN DONAN RIVER ESTUARY, CILACAP, CENTRAL JAVA. *JPHPI* 19(3): 267–76.

Gandhy, Abel. 2017. ANALYSIS OF INCOME INCREASE OF FLOATING CERAMBA FARMERS WITH THE DIVERSIFICATION OF CULTIVATED FISH SPECIES IN CIRATA CONTAINERS. *Jurnal Ekonomi dan Studi Pembangunan* 18(1): 25–33.

Istarani, Festri, and Ellina S Pandebesie. 2014. Study of the Impact of Arsenic (As) and Cadmium (Cd) on Decreasing Environmental Quality. *Jurnal Teknik POMITS* 3(1): D53–58. http://ejurnal.its.ac.id/index.php/teknik/article/view/5684.

Kartini, Tintin, and Sulwan Permana. 2016. Operational Analysis of Ir. H. Juanda Reservoir. *Jurnal Konstruksi* 14(1): 13–14. http://jurnal.sttgarut.ac.id.

Karunia, Syifa. 2015. ANALYSIS OF THE EXTERNALITY COSTS OF FLOATING CERAMBA BUSINESS WASTE IN JATILUHUR WADUK, PURWAKARTA DISTRICT Externality Cost Analysis of Floating Cages Business Waste Feed The In Jatiluhur Reservoir , Purwakarta Regency. B*uletin Ilmiah MARINA Sosek Kelautan dan Perikanan* 1(2): 77–88.

Komarawidjaja, Wage. 2017. Exposure to Industrial Liquid Waste Containing Heavy Metals in Rice Fields in Jelegong Village, Rancaekek District, Bandung Regency. *Jurnal Teknologi Lingkungan* 18(2): 173–81.

Maddusa, Sri Seprianto et al. 2017. Heavy Metal Content of Lead (Pb), Mercury (Hg), Zinc (Zn) and Arsenic (As) in Fish and Tondano River, North Sulawesi. *Al-Sihah : Public*

Health Science Journal 9(2): 153–59. journal.uin-alauddin.ac.id.

Mulyadi, Asep, and E. Siswandi Atmaja. 2016. Impact of Pollution in Saguling Reservoir on Floating Net Fish Cultivation. *Jurnal Geografi Gea* 11(2): 179–99.

Murtini, Jovita Tri, and Novita Rachmawati. 2007. Heavy Metal Content in Aquatic Fish and Sediments in the Saguling Reservoir, West Java. *Jurnal Pascapanen dan Bioteknologi Kelautan dan Perikanan* 2(2): 153–59.

Mutiara, Arindina Azzahrwaani, Ike Rustikawati, and Titin Herawati. 2013. ACCUMULATION OF LEAD (Pb) AND KADMIUM (Cd) AS WELL AS DAMAGE TO THE GILL, LIVER AND PATIN FISH MEAT (Pangasius Sp.) IN SAGULING RESERVOIR. *Jurnal Perikanan dan Kelautan* 4(4): 1–10.

PARAMITA, RINDU WAHYU, EKA WARDHANI, and KANCITRA PHARMAWATI. 2017. Content of Heavy Metal Cadmium (Cd) and Chromium (Cr) in Surface Water and Sediment: A Case Study of Saguling Reservoir, West Java, RINDU WAHYU PARAMITA, EKA WARDHANI,KANCITRA PHARMAWATI. *Jurnal Online Institut Teknologi Nasional Oktober* 5(2): 1–12.

Pratiwi, Dian Yuni. 2020. Impact of Heavy Metal Contamination (Lead, Copper, Mercury, Cadmium, Chromium) on Aquatic Organisms and Human Health. *Jurnal Akuatek* 1(1): 59–65.

Pratiwi, P., R. Rostika, and Y. Dhahiyat. 2011. Effect of Feeding Rate on Growth Rate and Deposition of Heavy Metals for Hard-lipped Barb Fish in Floating Net Cages Reservoir Ir. H. Djuanda. *Jurnal Akuatika Indonesia* 2(2): 1–11.

Priyanto, Nandang, Dwiyitno Dwiyitno, and Farida Ariyani. 2008. Content of Heavy Metals (Hg, Pb, Cd, and Cu) in Fish, Water, and Sediment in Cirata Reservoir, West Java. *Jurnal Pascapanen dan Bioteknologi Kelautan dan Perikanan* 3(1): 69–78.

Purnamaningtyas, Sri Endah, and Dimas Angga Hedianto. 2012. *Types of Fish in Ir. H. Djuanda, West Java, 2010-2011*. Purwakarta: Balai Penelitian Pemulihan dan Konservasi Sumberdaya Ikan.

Riani, Etty. 2010. HEAVY METAL CONTAMINATION OF CULTIVATED FISH IN FLOATING NET CAGES IN CIRATA CONTAINERS. *Jurnal Teknobiologi* 1(1): 51–61.

Selmi, Wiharto, and Patang. 2019. Analysis of Water, Soil Substrate and Heavy Metal Contamination of Lead (Pb) and Cadmium (Cd) in Tilapia (*Oreochromis niloticus*) in the Waiting Reservoir of Pampang, Bitoa Village, Makassar City. *Jurnal Pendidikan Teknologi Pertanian* 5(2): 36–46.

Suprian, Chefin, and Indah Rachmatiah S Salami. 2011. ACCUMULATION OF MERCURY (Hg) IN FISH CULTIVATION OF FLOATING NET CAGES AND WILD FISH IN JATILUHUR CONTROL. *Jurnal Teknik Lingkungan* 17(82): 68–76.

Sutrisno, Sutrisno, Santosa Koesoemadinata, and Imam Taufik. 2007. Heavy Metal Pollution Levels in Reservoir Ecosystems in West Java (Saguling, Cirata, and Jatiluhur). *Jurnal Riset Akuakultur* 2(1): 103–15.

Wicaksono, Ega Adhi, Sriati, and Walim Lili. 2016. Distribution of Heavy Metal Lead (Pb) in Macrozoobenthos in Reservoir Waters. *Jurnal Perikanan Kelautan* VII(1): 103–14.

Yulaipi, Sumah, and Aunurohim. 2013. Bioaccumulation of Pb and Its Relationship with the Growth Rate of Tilapia Fish. *Jurnal Sains dan Seni Pomits* 2(2): 1–5. http://ejurnal.its.ac.id/index.php/sains_seni/article/view/3965.