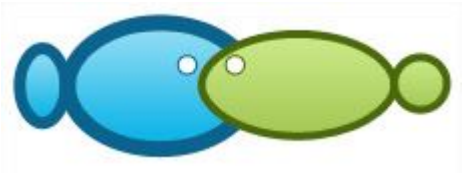

Evaluation of heavy metal contamination in various fish meat from Cirata Dam, West Java, Indonesia

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Abstract. Commodities of fresh water fish consumption which is generally marketed in Bandung, Indonesia and surrounding areas are carp, tilapia and catfish. These types of fish are from post-harvest fish farming in Floating Fish Net (FFN) in Cirata Dam. This study aimed to evaluate the accumulation rate of heavy metals Cd, Zn, Pb and Hg contained in fish meat in Cirata Dam namely common carp (*Cyprinus carpio* L.), Nile tilapia (*Oreochromis niloticus* L.) and striped catfish (*Pangasianodon hypophthalmus*). The method used in this research was survey method. Heavy metal tests were conducted by using AAS (Atomic Absorption Spectrometry). The results showed that heavy metals were detected in fish meat (*C. carpio*, *O. niloticus* and *P. hypophthalmus*) which cultured in Cirata FFN were Pb and Zn whereas Cd and Hg were found to be negative. Pb that were containing in fish meat ranged from 2.0318 to 3.1553 ppm. This range exceeds the allowance standard quality (2 ppm) of the Food and Drug Administration of Republic Indonesia (FDA RI). The contamination of Zn found in fish meat was observed ranged from 7.3985 to 10.4972 ppm which is within the limits that do not exceed the standard quality (40 ppm) of the FDA RI.
Key Words: accumulation, *Cyprinus carpio*, *Oreochromis niloticus, Pangasianodon hypophthalmus,* aquaculture, FFN, water pollution.

Introduction. Along with the increasing of education and knowledge about nutrition, the consumption level of fish in a society is also increasing. Fish, in addition, contain proteins, minerals and vitamins that are essential for humans (Medeiros et al 2012). Fish also contains unsaturated fatty acids such as omega 3 and 6 which prevent coronary heart disease and provide nutrients for the human brain. Therefore, the fish has two virtues as a source of nutrition and materials treatment (El-Moselhy et al 2014).

Fish consumption of community in Bandung city, Indonesia has been increasing recently, in 2014 has reached 33.90 kg/capita/year, while the World Health Organization recommended that level of fish consumption per capita is 36 kg/year (Department of Agriculture and Food Security in Bandung 2015). Most of fresh water fishes distributed in Bandung are largely supplied from Cirata Dam. Types of fish that are supplied namely *Cyprinus carpio*, *Oreochromis niloticus, Pangasianodon hypophthalmus*.

Cirata waters contain heavy metals Cd, Cu, and Zn in which the concentrations has exeeded the quality standards set by the Government of the Republic of Indonesia through Government Regulation No. 82 of 2001 (Damayanti et al 2010). In addition to heavy metal contamination, the water of Cirata Dam also contains very high ammonia concentration of 0.45 mg/L, while the standard quality limit is 0.016 mg/L (Sudradjat et al 2010).

The fish which is cultivated in water area contaminated by heavy metals are very likely containing heavy metals on its flesh (Benzer et al 2013). The higher the contamination of heavy metals in the water body, the higher are the bio-accumulation of heavy metals contained in the network aquatic organisms (Tapia et al 2012). This represents a serious threat to humans (Shafei 2015).

The rate of heavy metal accumulation in fish meat depends on the species of fish, age, gender and location where the fish are cultivated (Thakur & Mhatre 2015). The

purpose of this study was to evaluate the rate of heavy metal accumulation in the fish meat cultivated in Cirata Dam namely *C. carpio*, *O. niloticus* and *P. hypophthalmus*.

Material and Method

Acquiring of samples. Fish samples are consist of three species of fish namely *C. carpio*, *O. niloticus* and *P. hypophthalmus*. The samples were taken from Floating Fish Net (FFN) located in three locations of Cirata Dam, West Java, Indonesia (Figure 1) namely; inlet area (FFN in Calincing block), middle (FFN in Maleber block) and outlet (FFN in Gandasoli block). The size of sampled fish was at a rage of 200-250 grams. The samples were transported to the laboratory alive. The distance from the sampling location to laboratory is approximately 30 Km.

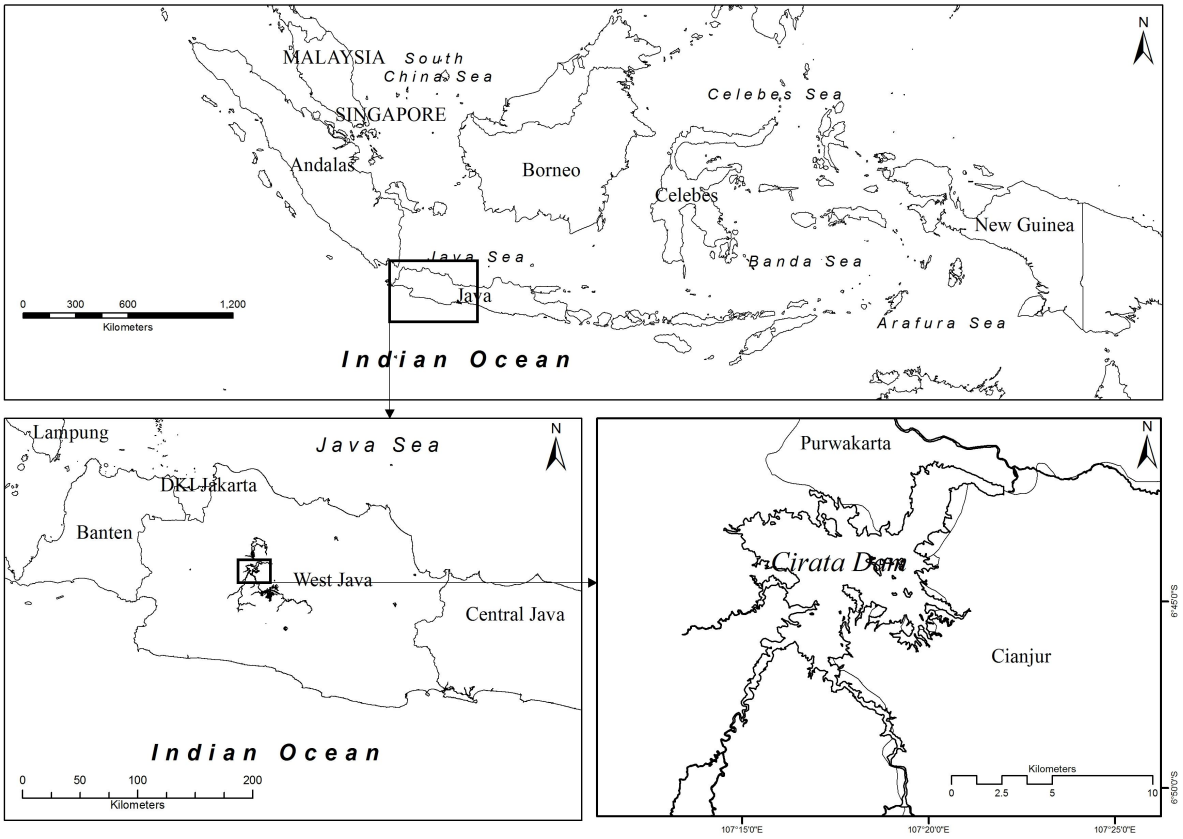

Figure 1. Map showing Cirata Dam.

Observations. Observations of heavy metal contamination found in fish flesh were carried out on Cd, Zn, Pb, and Hg. Observations of heavy metals is also carried out to the medium of water where fish are cultivated. Heavy metal testing was performed by AAS method (Atomic Absorption Spectrometry). The test procedure is based on the procedure of ISO 2354.5: 2011.

Data analysis. Data were analyzed descriptively and compared to the standard quality or the standard from FDA RI. Maximum standards allowed are as follows: up to Cd = 0.01 ppm, Zn = 40 ppm, Pb = 2 ppm and Hg = 0.03 ppm (Suyanto et al 2010).

Results. Levels of heavy metal concentrations in the fish cultivated in FFN of Cirata Dam are shown in Tables 1 & 3. Sampling was conducted at three locations, namely Cirata Dam namely FFN in Calincing block, FFN in Maleber block (inlet) and FFN in Gandasoli block (outlet).

Table 1

The test results of heavy metals in fish samples from Cilincing block (inlet)

Fish sample	*Pb (ppm)*	*Cd (ppm)*	*Zn (ppm)*	*Hg (ppm)*
C. carpio	3.001	0	11.808	0
O. niloticus	3.871	0	8.900	0
P. hypophthalmus	3.905	0	8.587	0
Standard quality*	2	0.01	40	0.03

* - FDA RI (Suyanto et al 2010).

Table 2

The test results of heavy metals in fish samples from Maleber block (middle)

Fish sample	*Pb (ppm)*	*Cd (ppm)*	*Zn (ppm)*	*Hg (ppm)*
C. carpio	2.641	0	12.926	0
O. niloticus	2.789	0	10.207	0
P. hypophthalmus	3.971	0	9.654	0
Standard quality *	2	0,01	40	0.03

* - FDA RI (Suyanto et al 2010).

Table 3

The test results of heavy metals in fish samples from Gandasoli block (outlet)

Fish sample	*Pb (ppm)*	*Cd (ppm)*	*Zn (ppm)*	*Hg (ppm)*
C. carpio	2.032	0	14.779	0
O. niloticus	2.504	0	10.212	0
P. hypophthalmus	3.683	0	7.399	0
Standard quality *	2	0.01	40	0.03

* - FDA RI (Suyanto et al 2010).

Heavy metals of Cd and Hg were not detected in any samples of fish meat from all FFN locations of Cirata Dam. Heavy metals of Pb and Zn were found in all samples of fish meat from all locations of FFN in Cirata Dam. Pb concentration in fish flesh samples ranged from 2.032 to 3.905 ppm, Zn concentration ranged from 7.399 to 14.779 ppm. Pb concentration exceeds the standard quality according to FDA RI in all sampled fish species. While the content of heavy metals Zn, Cd and Hg is still below the allowance standard quality. The result of the heavy metals concentration in the water where the fish are cultivated is shown in Table 4.

Table 4

The test results of heavy metals contamination in the water cultivation media of Cirata Dam

FFN Calincing block (Inlet)				*FFN Maleber block (Middle)*				*FFN Gandasoli block (Outlet)*			
Pb (ppm)	*Cd (ppm)*	*Zn (ppm)*	*Hg (ppm)*	*Pb (ppm)*	*Cd (ppm)*	*Zn (ppm)*	*Hg (ppm)*	*Pb (ppm)*	*Cd (ppm)*	*Zn (ppm)*	*Hg (ppm)*
0.042	0	0.057	0	0.042	0	0.085	0	0.021	0	0.060	0

Heavy metals of Cd and Hg were not detected in the water body at any location of FFN in Cirata Dam. Pb and Zn heavy metals were identified in the water body at any location of FFN in Cirata Dam. Pb contamination in the water body of Cirata Dam ranged from 0.021 to 0.042 ppm, while Zn concentration ranged from 0.057 to 0.085 ppm.

Discussion. The contamination of heavy metals into the flesh of fish can happen through penetration of the skin, food and gills (Fatima & Usmani 2013). Furthermore, heavy metals are absorbed by the blood and bind to blood proteins (Fatima et al 2013) and are distributed to all tissues of the organism and forms deposits (Thakur & Mhatre 2015). The rate of accumulation of heavy metals in fish tissue is strongly influenced by the concentration of metal, temperature, pH, salinity and dissolved oxygen in the water (Lakshman et al 2015). The rate of accumulation is also influenced by the periods of time of fish living in the contaminated water (Sthanadar et al 2013). These transfer factors of heavy metals from water into the flesh of the fish also affect the level of bio-accumulation (Praveena & Lin 2015).

Pb concentration in the flesh of consumption fish (*C. carpio*, *O. niloticus* and *P. hypophthalmus*) which were cultivated in FFN in Cirata Dam had exceeded the quality standards set by the FDA RI (Table 1). Pb does not have a significant biological function in the the fish organism but can be carcinogenic for humans who consume it (Ugokwe & Awobode 2015). If the fish meat, which contains of Pb is consumed by human, can not be metabolized and will be accumulated in the body (Yousafzai et al 2009). The capacity of the body tissue has limited ability to accommodate the accumulation of Pb and if it exceeds its capacity, it will cause a very serious illness (Praveena & Lin 2015). The excess of Pb on the human body can cause serious damage to the brain, heart, nervous system and red blood cells (Rao 2014). Moreover, it can lead to leukemia (Maiti & Banerjee 2012). Adult human blood has a normal capacity of Pb content of approximately 0,2 to 0,4 ppm; and if it already contains of 0.8 ppm, it can leads to anemia, liver damage, and convulsions (Sabir et al 2003).

Pb was more commonly found in *P. hypophthalmus* than *O. niloticus* and *C. carpio* in all location of FFN (Table 1). This result indicates that the species of fish is very influential on bio-accumulation of Pb. In addition, the rate of heavy metal accumulation in the flesh of the fish is also affected by its feeding behavior (habits) and the location of the cultivation site (Benzer et al 2013). The species of fish is related to its ability in the regulation of homeostasis (Irerhievwie & Akpoghelie 2015).

Based on Table 1, in addition to Pb, Zn also was found in the flesh of consumption fish cultivated in FFN Cirata Dam. Zn heavy metal contamination were found higher compared to Pb in every species of fish from each FFN cultivation location in Cirata Dam. This is due to contamination of Zn in the body of water where the fish are cultivated, and is higher than Pb contamination (Table 2). The existence of Zn in the water body in Cirata can be derived from the remaining unconsumed feed of the fish, the use of chemicals, or waste of engine oil discharged into the body of the dam water.

Zn is one of the essential metal for fish (Tapia et al 2012). Zn serves as a cofactor of enzymes involved in the metabolism of the fish and is involved in many biological processes (Irerhievwie & Akpoghelie 2015). Nevertheless, bio-accumulation of excessive Zn in the flesh of fish can cause toxicity, slow growth and reproductive disorders (Ntiforo et al 2012). In addition, this will slowly harm the humans who consume it because of biomagnification occurrence (Singare et al 2013). Excess of Zn in human body can cause dizziness, rapid fatigue and decrease of immune system functions (Ugokwe & Awobode 2015).

C. carpio accumulates more Zn than *P. hypophthalmus* and *O. niloticus* (Table 1). The high Zn accumulation in *C. carpio* can be derived from food sources. Zn is a mineral that is intentionally added to the fish feed (Tawwab et al 2013).

Conclusions. Heavy metals that were detected in the flesh of consumption fish (*C. carpio*, *O. niloticus* and *P. hypophthalmus*) cultivated in FFN of Cirata Dam were Pb and Zn, while Cd and Hg were found negative. Pb contained in fish meat observed was ranged from 2.0318 to 3.1553 ppm. This range exceeds the allowance of standard quality (2 ppm) of FDA RI. Zn contained in fish meat observed were ranged from 7.3985 to 10.4972 ppm which is still within the limits that do not exceed the standard quality (40 ppm) of FDA RI.

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