Copper and Lead Depuration in Nila Fish (*Oreocromis niloticus* L.)

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Abstract
Fresh water fish consumption in West Java Indonesia is high. There are two popular fresh water fish in West Java community namely Nile Tilapia or *Oreocromis niloticus* and carp or *Cyprinus carpio*. Most of the fresh water fish for West Java consumption was supplied by Saguling and Cirata reservoir fisheries. According to water quality monitoring, it was reveal that water quality in Cirata and Saguling were categorized Poor based on water standard Class I of Government Decree No. 82 Year 2001. Parameter that tends to be increased is heavy metal such as copper and lead. Fish has capability to uptake and depurate copper and lead from water which depend on the concentration and time of exposure. This study was aimed to investigate depuration time of copper and lead in Nile tilapia or *Oreochromis niloticus*. Uptake process was conducted in laboratory and followed by depuration process. Copper and Lead concentrations that used in uptake process were based on water quality standard and higher concentration in reservoir water quality monitoring. Copper and lead concentration in fish was calculated every 7 days during uptake process until 28 days and every day in depuration process for three days. For depuration process, additional samples of fish from Cirata and Saguling reservoir also analysed. According to the result, depuration process could not always decrease the Cu concentration because it was depend on several factors such as Cu concentration in the organ target, time of depuration, and the abnormalities of organ after accumulation process. Therefore Cu depuration need time more than three days. On the other hand lead concentration in depuration process decreased significantly in three days.

Keywords: *Oreochromis niloticus*, depuration, copper, lead

Introduction
Indonesian people like to eat a fresh water fish for their daily consumption. In West Java, Sundanese people usually put fresh water fish into the fresh water for several days to decrease odor from dirt before they cook it. The most popular fresh water fish are Nile Tilapia or *Oreocromis niloticus* and carp or *Cyprinus carpio*. These species were cultivated in several type of aquaculture such as private aquaculture or the reservoir. There are three reservoirs in West Java namely, Saguling, Cirata, and Jatiluhur. Most of the fresh water fish for West Java consumption was supplied by Saguling and Cirata reservoir fisheries (Oktaviatun, 2004). Previously these reservoirs were built as hydroelectric power supply, but later on they were used as tourism and fishery activities. Local community whose area was drowned by the built reservoirs allowed using the reservoir as aquaculture farming as compensation. As results, in these reservoirs many floating caged-fish aquaculture are occupied. This activity has change water quality of Saguling and Cirata reservoirs. In addition, these reservoirs also receive water from Citarum River which has polluted by industrial, domestic and agriculture activities.

According to water quality monitoring it was reveal that the quality of water in Saguling and Cirata reservoirs were categorized Poor based on water standard Class I of Government Decree No. 82 Year 2001. Parameters that tend to be higher are heavy metal such as copper

and lead. In 2004, concentration of copper and lead were still below the standard but it was increased every year. According to Kompas Newspaper (2008), copper concentration reach 0.04 and 0.11 mg/L in several sampling point of Cirata reservoir, this concentration above the standard which should be below 0.02 mg/L. On the other hand, Lead concentration also reached permission limit which is 0.03 mg/L. Concentration heavy metal in Citarum river also tend to be higher because the rapid change of the land used as industrial and resident area. According to Citarum river water quality monitoring in 2001 only 1.4% of total 146 sampling location fulfil the requirements river water quality standard in Government of West Java Province Decree No.39/2000 (Wangsaatmaja, 2001).

Fish has capability to uptake Cu and Pb from the water and bioaccumulated. This process depends on several factors such as the concentrations and time of exposure. Cu and Pb are lipophilic so can be easily bound in fatty tissue of fish even though fish has capacity to depurate (transfer or remove) the metal to surrounding environment (water) (EPA, 1996). Capability to accumulate the metal, especially Cu and Lead, has potential risk to upper tropic level such as human. Higher Cu accumulation could affect human health such as in homeostatic control (Harris, 1991). While Pb accumulation could effect gastric and will accumulate in bone for 30-40 years (US EPA: 2004, Darmono: 1995)

The aims of study are to investigate time of *depuration* of copper and lead concentration from the most dominant fish in Saguling and Cirata reservoir base on the local custom of Sundanese pople. Fisherman in Saguling and Cirata reservoirs grow Nile Tilapia or *Oreocromis niloticus* and carp or *Cyprinus carpio*. The research was conducted in several studies. The first study investigated lead and copper depuration in laboratory while the second study investigated lead depuration process in Cirata and Saguling fish. The results would be use as recommendation for community and further studies.

Material and Methods

The research was conducted in laboratory and consists of two step, firstly, metal uptake process than continue with the depuration process. *O. niloticus* were obtained from Ciherang fish hatchery both male and female at 4-5 weeks. Acclimatization was conducted for 15 days and 28 days for uptake process. For copper depuration studies, the fish were divided into three groups, one group for control and two groups for treatment (duplo). Each group was placed into flow-trough tank with flow rate 60ml/min. Stock solution was made using $CuSO_4.5H_2O$ (SMEWW, 2001) and dechlorinated watertap for the dilution water. Cu concentration observed were 0.002;0.02; and 0.04 mg/L. In the other hand, lead depuration process used semi static tank and stock solution was made using $Pb(NO_3)_2$ (US EPA, 2001). Pb concentration observed were 0.03 mg/L and 1 mg/L according to Government Regulation No. 82/2001 for water quality standard.

The studies also conducted in field scale using *O. niloticus* from the Saguling and Cirata reservoirs. The fish that ready to harvest (3-4 month) were collected and moved in to aquarium supplied with aerated dechlorinated tapwater from PDAM, Bandung. There were to different volume of water that was used in depuration process, 9 liters and 18 liters of water. Lead concentration of fish in depuration process was observed in day 0 and day 3.

Indonesia National Standard (SNI) 01-2362-1991 and 01-2368-1991 were used to analyse Cu and Pb concentration in fish and water samples. Wet and dry weight of fish sample was

calculated, using 2-3 grams of fish sample (dry weight) which was destructed using H_2NO_3 pa, added with H_2O_2 and aquadest until 25 ml of volume. All sample was analyzed by AAS and calculated to obtain copper and lead concentration in fish.

Results and Discussion

Cu concentration in fish can be show in Fig.1. For Cu concentration of 0.002 mg/L, Cu uptake into total body concentration was increased at day-7, declined at day-14 and raised again in day-21 and 28. Different pattern was found at 0.02 mg/L and 0.04 mg/L Cu concentration which total body concentration rose at day-14 and 21 and declined at day 21 and 28. Even though Cu concentration in total body fluctuated every week for each concentration of treatment, at the end of process (day-28) Cu concentration was increased from day-0 during accumulation process. The concentration of Cu uptake followed an order as : 0.04 mg/L > 0.02 mg/L > 0.002 mg/L.

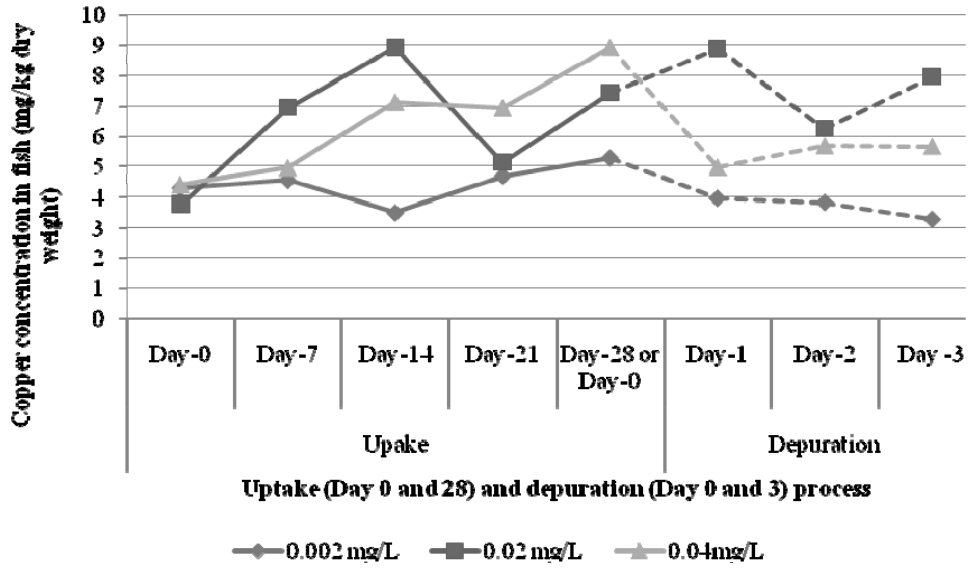

Figure 1. Uptake and Depuration of copper in fish with different copper concentration in water.

In depuration process, 0.002 and 0.04 mg/L treatment have similar pattern. Concentration of copper in fish in first day significantly decreased but increased in second day and finally decreased for 0.002 mg/L treatment and increased for 0.04 mg/L. Generally copper concentration in fish in 0.002 and 0.04 mg/L treatment decreased on day-3. On the other hand, 0.02 mg/L treatment had fluctuated pattern, copper concentration on day-3 higher than copper concentration on day-0

Fluctuated of Cu concentration in fish during depuration process interfered by several factors. Cu concentration measured was the total concentration which consist of Cu concentration each target organ. Kristijarti (2006) state that Cu concentration in liver and gill during depuration process (day-1 and day-3) still high, but in the muscle was relatively stable. Arellano et al (2000) conducted his research exposed *Solea senegalensis* and *Halobatracus didactylus* with Cu 100µg Cu+/L on the organ target and the results showed that there was decrease in copper levels in liver on day-2 and 4 and day-4 in gill during depuration process,

but in the muscle there was no significant differences between accumulation and depuration process.

The other factors that influenced depuration process were detoxification of Cu by liver and gill that plays role in detoxifications as well as storage (Kotze et all, 1999). This organ could be dysfunction because of internal Cu concentration exceeded the capacity and capability of the liver and gill to detoxicate the metal. According to Kristijarti (2006) there were abnormalities of organ tissue especially in liver and gill tissue at the end of accumulation process. Depuration process cannot always decrease and recover this abnormality. This condition also found in Cerqueira dan Fernandes (2002) research, which investigated the changed in *Prochilodus schofa* (tropical fish) gill tissue and in blood responses after 96-h Cu exposure and transfer to clean water. Restoration of gill structure was slow, with no tissue improvements in the first 2 days in clean water from the 7th to the 15th days. The recovery of gill tissue began to become evident, with complete recovery occurring on the 45th day in clean water.

Uptake process for lead in fish show different pattern than copper uptake (Fig.2). Lead uptake in 1 mg/L significantly increased every 7 days until 28 days while in 0.03 mg/L treatment lead concentration in fish increased slowly. In depuration process, lead concentration was significantly decreased in both treatments on day-1 and slowly decreased until day-3. Lead concentration in depuration process on day-3 was decrease more than 90% for 0.03 mg/L treatment and 86% for 1 mg/L treatment.

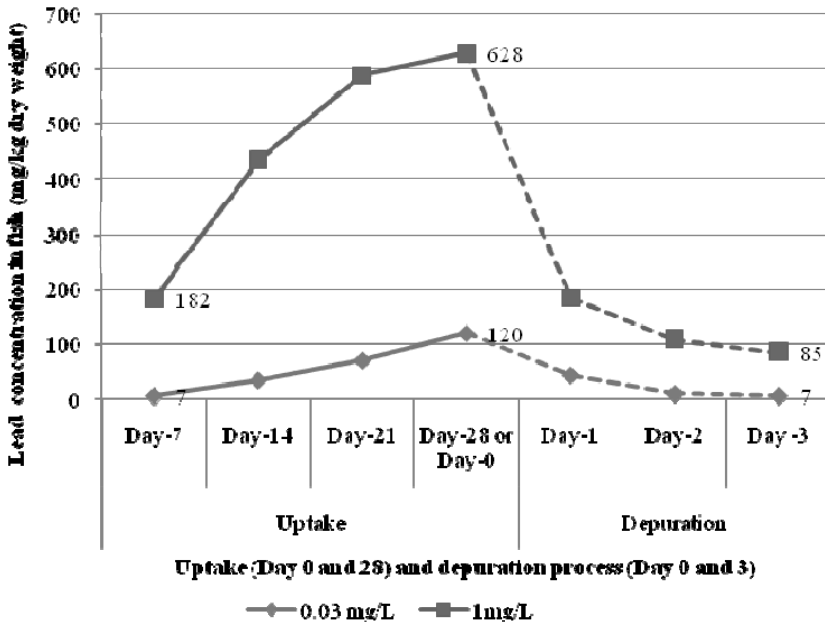

Figure 2. Uptake and Depuration of lead in fish with different lead concentration in water.

Fish from Saguling and Cirata was taken as a sample for uptake process. Lead concentration in Saguling fish was higher than Cirata Fish because Saguling reservoir water quality was poorer than water quality in Cirata reservoir. Depuration process was conducted in laboratory using un-chlorinated tap water. Lead concentration in fish during depuration process can be showed in Fig.3. Lead concentrations in fish were slowly decreased during depuration process in 9L tank (1fish per litre) for both Saguling and Cirata reservoir. In the contrary, lead

concentration in fish at 18 L (1fish per 2litre) tank tend to increased on day-1 and significantly decreased on day-2 and unmeasured in day-3.

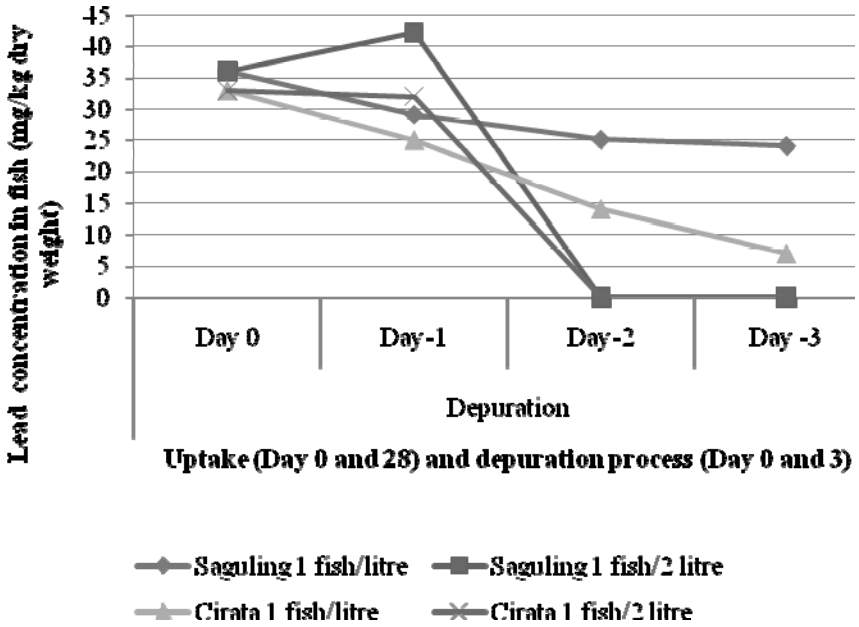

Figure 3. Lead Depuration in Saguling and Cirata fish.

Both studies showed that Copper and Lead has different mechanism in uptake and depuration process for *O. niloticus*. Copper concentration in fish tends to has fluctuated pattern during uptake and depuration process with different concentration of treatment while Pb has typical pattern in different treatment similar pattern. Cu will accumulate in gills and liver while Pb will accumulate in fish skin (Octaviatun, 2004). In depuration process day-3, copper concentration still high and the efficiency of depuration below 50% while lead depuration has higher efficiency (above 80%). As mention before, depuration process for Cu depend on several conditions such as Cu concentration in the organ target, time of depuration, and the abnormalities of organ (liver and gills) after accumulation process. The studies also showed that copper need longer time than lead in depuration process. Therefore, community should keep the fish more than 3 days in unpolluted water to reduce copper concentration in fish before they consume it while time to reduce lead concentration in fish 3 days would be effective.

However, even though fish has capacity to depurate copper and lead by replace it to the unpolluted water, further research should be conducted especially in field scale and find out water parameters such as pH, hardness, combination pH-hardness or other combination of parameter that could effectively reduce Cu concentration in fish during depuration process

Conclusion

Copper and lead has different mechanism in uptake and depuration process. Copper concentration in fish tends to has fluctuated pattern while lead has typical pattern in different concentration of treatment.

Depuration process could not always decrease the Cu concentration because it depend on several condition such as Cu concentration in the organ target, time of depuration, and the abnormalities of organ after accumulation process. Therefore Cu depuration need time more than three days.

Depuration process can significantly decrease the Pb concentration in fish in three days for both in laboratory studies and field studies

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