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Effect of tannery wastewater exposure on chromium detected in the gill of *oreochromis niloticus*

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Abstract. This study aims to analyze the bioaccumulation of chromium (Chromium) contained in the gill of *Oreochromis niloticus* L. due to exposure to wastewater from a leather tanning industry in West Sumatra. Tilapia was exposed to the wastewater for 30 days, and Chromium concentration was measured in the gill of tilapia with Atomic Absorption Spectrophotometer (AAS). The variation of wastewater used was 1.85% and 3.69% of the LC-50 96 hour. The results showed that the BCF value was <100 for both variations. It can be concluded that *Oreochromis niloticus* L. has low bioaccumulation of chromium contained in tannery wastewater.

1. Introduction

The leather tanning industry utilizes chromium as a tanner; this element is classified as a toxic substance. Chromium is difficult to degrade naturally, can be toxic to fish and *another organism* (Edwin, Ihsan, & Pratiwi, 2017; Ihsan, Edwin, Husni, & Rukmana, 2018), have a long half-life especially in the body of aquatic biota (Moore and Ramamoorthy, 1984). Heavy metal pollution is very detrimental to the fish physically and physiologically, and bioaccumulate in the fish tissue as its increase with the increasing of weight and age (Irianto, 2005). Bioaccumulation of chemicals in water is an important criterion in evaluating the ecology and level of pollution of an environment (Ivanciuc et al., 2006). The ability of fish to accumulate heavy metal is expressed by bioconcentration factor (BCF). BCF can be used to determine the ability of living things to absorb and store pollutants (Connell and Miller, 2006). Gills are an important organ to help it breathe. Polluted water environment for fish may damaged the gills of fish and worsen their health performance.

One of the biggest leather tanning industries in West Sumatra has issued an effluent above the quality standard even after wastewater treatment, where the wastewater is discharged into the river. One of the main species lives in the river is *Oreochromis niloticus*, which receives direct impacts from the tannery wastewater industry. It has an economic value as community catch the fish to be consumed. *O. niloticus* has widespread because it is euryhaline (Agah et al., 2009). It lives in various freshwater habitats, is tolerant of temperature fluctuations and Dissolved Oxygen (DO), resistant to diseases, and can utilize low protein feed. Also, it can be maintained in the laboratory (Muhammad, 2002).

Thus, the objectives of this research were to analyze the bioaccumulation of chromium in the gills of fish as well as calculating the bioconcentration factor of chromium in the gills of *O. niloticus*.



2. Materials and Method

Experiment was carried out on *O. niloticus* which were obtained from fish nurseries in the Bangek River, Padang City. Acclimatization was carried out for seven days (APHA, 2014) before fish being exposed to wastewater for experiments. Acclimatization was carried out to adapt the fish to the physical state of the laboratory (APHA, 2014). Aquariums were equipped with aerators and fish are given food in the form of fish pellets three times a day. During acclimatization, fish were also measured for environmental conditions such as DO, pH, and temperature.

The aquarium consisted of tannery wastewater which was divided into three different concentrations, and three aquariums were used to see the bioconcentration of chromium in fish gill tissue in each variation of exposure. The concentration used refers to the LC50 value in the previous study of 25.85% (Edwin, 2007) of tanning skin wastewater, which was 1/14 LC50-96 hours (1.85%) and 1/7 LC50-96 hours (3.69 %) (Halappa and David, 2009). A control experiment was also carried out with no wastewater being exposed to the aquarium. Initial chromium concentration was 1 mg/L, Biochemical Oxygen Demand (BOD) of 53.27 mg/L, Chemical Oxygen Demand (COD) of 113.2 mg/L, Total Suspended Solid (TSS) of 64 mg/L, fat and grease of 11.44 mg/L, Ammonia of 1.94 mg/L, sulphide of 1.23 mg/L and pH of 9.4. Each aquarium contains five a fish (*O. niloticus*) with a size of 10-13 cm (Vinodhini and Narayanan, 2008). In the main experiments, fish were exposed to wastewater for 30 days (Meena et al., 2016). Fish samples were dissected for gill organ harvesting on day 0, 10th, 20th day and 30th day of observation. Fish caught randomly from the aquarium, then destruction test was carried, and Chromium metal concentration on gill organs was measured by Atomic Absorption Spectroscopy (AAS). After that, BCF values are carried out to the equation 2.1 (LaGrega et al., 2001). The significance of wastewater concentration to chromium measured in gill tissue of fish was also calculated by using one-way ANOVA.

$$BCF = \frac{C_{\text{organism}}}{C_{\text{media}}}$$

Information:

C_{organism} = concentration of pollutants in organisms (ppm)

C_{water} = concentration of pollutants in water (ppm)

BCF value category namely:

BCF > 1000 : very accumulative

BCF 100-1000 : moderate accumulative

BCF < 100 : low accumulative

3. Results and Discussion

Before conducting bioaccumulation tests, acclimatization of test animals was carried out including measurements of Dissolved Oxygen (DO), pH and temperature were carried out. The results of these environmental parameters have been found to support the survival of tilapia based on USEPA (2002). The results showed that environmental quality meets the range requirements suitable for *O. niloticus* life. DO levels at each concentration variation ranged from 6.9 to 8.4 mg / l and there were no significant changes during bioaccumulation testing. The pH level in each concentration variation was 7.1-8.3, and there was no significant changes during the bioaccumulation test. The temperature of the was ranged between 25.4-27.9°C. Observational data showed that pH, DO, and water temperature during the experiments were still in the range recommended for fish environment.

The measurement of chromium concentration in the gill of tilapia can be seen in figure 1, and figure 2 while the results of BCF calculation in the gill organs of tilapia is showed in figure 3. The concentration of chromium in fish organs is higher as the length of exposure time, while nearly zero chromium were obtained in the control experiment. Significance test of chromium in Gill tissue vs test water was obtained <0.05, which means chromium found in gill experiments were positively contributed by tannery wastewater contained in the test water. The high concentration of chromium in the body of fish is due to the accumulative nature of aquatic organisms. Aquatic organisms take heavy

metals from water bodies or sediments and concentrate them into their bodies up to 100-1000 times greater than the environment (Rahman et al., 2012).

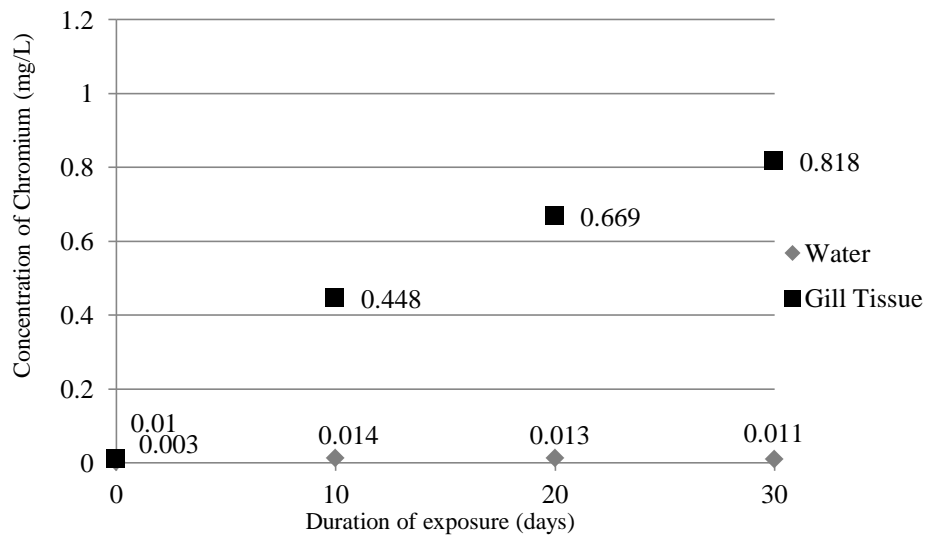


Figure 1. The concentration of chromium in water and fish gills in 1.85% wastewater exposure

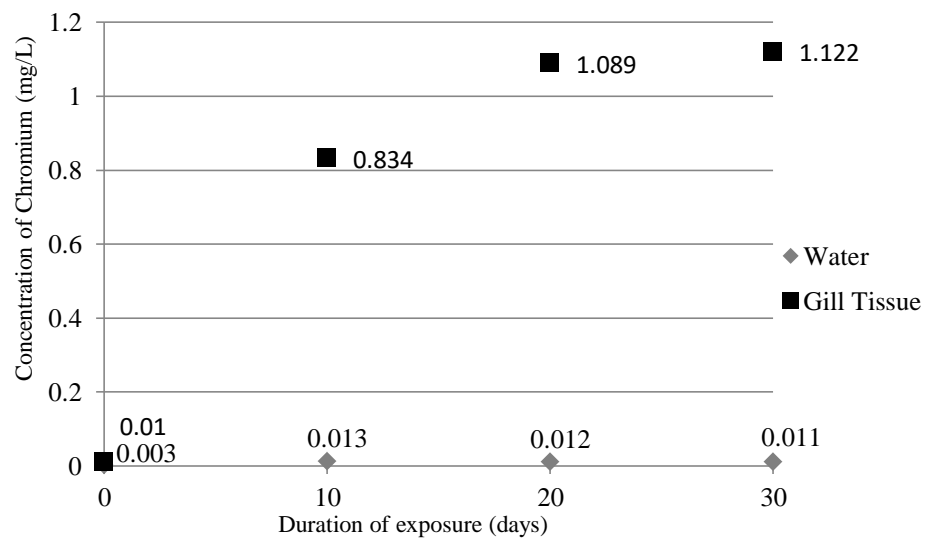


Figure 2. The concentration of chromium in water and fish gills in 3.69% wastewater exposure

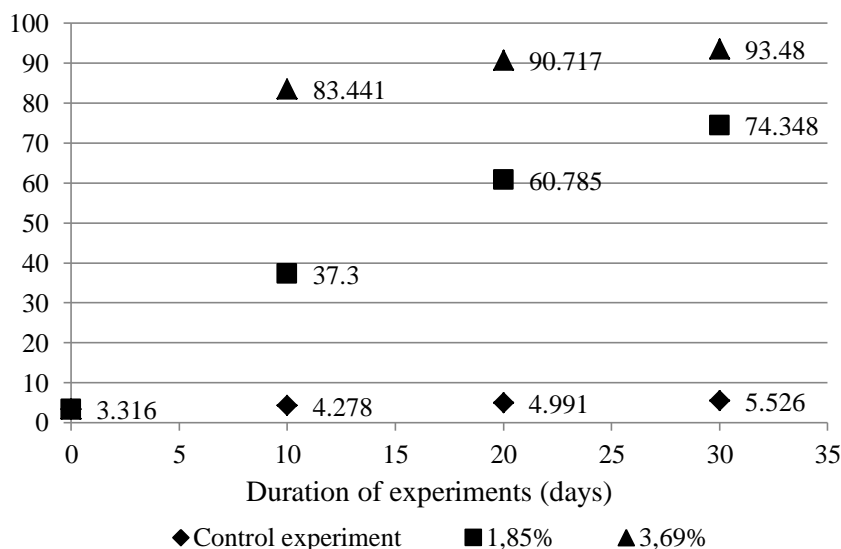


Figure 3. Bioaccumulation factor obtained from experiment

Clark (1986) stated that gills are the first organ to experience direct contact with water. Gills are very sensitive to the influence of heavy metals. Gills not only absorb oxygen quickly but also filter water, so that metals dissolved in water, including chromium, can enter the body through the gills.

Bioconcentration factor value was at a value of <100, meaning the ability of chromium bioaccumulation by *O. niloticus* in the gills during sublethal exposure to 30 days of tanning industry wastewater is in the low accumulative category. Bebianno et al. (2004) stated metal accumulation in gills due to direct metal contact with gills during respiration. High accumulation of heavy metals in the gills is caused by the epithelium in the gills which is the thinnest part of all the organs where the metal passes. The metal accumulation in the gills affects the ability of *O. niloticus* in the rate of oxygen consumption (Edwin, 2007).

4. Conclusion

The concentration of chromium in water and the gills of *O. niloticus* was higher as the length of exposure time and the higher chromium concentration of tanning wastewater. The bioconcentration factor values obtained ranged between 3,316-93,480 which means low accumulation ability to accumulate chromium in the gills organ of the fish.

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