Effect of tannery wastewater exposure on chromium detected in the meat of tilapia (*Oreochromis niloticus* L)

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Abstract. This study aimed to analyze the bioaccumulation of chromium (Cr) in the meat of tilapia (*Oreochromis niloticus* L) due to exposure to tannery wastewater. The wastewater concentration variations were 1.85% and 3.69% of the LC50 96-h. The study was carried out in triples, seven days of acclimatization, and 30 days of observation (exposed to wastewater). The measurement of Cr using Atomic Absorption Spectrophotometry (AAS) and calculation of BCF states the level of bioaccumulation in fish meat. The result showed the BCF value at a concentration of 1.85%, and 3.69% ranged 2.667-40.984, and 2.667-85.651 consecutively. It concluded that tilapia has a low accumulation rate.

1. Introduction

Chromium (Cr) was once considered a hazardous heavy metal; nonetheless, it is now used as a tanner in the leather tanning industry. Cr was difficult to depreciate naturally, and it was potentially toxic to fish and other species. [1,2]. It has a long half-life, especially in the body of aquatic biota [3]. Heavy metal exposure was physically and physiologically harmful to the fish, and it bioaccumulated in the fish's body as it grew older and heavier. [4]. Chemical bioaccumulation in water was a critical criterion for assessing an environment's ecology and pollution level. [5]. The ability of fish to collect heavy metals was measured by the bioconcentration factor (BCF). The BCF can be used to determine the biota's ability to absorb and retain contaminants. [6]. Toxicants absorbed by the gills or skin, then spread throughout the body through the circulation, resulting in the accumulation of heavy metals in the meat, are the source of metal accumulation in fish meat. In addition, fish meat is a good source of protein for humans. Fish meat can be harmed by dirty water, and the food cycle might be disrupted. [7].

Despite treatment, one of the largest tannery industries in West Sumatra, Indonesia, has discharged wastewater that exceeds the quality threshold. The effluent was released into the river by this industry. Tilapia (*Oreochromis niloticus* L), one of the river's most important species, was fed tannery wastewater directly. Tilapia has monetary worth since it is consumed by the community. This fish can be found in a variety of freshwater environments. It was not only widely distributed (because of its euryhaline nature) but also temperature and Dissolved Oxygen (DO) tolerant, unaffected by diseases, and able to eat a low-protein diet. The researchers were able to keep tilapia in the lab [8,9]. As a result, the goal of this study was to look into Cr bioaccumulation and compute the Cr bioconcentration factor in tilapia meat.
2. Methodology

The experimental treatment of tilapia is the same as the research of Edwin et al. [10]. We obtained tilapia from fish nurseries in the Bangek River, Padang City, West Sumatra, and acclimatized them seven days before the wastewater exposed fish for experiments. We put the tilapia into the aquarium (equipped with an aerator), then fed the fish three times a day (pellets). We also collected DO, pH, and temperature data for that seven days.

The aquarium consists of three different concentrations of tannery wastewater. We use three aquariums to observe the biological concentration of Cr in fish under each exposure change. The concentration used refers to the LC50 value of 25.85% [11] tanning wastewater in the previous study, which is 1/14 LC50-96 hours (1.85%) and 1/7 LC50-96 hours (3.69%) [12]. We conducted control experiments also, and no wastewater was exposed to the aquarium. The initial Cr concentration was 1 mg/l, the biochemical oxygen demand (BOD) was 53.27 mg/l, the chemical oxygen demand (COD) was 113.2 mg/l, the total suspended solids (TSS) was 64 mg/l, fat and oil It was 11.44 mg/l, ammonia was 1.94 mg/l, sulfide was 1.23 mg/l, and the pH was 9.4. Each aquarium contained five tilapias of 10 – 13 cm [13]. In the main experiment, wastewater exposed fish for 30 days. [14]. We dissected tilapia samples to harvest meat on the 0th, 10th, 20th, and 30th days of observation. Randomly catch fish from the aquarium, conduct a destruction test, and measure the Cr metal concentration on the fish meat using atomic absorption spectroscopy (AAS). After that, the BCF value is calculated as Equation 1 [6]. One-way analysis of variance (ANOVA) was also used to calculate the significance of wastewater concentration to Cr in fish.

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BCF = \frac{C_{\text{organism}}}{C_{\text{water}}}
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3. Results and discussion

Before the bioaccumulation test, the test animals were acclimatized, including measuring dissolved oxygen (DO), pH, and temperature. Based on USEPA data, we discovered that these environmental conditions support tilapia life (2002). The findings reveal that the environmental quality matches the needs of tilapia in order for them to live. The DO level ranged from 6.9 to 8.4 mg/L for each concentration shift during the bioaccumulation test, with no significant change. The pH value under each concentration change is between 7.1 and 8.3, and there is no noticeable change in the bioaccumulation test. The temperature range is between 25.4-27.9°C. Observational data show that the DO, pH, and water temperature during the experiment are still within the recommended range of fish environment.

![Figure 1](image_url). The concentration of chromium in water and fish meat (1.85% exposure).
Figures 1 and 2 show the measurement of Cr level in tilapia meat. In addition, Figure 3 illustrates the BCF calculation results for tilapia. The Cr concentration in fish organs increased with exposure time, while the Cr content in the control experiment was almost zero. The significance test of Cr in meat vs test water, which yielded a result of 0.05, indicates that the test water contains tannery effluent, which contributes to the Cr discovered in the meat experiment. The buildup of aquatic organisms is responsible for the high concentration of Cr in fish. Xenobiotics (e.g., heavy metals, pesticides) are obtained by aquatic organisms from water bodies or sediments and are concentrated 100-1000 times higher than the environment. [15–17].

The Cr concentration in tilapia meat at the beginning of the study (day 0) was 0.008 ± 0.000 mg/kg in three variations, while the concentration of Cr in tilapia meat after the study (30th day) of 0.013±0.003 mg/kg (control), 0.492±0.010 mg/kg (1.85%) and 1.028±0.017 mg/kg (3.69%). In meat with a concentration of 3.69% wastewater on the 30th day, we observed the highest Cr concentration. Based on
the Food and Agriculture Organization/FAO (1983), the quality standard for Cr in fish meat is 1 mg/kg. Compared with Cr concentration in control and 1.85%, Cr concentration in meat is still below the specified quality standard. In comparison, at a concentration of 3.69% on the 30th day of exposure, Cr concentration has exceeded the specified quality standard.

The BCF value in tilapia meat at the beginning of the experiment (day 0) was 2.667 ± 0.000 for all variations, while the BCF value in tilapia meat after the 30th day was 4.019±0.870 (control); 40.984±0.798 (1.85%) and 85.651±1.381 (3.69%). The bioconcentration factor value was at <100. It means the capability of chromium bioaccumulation by meat tilapia (throughout sublethal of tannery wastewater exposure to 30 days) is in the low accumulative category.

Although it is low, Cr in tilapia still has to be watched out for because of the cumulative nature of the heavy metal itself. If consumed continuously for an extended period, it will cause chronic poisoning. Cr's chronic poisoning caused by Cr causes damage to the fish body's physiological systems such as the kidneys, lungs, heart, and blood circulation system [10,18].

4. Conclusion
The Cr concentration in tilapia (Oreochromis niloticus L) meat increased as exposure time and tannery effluent Cr concentrations increased. The obtained bioconcentration factor value ranges from 4.019 to 85.651, indicating that fish can only accumulate Cr.

References
[1] Ihsan T, Edwin T and Vitri RY 2014 Jur Dampak 14(2) 98-103
[2] Ihsan T, Edwin T, Zupit JR, Ananda SF and Nofrita 2021 IOP Conf Ser Mater Sci Eng 1041, 1
[3] Ali H, Khan E and Ilahi I 2019 J Chem 2019 1-14
[4] Yousif R, Choudhary M I, Ahmed S and Ahmed Q 2021 Nusant Biosci 13(1) 73-84
[5] Ivanciuc T, Ivanciuc O and Klein D J 2006 Mol Divers 10(2) 133-45
[6] Milošković A, Dojcinovic B, Đuretanović SK, Kojadinović NR, Radenković M, Milošević D and Simic VM 2016 Environ Sci Pollut Res 23(10) 9918-33
[7] Bosch A, O’Neill B, Sigge G and Kerwath S 2015 J Sci Food Agric 96 32-48
[8] Agah H, Leermakers M, Elskens M, Fatemi S M R and Baeyens W 2008 Environ Monit Assess 157 499-514
[9] Charo HK 2006 Selection for Growth of Nile tilapia (Oreochromis niloticus L.) in Low Input Environments PhD Thesis
[10] Edwin T, Ihsan T and Tamsin H T 2019 IOP Conf Ser Mater Sci Eng 602 1
[11] Edwin T, Ihsan T, Putra M A, and Guspariani G 2018 Int J Adv Res 6(5) 742-8
[12] Halappa R and David M 2009 Turkish J Fish Aquat Sci 9(2) 233-8
[13] Vinodhini R and Narayanan M 2008 Int J Environ Sci Technol 5(2) 179-82
[14] Meena R, Chandrakala R and Indra N 2017 Int J Appl Res 3(1) 468-70
[15] Ihsan T, Edwin T, Paramita D and Frimeli N 2021 IOP Conf Ser Earth Environ Sci 623 1
[16] Ihsan T, Edwin T and Yanti RD, Nat Environ Pollut Technol 18(4) 1399-403
[17] Kaoud H A 2015 Eur J Acad 2(9) 23-6
[18] Kortei N K, Heymann M E, Essuman E K, Kpodo F, Lokpo S Y and Owusu N 2020 Toxicol Reports 7 360-9