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Cadmium Contents in Water and Tilapia (*Oreochromis niloticus*) in Telaga Tunjung Dam, Tabanan, Bali

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Abstract. Agricultural activities around the Telaga Tunjung Dam also have the potential for the entry of heavy metal cadmium (Cd) into the water and accumulate in aquatic organisms, especially in fish. The presence of cadmium (Cd) in water and fish that exceeds the limit can have a negative impact on human health. The purpose of this study was to determine the cadmium (Cd) content in water and tilapia that had been caught in the Telaga Tunjung Dam. The study was conducted at the Telaga Tunjung Dam from February to March 2023. The research method used was a comparative descriptive method. The highest cadmium (Cd) content in water was detected at station IV, which was 0.078 mg/l. Cadmium (Cd) content was also detected in tilapia liver at 1.043 mg/kg, and the highest cadmium (Cd) content was detected in tilapia meat at 1.541 mg/kg. These values have exceeded the quality standard threshold set by Bali Governor Regulation No. 8 of 2007 (0.01 mg/l), and SNI 7387:2009 for the fish and processed fish category (0.1 mg/kg). Meanwhile, the results of measurements of dissolved oxygen (DO), temperature and pH are still optimal and support the life of aquatic organisms.

Keywords: Cadmium Content; Tilapia (*Oreochromis niloticus*); Waters; Telaga Tunjung Dam

I. INTRODUCTION

Telaga Tunjung Dam is located in Timpag Village, Kerambitan District, Tabanan Regency, Bali Province. The area of this dam reaches 16.5 Ha with a storage volume of 1,261,000 m³ [1]. This dam was built for industrial purposes, irrigation and tourism development. The Yeh Mawa River and Yeh Ho River are rivers that flow into the Telaga Tunjung Dam. Around the upstream of the dam there are agricultural, plantation and residential areas. Agricultural activities begin with land and seed preparation, fertilization, pest control using pesticides, weeding, and harvesting [2]. Increased agricultural activities can increase the cadmium (Cd) content in water and biota in the Telaga Tunjung Dam. Cadmium (Cd) is often used as a co-ingredient in the manufacture of fertilizers and pesticides of the insecticide and fungsides groups [3]. Heavy metals contained in these fertilizers, such as cadmium (Cd), have the potential to damage the ecosystem if these heavy metals enter the waters and exceed the threshold [4]. According to Roechan in 1982, TSP (Triple Super Phosphate) fertilizer contains heavy metal cadmium (Cd) levels ranging from 1-170 mg/kg.

If heavy metal cadmium (Cd) content that exceeds the threshold in water, especially in aquatic biota in Telaga Tunjung Dam, such as in fish, if consumed by humans it can have a negative impact on human health. These impacts include damage to the lungs, liver, high blood pressure, disorders of the kidney system and digestive glands, causing brittle bones, breast cancer, and death. While the negative impacts on fish are changes in activity, impacts on abnormal growth to death [5].

Cadmium (Cd) undergoes biotransformation and bioaccumulation in living organisms (plants, animals and humans). In the body of aquatic organism, the amount of accumulated heavy metal will continue to increase in the food chain (biomagnification) [6]. Further research is needed regarding the content of heavy metal cadmium (Cd) in Telaga Tunjung. Tabanan, Bali in biomonitoring efforts to prevent adverse impacts on aquatic biota and human health, this is because the content of cadmium in very small concentrations has high toxicity.

II. METHODS

Time and Location

This research was conducted in February-March 2023. This research was located at Telaga Tunjung Dam, Tabanan, Bali. The purposive sampling method was used to determine four observation station points in sampling.

Station I is the estuary of the Yeh Mawa River Dam, station II is the estuary of the Yeh Hoo River Dam, station III is the middle part of the dam, and station IV is the estuary of the dam. Purposive sampling is a technique for determining and taking samples determined by researchers based on certain considerations [7]. Analysis of heavy metal content in fish was carried out at the Udayana University at Analysis Laboratory, while the measurement of water quality parameters was carried out in situ.

Methods

Water sampling was carried out using the composite sampling technique. The composite sampling technique involves taking water samples from several collection points which are then combined, mixed, and stirred until evenly distributed before analysis. Water sampling was carried out at a depth of 5 meters. Measurement of Dissolved Oxygen (DO) temperature, and pH was carried out in situ.

Three fish Tilapia (*Oreochromis niloticus*) samples were taken from four stations. After being taken, the fish were cleaned and stored in a cool box containing ice cubes at a temperature of 4℃ to maintain the freshness of the fish. The fish samples were taken to the laboratory for analysis of cadmium content.

Research Parameters

This study used a comparative descriptive method in the analysis of cadmium (Cd) content in water, liver, and meat of Tilapia (*Oreocromis niloticus*). The descriptive method was used to collect, classify, analyze, and interpret data, while the comparative method was used to compare data. In the analysis of water quality in the Telaga Tunjung Dam, cadmium (Cd) content data in water will be compared with the threshold set by Bali Governor Regulation No. 8/2007 concerning Water Quality Management and Water Pollution Control.

Class II criteria for water have a maximum cadmium (Cd) content of 0.01 mg/L. Furthermore, the content of heavy metal cadmium (Cd) in the meat and liver of Tilapia will be compared with the standard threshold value set by the Indonesian National Standard (SNI) 7387:2009. The SNI sets the limit value of cadmium (Cd) in fish meat and liver at 0.1 mg/kg.

III. RESULTS AND DISCUSSION

Cadmium (Cd) Content in Water in Telaga Tunjung Dam

In this study, Cadmium (Cd) content detected at station II (upstream of the Yeh Hoo River) was 0.038 mg/L and the highest cadmium (Cd) content was detected at station IV (dam outlet) was 0.078 mg/l. Cadmium (Cd) content was not detected at station I (upstream of the Yeh Mawa River) and station III (middle of the dam) was not detected or below the detection limit of AAS (Atomic Absorption Spectrophotometer) (Figure 1).

The highest content of heavy metal Cadmium (Cd) was found at station IV (0.078 mg/l). This is because station IV is the outlet of the dam where water that potentially contains cadmium flows from the inlet and accumulates at the dam outlet. The increase in cadmium contamination in water samples was caused by sampling carried out on the central reservoir water flow or the last reservoir of all river water flows, so that the cadmium contained in the river will accumulate in the central reservoir flow [8].

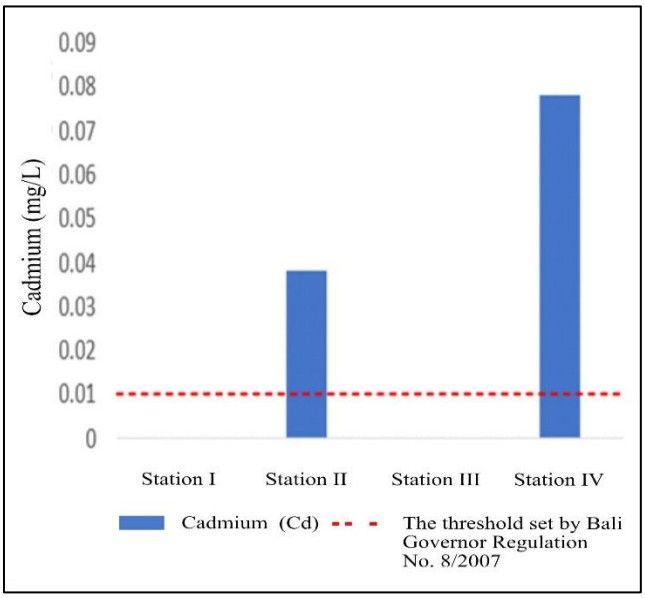

Fig. 1. Cadmium (Cd) Content in Water Telaga Tunjung Dam, Bali

The cadmium (Cd) content was found at two stations, station II which was measured at 0.038 mg/l and station II was measured at 0.078 mg/l showed that both stations Cd content had exceeded the maximum limit of heavy metal contamination required by Bali Governor Regulation No. 8 of 2007 with a maximum limit set at 0.01 mg/l.

Cadmium (Cd) Content in Liver and Meat of Tilapia at Telaga Tunjung Dam

The cadmium (Cd) content detected in tilapia liver was 1.043 mg/kg and tilapia meat was 1.541 mg/kg (Figure 2). This value exceeds the standard threshold set by SNI 7387:2009 in the food category of 0.1 mg/kg.

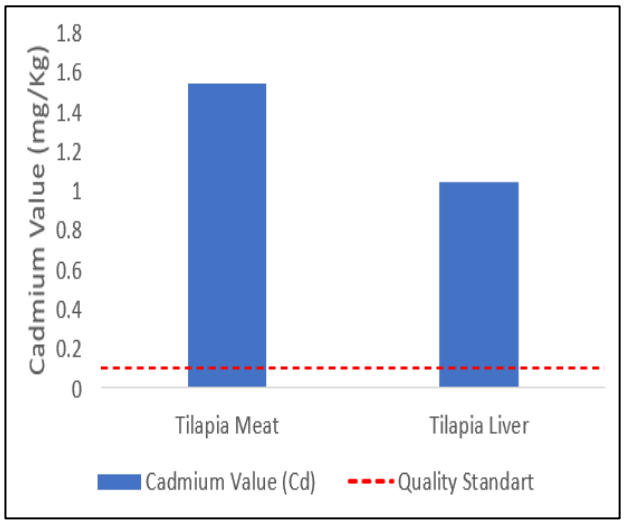

Fig. 2. Cadmium (Cd) Content in Tilapia Liver and Tilapia Meat in Telaga Tunjung Dam, Tabanan, Bali

The analysis results showed that the content cadmium (Cd) found in the liver and meat of tilapia was measured at 1.043 mg/kg and 1.541 mg/kg. The cadmium content in the liver and meat of tilapia showed high results when compared to the maximum standard threshold set in SNI 7387:2009, which is 0.1 mg/kg in fish and its processed products. This study shows that tilapia caught in the Telaga Tunjung Dam have been contaminated with the heavy metal cadmium (Cd). Cadmium (Cd) can accumulate in fish through the food chain. Furthermore, cadmium can enter the fish body through three main processes: with water through the respiratory system, through the skin membrane on the body's surface, and through particles or digested food [9].

The presence of cadmium in the liver is also due to the liver's role as a detoxification organ [10]. The presence of cadmium in the water and fish in the Telaga Tunjung dam may be due to the extensive agricultural activity around the river near the dam. Increased agricultural activity has led to an increase in the use of inorganic fertilizers containing phosphate. Phosphate fertilizers contain cadmium ranging from 0.1 to 170 ppm [11].

Water condition based on Dissolved Oxygen (DO), Temperature, and (pH) Parameters at Telaga Tunjung Dam

The range of Dissolved Oxygen (DO) obtained during the study was 3.7 mg/L -7.2 mg/L. The highest value was found at station IV in the afternoon was 7.2 mg/L. The lowest value was measured at station II in the morning was 3.7 mg/L. This could be due to the lack of sunlight entering due to the canopy covering the waters. The concentration of dissolved oxygen in water can also be influenced by the rate of photosynthesis. The minimum oxygen solubility needed to support the life of aquatic organisms is around 4 mg/l [12]. According to Bali Governor Regulation No. 8 of 2007 concerning Environmental Quality Standards and Environmental Damage Standard Criteria, class II water quality must meet the dissolved oxygen parameter of 4 mg/l.

Based on water temperature measurements during the study, the temperature range was 27.9°C - 32.7°C. The highest temperature was found at station III in the afternoon at 32.7°C, and the lowest at station IV in the morning at 27.9°C. The temperature difference between each station was not significant. The temperature in the waters is influenced by atmospheric conditions, weather, sunlight intensity, and the amount of canopy covering the water [13]. The optimal temperature range for aquatic organism is 25°C-32°C [14].

Measurements of pH parameters at Telaga Tunjung Dam showed a range of 6.6-6.9. In general, pH reflects the acidity or alkalinity of a body of water. pH of 7 is considered neutral, pH < 7 indicates acidic conditions, while pH > 7 indicates alkaline conditions [14]. The range of pH values found during the study was between 6.6-6.89. According to Bali Governor Regulation No. 8 of 2007 concerning Environmental Quality Standards and Environmental Damage Standard Criteria, class II water quality must have a pH value between 6 and 9. Thus, the water quality parameters, namely dissolved oxygen, temperature and pH in Telaga Tunjung Dam are still good for the life of aquatic organisms. So it can be concluded that in this study the water quality parameters include Dissolved oxygen (DO), Temperature and pH value in the Telaga Tunjung Dam still supports the life of organisms.

IV.CONCLUSION

The content of heavy metal cadmium (Cd) in Telaga Tunjung Dam was detected in the water at station II at 0.038 mg/L and the highest cadmium content detected at station IV at 0.078 mg/L. Meanwhile, the cadmium (Cd) content was measured in fish liver at 1.043 mg/kg and the highest cadmium content was measured in tilapia meat at 1.541 mg/kg. These values have exceeded the standard threshold set by Bali Governor Regulation No. 8 of 2007 at 0.01 mg/l and SNI 7387:2009 for the fish and processed fish category at 0.1 mg/kg. The results of dissolved oxygen (DO), temperature and pH measurements are still optimal to support the life of aquatic organisms.

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