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Analysis of Mercury Heavy Metal Content in Climbing perch fish (*Anabas testudineus*) from Rawa Taliwang Lake

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Abstract: The heavy metal mercury is at risk of disrupting brain development in children if it accumulates in the human body. The aim of the study was to determine the content of heavy metal mercury (Hg) in Climbing perch fish (*Anabas testudineus*) originating from Rawa Taliwang Lake to enrich the Ecotoxicology course material. The special benefit is to protect consumers who consume fish from heavy metal contaminants. The research was conducted in Rawa Taliwang Lake, which is in an area submerged in water. There are 2 research stations, namely in the eastern and western parts of the lake. Gill nets were used to catch fish. Fish samples were taken 3 to 4 times at each station. The Fish species taken was the Climbing perch fish (*A. testudineus*). Furthermore, each fish sample was put into a plastic bag and then stored in a sample box. The research sample was then analyzed at the Environmental Laboratory Center for the West Nusa Tenggara Environment and Forestry Office. The method of data analysis was carried out by taking muscle tissue from fish and then analyzing the content of heavy metals in the form of Hg using an Atomic Absorption Spectrophotometer (AAS). The wet destruction stage in the destruction sample is the process of degradation of organic material samples by utilizing strong acidic liquids, namely HNO_3, as a destructive agent. The data obtained are in the form of Pb heavy metal levels in ppm (parts per million). The next stage is that the Pb concentration obtained is processed descriptively and then displayed in table form according to the AAS results. The conclusion of this study is that the heavy metal content of Hg in Climbing perch fish (*A. testudineus*) originating from Rawa Taliwang Lake to enrich Ecotoxicology course material was <0,0001 ppm.

Keywords: Climbing perch fish; Mercury (Hg); Rawa Taliwang Lake.

Introduction

Aquatic organisms are species that are able to live in water. Climbing perch fish (*Anabas testudineus*) is one species that depends on aquatic ecosystems for its life. The Rawa Taliwang Lake (RTL) area is a freshwater body of water located in West Sumbawa Regency with an area of 819.20 ha. This area was once designated as a Nature Tourism Park based on the Regulation of the Minister of Forestry and Plantations No. 418/Kpts-II/1999 dated June 15, 1999, covering an area of 1,406 ha. However, the Ministerial Regulation has been revoked and replaced by the Ministerial Regulation No. 589/Menhut-II/2009 concerning the Determination of Forest Areas and Marine Conservation. Areas in West Nusa Tenggara Province on October 2, 2009 [1]. One of the water bodies that has a diversity of fish species is in RTL [2]. Climbing perch fish (CPF) is a species of fish found abundantly in this location. Fish are organisms that can be bioindicators for aquatic ecosystems. RTL, as one of the freshwater ecosystems, plays an important role in determining the occurrence of biological processes of various aquatic creatures [3].

Administratively, Rawa Taliwang Lake is included in two sub-district administrative areas, namely Taliwang District (covering Seloto and Pakirum Villages and Sampir Village) and Seteluk District, namely Meraran Village. Geographically, Lebo Lake is located between latitudes 8°34'0"LS and 116°13'0"BT with regosol and litosol soil types and hilly to mountainous topography with an altitude of 200-400 m above sea level [1].

The water condition in RTL can rise and fall in volume. In the dry season, the lake water shrinks until part of the lake area becomes dry [2]. RTL is used by the community, among others, as a freshwater fish catching and cultivation area, including a breeding ground for field snails, a water source for agricultural irrigation, a source of raw water for households, and ecotourism potential, and also plays an important role as a flood controller for Taliwang City. This lake has high natural resource potential in improving the community's economy [1].

Human activities, especially activities in the agricultural sector, where farmers always use insecticides, herbicides, fungicides and fertilizers. From these human activities, it provides an opportunity for water and organisms in RTL to be contaminated with heavy metals such as mercury (Hg) and even other heavy metals [2].

The condition of increasing Hg metal in water bodies such as lakes, especially at the beginning of the rainy season, needs to be watched out for because according to [4] heavy metals that enter the water will spread and accumulate in

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sediments, then accumulate in the bodies of aquatic organisms such as fish [3]. In addition, Hg is a persistent heavy metal, so if contamination occurs in living things, it can harm their own bodies [5]. Humans who consume fish contaminated with mercury can accumulate the heavy metal, which is very dangerous and can cause poisoning (toxic) in humans [6].

The increase in water temperature will affect the accumulation of heavy metals such as Hg in fish tissue and other organisms. Increasing water temperature can affect the metabolic rate of organisms living in aquatic ecosystems [7]. The increasing water temperature tends to increase the accumulation and toxicity of heavy metals, including Hg. [8], said that fish and those exposed to heavy metals such as Hg will tend to accumulate more heavy metals at a temperature of 30 °C when compared to room temperature.

Fish and invertebrates that live in limited habitats such as dams, rivers, lakes and swamps are certainly more susceptible to contamination by heavy metals when compared to other organisms that live in open water bodies, such as in the sea. Heavy metal contamination in CPF will easily occur in lake waters. The accumulation of heavy metal Hg in fish tissue occurs after adsorption of Hg from water, feed or food such as contaminated algae [9].

Water and soil pollution can come from garbage, liquid waste and other pollutants such as fertilizers, pesticides, burning of fossil fuels, and the use of detergents [10]. Water in water bodies, including lakes, can easily be contaminated by various heavy metals such as Mercury [11]. The results of the researcher's observations showed that farmers around RTL still use fertilizer in their rice fields to fertilize plants, such as rice plants [12].

RTL receives water and sediment sources from various watercourses around it that enter the lake's water body [12]. There are many species of plants growing in RTL L [3]. Various types of plants can take part as natural bioremediation agents because they can absorb heavy metal content in nature, such as Cd, Fe, Mn, Cr, Hg and Cu. This bioremediation function is called biosorption [13]. These plants have the ability as biofilters, namely the ability to filter, bind and trap pollution in the wild in the form of excess sediment, garbage and other household waste. This function plays a role in improving water quality [14].

Many pollutants have been studied in water bodies in Indonesia. Important information, for example, from the results of research [15], which shows that the levels of heavy metals/pollutants in water bodies and sediments in the Cisadane river estuary. The results of the study showed that the levels of heavy metals (Pb, Cd, Cu, Zn and Ni) in water in estuary waters ranged between: Cd ≤ 0.001-0.001 ppm, Cu ≤ 0.001-0.001 ppm, Zn ≤ 0.001 ppm and Ni ≤ 0.001-0.003 ppm.

Several research results show that in fish organs, heavy metal content, such as Hg, has been found [16]. The results of research [17], in freshwater fish such as Tilapia and Snakehead fish, were contaminated by heavy metals. The content of Hg in Tilapia and Snakehead was found at 6.68 ppb, followed by Cd, 2.32 ppb, Cu, 24.50 ppb and Pb, 1.60 ppb. Other research on freshwater fish showed Pb content in Snakehead fish was 11.01 ppm, and in Tilapia fish reached 10.83 ppm [18]. Accumulation of heavy metals was also detected in the gills and liver of Snakehead fish [19]. Next [20] reported that in other freshwater fish such as Tilapia, heavy metal content was found, for example Cd 0.16 ppm, Pb 0.22 ppm and Cu 0.79 ppm.

The results of research on fish show that the organism accumulates heavy metals. In CPF, heavy metal content was found. The results of the study showed that the Cd content in CPF was 84 ppb [21]. The results of the analysis from Beloso fish meat found Pb content of 0.005 mg/kg (ppm), copper (Cu) 0.293 mg/kg, and Cadmium (Cd) 0.032 mg/kg [22]. From the description, it shows that fish tissue is able to accumulate various types of heavy metals, including Mercury.

Heavy metals are very dangerous and pose a threat to pollute the aquatic environment. The main cause of heavy metals becoming dangerous pollutants is that heavy metals cannot be destroyed (*non-degradable*) by living organisms in the environment [23]. In addition, there is an accumulation of heavy metals such as Hg in the environment, especially settling into sediment at the bottom of water bodies [24].

Considering the presence of heavy metals on aquatic organisms and as a study material, and determining development policies and enriching course materials such as Ecotoxicology, the author is interested in conducting research on the Measurement of Heavy Metal Content Hg in Climbing perch fish (*Anabas testudineus*) from Rawa Taliwang Lake, West Sumbawa Regency.

The results of observations conducted by the author indicate that the water body in RTL receives water from the surrounding area that passes through agricultural areas that use fertilizers, herbicides, fungicides, insecticides and passes through the community mining processing area, so that the water body in the lake receives a pollution load. Heavy metals can be accumulated by algae in the water and at the bottom of the waters, following the food chain, entering the fish's body and accumulating. Therefore, to determine the content of heavy metal Hg in Climbing perch fish (A. testudineus), it is necessary to conduct research.

Research Methods

This research was conducted in March-June 2024. This research was conducted in Rawa Taliwang Lake. There are two research stations, namely in the eastern and western parts of the lake. The determination of the station is based on the existence of the lake's topography.

Data collection method

The sampling technique used in this study was purposive sampling. The reason for using purposive sampling is that not all samples have criteria that match the characteristics of the study. The criteria in these samples are the length and weight of the Climbing perch fish. Then the samples of this fish were analysed in the Analytical Chemistry Laboratory of the University of Mataram and in

the Environmental Lab of the West Nusa Tenggara Environment and Forestry Service.

Data Analysis Method

The analysis process begins with the selection of Climbing perch fish samples, which are 6-8 months old and weigh 150-250 g/fish. The next step is to take muscle tissue as the part to be tested [25]. Wet samples were weighed as much as 0.5 g. Furthermore, Pb content analysis was carried out using Atomic Absorption Spectrophotometry (AAS), wet destruction stage on sample destruction is the process of degradation of organic material in samples by utilizing strong acidic liquids, namely HNO3, as a destructive agent [26]. The steps in sample destruction are carried out by; inserting 0.5 grams of sample into a Kjeldahl flask, then adding 1 gram of catalyst, namely a solution of Na_2SO_4 and $CuSO_4$ with a ratio of 2: 1, followed by adding 6 mL of H_2SO_4 as a solvent, then heated for 2-3 hours at a temperature of 350ºC until the solution becomes clear, and then cooled. To determine the concentration of Pb, it is measured using Atomic Absorption Spectrophotometry (AAS) with the following steps: Using a computer to measure Atomic Absorption Spectrophotometry (AAS), the test cathode lamp Atomic Absorption Spectrophotometry (AAS), the Hollow Cathode Lamp (EDL) is turned on which emits light at a characteristic wavelength for the Pb to be analysed, and the position of the lamp is adjusted so that maximum absorption is obtained, the standard solution is sucked and then the atomic absorption reading is measured in the AAS Test. The data obtained is in the form of Pb heavy metal levels in ppm (parts per million). The next stage is that the Pb concentration obtained is processed descriptively, and then the data is displayed in table form according to the AAS results. Pb concentration is calculated using the formula:

$$\text{Hg concentration} = \frac{(a-b)}{w} \text{ x V}$$

Description:
K = heavy metal content in the sample (mg/kg or ppm)
a = sample concentration level (mg/l)
b = blank concentration level (mg/l)
V = Final volume of sample solution (ml)
w = sample weight (g)

Results and Discussion

From 2 research stations on the analysis of heavy metal Mercury (Hg) content in Climbing perch fish (*A. testudineus*) from Lake Rawa Taliwang, West Sumbawa Regency, are presented in Table 1.

The Hg concentration in CPF originating from RTL is reached <0.0001 ppm. CPF usually live in river, swamp and lake waters so they can play an important role as bioindicators in lakes [27]. This Hg metal concentration is below the threshold according to the decision of the Food and Drug Supervisory Agency (BPOM) No. 9 of 2022, which is required regarding the Maximum Limit of Metal Contamination in Fish and Processed Products, by 0.1 ppm. The levels of heavy metal Hg in CPF from this lake are suspected to come from agricultural activities because the research location is included in an area which is surrounded by rice fields. The source of this heavy metal is due to the use of fertilizers by farmers [2]. Phosphate fertilizer also contains heavy metals [4]. If humans consume fish containing Hg, the metal can accumulate in the body, and it is dangerous because it can damage human tissue. The results of the study showed that the Hg content was still below the threshold, and from this Hg standard, CPF from RTL, West Sumbawa Regency, is still safe for consumption.

Table 1. The concentration of heavy metal Mercury (Hg) in the climbing perch fish

Fish Species	Sample Location/Treatment	Hg concentration (ppm)
Climbing perch fish (*A. testudineus)*	A. Eastern parts	
1	Location 1 (1)	<0,0001
2	Location 1 (2)	< 0,0001
	B. Western parts	
1	Location 2 (1)	<0,0001
2	Location 2 (2)	< 0,0001

Source: Laboratory analysis results at the DLHK Environmental Lab, West Nusa Tenggara

The results of this study are also supported by the results of other studies on heavy metals in CPF. The content of heavy metal Hg in fish was found to be 6.68 ppb, which is still below the threshold set by Food and Drug Supervisory Agency (BPOM) No. 9 of 202, concerning the maximum limit of heavy metal contamination in processed foods of 0.1 mg/kg [28].

The results of the study on CPF are in line with the results of the study [3], which showed that there is a content of other heavy metals, such as Cd, a dangerous heavy metal, in Tilapia fish from RTL West Sumbawa Regency, which is below <0.01 ppm. The content of Cd metal, like Hg in this study, is still below the threshold according to the provisions of the Food and Drug Supervisory Agency (BPOM) No. 9 of 2022 concerning the Maximum Limit of Heavy Metal Contamination in Processed Food, namely 0.1 mg/Kg (ppm).

Excessive increase in Hg levels can have negative impacts on humans and animals due to its nature that damages the nervous system and is easily accumulated in tissues and organs of the body [24]. Human health can be very dangerous if it often consumes fish or organisms that have been exposed to Hg [10]. Environmental changes can also have a real impact on phytoplankton, including algae and other plant species, because algae, as plants, are organisms that have the fastest response to environmental changes [29]. Various plant species are more sensitive to environmental changes when compared to humans or animals [30].

Heavy metals can accumulate in various types of organisms, including fish [31]. The results of the study [26] showed that the average level of Cu metal was 0.0882 mg/kg in milkfish (*Chanos chanos* Forsk) samples. Other studies have shown the presence of heavy metals in freshwater fish [32].

The characteristics of heavy metals that cannot be destroyed (*nondegradable*) by living organisms in the environment are the main cause of heavy metals becoming pollutants that are harmful to various organisms [33]. As a result, these metals accumulate in the environment, and it settle at the bottom of the waters forming complex compounds with organic and inorganic materials [34]. These heavy metals can be taken up by algae and then enter the food chain, including the body of the CPF.

Heavy metals in sediments can be taken up by plants, including algae, that are food for herbivorous fish. These heavy metals can come from agricultural activities, mining carried out by water through rivers. Furthermore, various types of heavy metals can dissolve in river water, be adsorbed by fine particles (*suspended solids*) and carried to the lake by the water in the river. In the lake, river water and lake water mix together, so that fine particles containing heavy metals can settle in the sediment. The result of such an incident can make the levels of heavy metals in the sediment in the lake higher than in other waters, such as in the open sea. In general, river or lake estuaries experience a sedimentation process, where metals that are difficult to dissolve undergo a dilution process in the water column, then become sediment that settles at the bottom of the water body in the lake [24].

It has been found in many places, such as lakes and bays, where the waters are contaminated by heavy metals, such as in the waters of Kendari Bay [5]. Community activities such as mining and industrial activities as sources of water pollution need to be strictly monitored so as not to burden water bodies due to their waste, so that organisms living in water bodies are protected from heavy metal contamination such as Hg, because based on the results of this study, Hg levels have been detected in the tissues of organisms such as rice field snails [35].

Heavy metal Mercury (Hg) is a metal that can be carried by water from sources of contamination, such as those from agricultural and mining activities. Heavy metal Hg is thought to originate from Hg contamination from agricultural and mining areas around RTL. Mercury is easily absorbed by organic substances in soil/sediment and becomes very dangerous if mercury in the sediment is absorbed through the food chain. Heavy metals can enter the food chain, for example, because sediment containing Hg will be absorbed by plants and then eaten by herbivorous animals that always depend on plants [36]. Metal Hg can accumulate in the body of animals through the food chain, which can ultimately have an impact on humans if humans consume contaminated animals with the heavy metal Hg [37].

There are still many mining activities that use heavy metal Hg; if the soil routinely receives Hg from various sources, it can cause heavy metal Hg to accumulate and be absorbed by vegetables growing in local agricultural land [8]. In addition, Hg in the aquatic ecosystem can accumulate in various organisms such as fish, snails and shrimp. Sensitivity to Hg can vary greatly between aquatic organisms [14]. Organisms that live in salt water are known to be more resistant to Hg poisoning than organisms that live in fresh water. Sources of heavy metal pollution, such as Hg in plants, can come from fertilisers, pesticides, irrigation water, or even from the surrounding air [39].

Conclusion

From the previous description and discussion, it can be concluded from this study that the content of heavy metal Mercury (Hg) in Climbing pear fish *(A testudineus*) from Rawa Taliwang Lake is 0.0001 ppm. This result is still below the permitted threshold according to Drug Supervisory Agency (BPOM) No. 9 of 202, concerning the maximum limit of heavy metal contamination in processed foods of 0.1 mg/kg. The results of this study indicate that snakehead fish from Lake Rawa Taliwang are safe for consumption in terms of mercury contamination, because the content of heavy metals is much lower than the threshold set by BPOM. Although the results are safe, it is important to continue to monitor and periodically test the content of heavy metals in local water resources, in order to prevent the possibility of mercury accumulation in the future, which can endanger human health.

Author's Contribution

Khairuddin: conceptualization of the study, sampling design, and drafting of the manuscript. M. Yamin: laboratory analysis, data interpretation, and contributed to the methodology section. Kusmiyati: statistical analysis, data validation, and final manuscript editing.

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