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Analysis of Mercury (Hg) Content in Tilapia Fish (Oreochromis mossambicus) from Rawa Taliwang Lake to Enrich the Course Materials on Ecotoxicology

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Abstract: Rawa Taliwang Lake is one of the lakes in West Sumbawa Regency which is surrounded by mining. Mining waste in the form of mercury can accumulate in tilapia fish which are consumed by many people around the lake. consumption of tilapia fish with mercury content can endanger health. The purpose of this study was to determine the level of mercury in tilapia fish from Rawa Taliwang Lake. This research was conducted for six months, starting from September 2022 to March 2023. Sampling was carried out using a purposive sampling method using 2 station points. The samples used were 3 fish taken from station 1 and station 2. Sample analysis was carried out in the analytical laboratory and environmental of West Nusa Tenggara using AAS (atomic absorption spectrophotometry). The part that was analyzed was the tilapia fish meat. The results of the analysis showed that the mercury content in tilapia fish from Rawa Taliwang Lake was 0.73 mg/kg which exceeded the Hg contamination limit set by the Food and Drug Supervisory Agency regulation no 9 of 2022. So tilapia fish from Rawa Taliwang Lake was unfit for consumption. The results of this study can be used as additional material in the learning process of ecotoxicology.

Keywords: Tilapia fish, mercury, rawa taliwang lake.

Introduction

Rawa Taliwang Lake is one of the lakes located in West Sumbawa district. Administratively, Lake Rawa Taliwang is located in the districts of Taliwang and Seteluk (Kawirian et al, 2018). There are various human activities around Lake Rawa Taliwang such as agricultural, mining and electronic industry activities. High human activity around the lake can cause heavy metal content in the lake (Khairuddin et al., 2019; Khairuddin et al., 2022).

The condition of the Rawa Taliwang lake has indicated that it is experiencing heavy metal pollution. This is based on some of the results of previous studies conducted by Kirana et al (2021) which found a heavy metal Cu content in one of the biota in Lake Rawa Taliwang of 0.679 mg/Kg. Legiarsi et al (2022) also conducted an analysis of the heavy metal content of Cd in Lake Rawa Taliwang using snakehead fish, the results showed that snakehead fish from Lake Rawa contained a Cd of 0.1405 mg/Kg. The results of monitoring by the Environmental Agency of Sumbawa Regency on Lake Rawa Taliwang also found Hg content at one of the river points that empties into Lake Rawa Taliwang. The existence of the Hg comes from the processing of community gold which is carried out illegally.

How to Cite:
Example: Susilawati, S., Doyan, A., Muliyadi, L., & Hakim, S. (2019). Growth of tin oxide thin film by aluminum and fluorine doping using spin coating Sol-Gel techniques. *Jurnal Penelitian Pendidikan IPA*, *1*(1), 1-4. https://doi.org/10.29303/jppipa.v1i1.264

Hg or mercury is a type of heavy metal that is known to be harmful to human health (Komarawidjaja et al., 2017). Mercury has different toxicity depending on the form of the chemical compound. Inorganic mercury is toxic to the kidneys, while organic mercury can be toxic to the central nervous system (Kuniyo, 2020). The use of mercury in various fields is very wide and its production is quite high, so it is necessary to detect its existence considering that this metal is classified as a dangerous metal. Mercury that accumulates in waters can enter the body of biota, one of which is fish (Kuniyo, 2020).

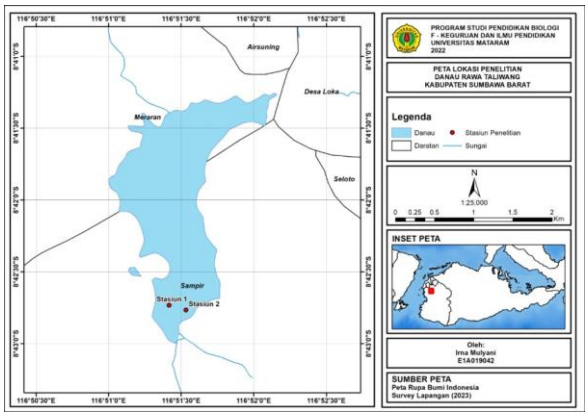
The type of fish that can be found in Rawa Taliwang Lake is tilapia fish (Oreochromis mossambicus). Mujair fish is one type of fresh water fish that can be consumed. The metal content contained in the bodies of small fish consumed by tilapia fish can cause accumulation of heavy metals. These heavy metals can accumulate in growing fish for a long time (Rosahada et al, 2018). Mujair fish (Oreochromis mossambicus) which is consumed with mercury content in it can endanger human health (Aliza et al., 2022).

Mercury that enters the body through consumption of food contaminated with mercury can disrupt the central nervous and endocrine systems, kidneys, and has the potential to damage the mouth, hearing, and damage to brain function (Sonata et al., 2021; Deep & Maiti, 2019 ; Aliza et al., 2022). Pregnant women who consume mercury-contaminated organisms have the potential to give birth to babies with serious birth defects (Hidayat, 2020). Therefore it is necessary to detect the Hg content in food consumed by humans. Information on the content of dangerous heavy metals in foodstuffs can enrich the discussion of ecotoxicology material. Based on the description above, it is necessary to conduct research on the mercury content in mujair fish originating from Lake Rawa Taliwang to determine the mercury content in one of these foodstuffs.

Method

Location and Time of Research

This research was conducted at two stations in Rawa Taliwang Lake, West Sumbawa Regency. Station 1 is located at coordinates 8°42'44" South Latitude and 116°51'25" East Longitude. Station 2 is located at coordinates 8°42'46" South Latitude and 116°51'32" East Longitude.



Gambar 1. Research sites

Sample processing and testing was carried out at the University of Mataram Analytical Laboratory and West Nusa Tenggara Environmental Laboratory. The research was conducted from September 2022 to March 2023.

Data processing

This study used mercury as a variable in tilapia fish samples from Lake Rawa Taliwang using purposive sampling method. The tools used for sampling are fishing nets. Environmental parameter tests were carried out using a pH meter, thermometer and refractometer. The tilapia fish sample which had been cleaned from the scales was taken for its flesh, then cut into small pieces and weighed at 0.5 gram using an analytical balance. Tilapia fish meat was put into a different kjeldal flask and then added 1 gram of catalyst (a mixture of Na2SO4 and CuSO4 with a ratio of 20:1) and 6 mL of H2SO4 solvent. Then 5 ml of concentrated HNO3 was added to the sample solution. The sample was then heated to 350oC using the Kjeldal Term for 2-3 hours until the solution was clear. Then the solution was added with distilled water and then the process of reading the calibration curve and samples was carried out using the Atomic Absorption Spectrophotometer (AAS) test method.

Data analysis

Data analysis was carried out by calculating the concentration of mercury in tilapia fish using the following formula (Mulyani et al., 2012):

$$K=\frac{(a-b)}{W} \times V$$

Information :

a = sample concentration value from AAS readings (mg/l)

b = blank concentration value of AAS reading results (mg/l)

K = heavy metal content in the sample (mg/kg or ppm)
V = final volume of sample solution (L)
W = sample weight (kg)

The results of calculating the Hg content are then compared with the regulation of the Food and Drug Supervisory Agency Number 9 of 2022 concerning requirements for heavy metal contamination in processed food to determine the feasibility of consuming mujair fish taken from Rawa Taliwang lake. The maximum limit for Hg content in processed fish products is 0.50 mg/kg (except for processed predatory fish such as shark, tuna, marlin 1.0).

Resultand Discussion

The results of the analysis on the content of mercury (Hg) in tilapia fish taken from Lake Rawa Taliwang are expressed in milligrams/kilograms (mg/Kg) or parts per million which are presented in the following table:

Table 1: Hg concentration in tilapia fish

No	Sample location	Connected	Sample concentration (mg/l)	Hg content mg/Kg (ppm)
1.	Station 1	1	0.0041	0.81
2.		2	0.0041	0.81
3.	Station 2	1	0.0033	0.65
4.		2	0.0033	0.65

The average concentration of mercury (Hg) in tilapia at station 1 (8°42'44" LS and 116°51'25" E) is 0.81 mg/Kg while the average concentration of mercury (Hg) in tilapia at station 2 (8°42'46" South Latitude and 116°51'32" East Longitude) namely 0.65 mg/Kg. The results of this study are in line with previous research conducted by Zuhairiah et al (2019) which found a mercury content in tilapia fish of 0.4034 mg/kg. Mercury is also found in other types of fish based on research conducted by Azizah & Maslahat (2021) who found the mercury content in wader fish to be . Not only fish, mercury can also accumulate in other organisms, for example in the body of clams as in Khairuddin et al (2018) who found the mercury content in several types of blood clams (Anadara granosa) of 0.040 ppm, Hiatula clams (Hiatula chinensis) 0.031 ppm and Clams (Siliqua winteriana) 0.017 ppm.

Source of Mercury in Rawa Taliwang Lake

The content of mercury (Hg) in Lake Rawa Taliwang is estimated to come from gold mining, metal goods industry and agricultural activities around the lake. The results of Yulis' research (2018) revealed that the impact of gold mining without a permit was proven to increase Hg levels caused by direct waste disposal. This is due to the accumulation of gold mining waste. Traditional gold miners use mercury to capture and separate gold grains (Ghassani & Titah, 2020).

There are 9 metal goods industries located in West Sumbawa City (Disperin, 2020). The results of Dewi's research (2022) which analyzed heavy metal contamination in the city of Surabaya showed that there were contents caused by metal industry waste around the city of Surabaya. Similar research by Rinawati (2021) showed the results of the concentration of mercury in waters with a distance of 79 m from the industrial location of 1.17 ppm which is above the quality standard (0.05 ppm).

Agricultural activities have contributed to increasing mercury in Rawa Taliwang Lake. This is caused by the use of fertilizers, herbicides and fungicides that contain heavy metals (Khairuddin et al., 2018; Khairuddin et al., 2022). In line with Riyanti et al (2022) which revealed that agricultural irrigation had a significant effect on increasing mercury. This was then supported by data from the Central Bureau of Statistics for West Sumbawa Regency in 2015 regarding the area of rice fields in West Sumbawa Regency, which is 11737 ha. Farmers who manage rice fields in West Sumbawa Regency certainly use fertilizers, fungicides, insecticides, and other types of poisons for their rice fields (Khairuddin et al., 2022). According to Khairuddin (2021), the use of fertilizers, fungicides, insecticides, herbicides and other types of poisons on agricultural land contains heavy metals which can accumulate in waters, especially during the rainy season.

Feasibility of Consuming Mujair Fish in Rawa Taliwang Lake

The maximum limit for mercury content is set based on the Regulation of the Food and Drug Supervisory Agency No. 9 of 2022, which is 0.50 mg/Kg for processed fish products. The average concentration of mercury (Hg) in tilapia at station 1 (8°42'44" LS and 116°51'25" E) is 0.81 mg/Kg while the average concentration of mercury (Hg) in tilapia at station 2 (8°42'46" South Latitude and 116°51'32" East Longitude) namely 0.65 mg/Kg. This shows that tilapia fish found at Station 1 (8°42'44" LS and 116°51'25" E) and Station 2 (8°42'46" LS and 116°51'32" E) exceed the maximum limit of mercury content so it is not safe for consumed.

Mercury that has accumulated can continue to increase in concentration along with an increase in the position of biota in the food chain system which is known as biomagnification (Hasibuan et al, 2021). So Mariwy et al (2022) recommend not consuming fish that has been contaminated with mercury even at low concentrations. In addition, mercury that accumulates in biota's bodies can stimulate enzymatic systems that

can reduce biota's ability to adapt to polluted environments.

The Danger of Mercury for Health

Heavy metals are harmful substances for the body because they can bioaccumulate and cannot be degraded (Khairuddin et al., 2018; Khairuddin et al., 2021). The process of entry of mercury in the body affects the disturbance it causes. Patients who are exposed to mercury through vapor can experience disturbances in the respiratory tract and disturbances in the form of decreased brain function. The decline in brain function is caused by disturbances in the cortex. Mercury that enters the body either by inhalation or ingestion causes damage to the digestive tract, liver and kidneys. Mercury that enters through the skin can cause localized dermatitis (Adhani & Husaini, 2017).

Cases of poisoning caused by mercury have occurred in many areas. The case of mercury poisoning that killed many people was the case that occurred in Minimata with a total of 111 people who died (Pinontoan et al, 2019). Indonesia needs to be aware of potential cases due to mercury pollution considering the large number of illegal gold mining. The results of Masruddin & Mulasari's research (2021) show that several gold miners around illegal gold mining suffer from chronic and acute illnesses caused by mercury. Complications due to mercury poisoning that gold miners most often complain about are neurological effects, tremors, memory problems, and visual disturbances (Habibia et al, 2021). Yamin (2021) revealed that the biggest sufferers from mercury poisoning are fishermen who consume fish from waters polluted with mercury.

Effect of Environmental Parameters

The concentration of heavy metals in Rawa Taliwang lake is influenced by environmental factors. According to Sari et al (2017) the concentration of heavy metals changed due to changes in current, temperature, salinity, pH, ionic strength, amount and type of contaminants, and depth. Environmental parameter measurement data carried out during the study were measurements of temperature, pH, and salinity.

Table 2: Environmental quality parameters of Rawa Taliwang Lake

No.	Location	Temperature (°C)	pH	Salinity (ppt)
1.	Station 1	29	7.9	0.5
2.	Station 2	29	7.9	0.5

The temperature measurement results in Lake Rawa Taliwang are 29oC. This temperature measure can affect the amount of heavy metal concentrations in Rawa Taliwang lake. The results of Testi et al (2019) showed that there was a high difference in the concentration of Pb metal which was thought to be caused by an increase in temperature. Increasing temperature can increase the toxicity of mercury in these waters (Mariwy et al, 2022; Khairuddin et al., 2022).

The results of pH measurements in the Rawa Taliwang lake were 7.9. This measure has no effect on the toxicity of heavy metals in waters. This is because heavy metals will form complex compounds with other compounds at a pH greater than 9 (Testi et al, 2019).

The result of measuring salinity in Lake Rawa Taliwang is 0.5. Many factors affect salinity such as rainfall (Handayani, 2020). This size certainly affects the concentration of heavy metals. Because the lower the salinity, the concentration of heavy metals increases (Testi et al, 2019). When there is a decrease in salinity due to desalination, the concentration of heavy metals will increase and the level of bioaccumulation will be even greater (Hidayah et al, 2019).

Research Results to Enrich Ecotoxicology Materials

The results of this study can be used as additional material in the learning process of ecotoxicology lecture material. The results of this study provide information that the mercury content in tilapia fish in Lake Rawa Taliwang exceeds the threshold for heavy metal contamination based on BPOM regulation no 9 of 2022. According to Khairuddin et al (2017) the next generation of development needs to be equipped with knowledge about the impact of heavy metals on humans so as to avoid the impact of the contamination.

The results of this study can make ecotoxicology lecture materials contain local research sources that are closer to students. According to Nurhidayati & Khaeruman (2017) the use of the surrounding environment as a resource in lectures makes students better understand teaching materials not only theoretically but becomes more applicable and cares about the environment around them. The results of this study also refer to the latest research results along with the increasing number of research results that have been conducted by other researchers.

Conclusion

Based on the results of an analysis using AAS, the concentration of mercury in tilapia fish from Lake Rawa Taliwang was 0.73 mg/kg. The concentration of mercury in the tilapia fish exceeds the threshold for metal contamination in food based on the Food and Drug Supervisory Agency regulation No. 9 of 2022. This makes tilapia fish taken from Lake Rawa Taliwang unfit for consumption. The results of this study can be

used as additional material in the learning process of ecotoxicology lecture material.

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