J. Pijar MIPA, Vol. 18 No. 3, May 2023: 404-409
DOI: 10.29303/jpm.v18i3.4862

ISSN 1907-1744 (Print)
ISSN 2460-1500 (Online)

ANALYSIS OF CADMIUM HEAVY METAL CONTENT IN RICE SNAIL (*Pila ampullacea*) FROM RAWA TALIWANG LAKE

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Received: March 20, 2023. Accepted: April 7, 2023, 2023. Published: May 27, 2023

Abstract: Snails are one of the aquatic organisms that can be used as biological indicators of heavy metals in water. This study aims to determine the amount of cadmium heavy metal content in rice snails (*Pila ampullacea*) from Rawa Taliwang Lake, which can be used to enrich lecture material on environmental knowledge and to determine the feasibility of consumption of rice snails *(Pila ampullacea*) in accordance with the threshold of heavy metal contamination in food. The research was conducted over ten months, from August 2022-June 2023, at Rawa Taliwang Lake. Data were collected using the purposive sampling method at two research stations, namely the East and West sides. The samples in this study were four rice snails caught using a net. The samples were then deconstructed and analyzed using Atomic Absorption Spectrophotometry (AAS). The rice snail body parts studied were the flesh cleaned and separated from the shell and internal organs. The analysis showed that the average cadmium (Cd) heavy metal content in the flesh of rice snails (*Pila ampullacea*) from Rawa Taliwang Lake was 0.19 mg/kg, which means that it is suitable for consumption because it is below the maximum threshold of cadmium (Cd) contamination allowed in gastropods which are 0.30 mg/kg according to the Food and Drug Administration Regulation No. 9 of 2022.

Keywords: *Cadmium (Cd), Rice Snails, Rawa Taliwang Lake.*

INTRODUCTION

Heavy metals are water pollutants whose presence is very dangerous, even in small amounts [1]. Heavy metals become dangerous pollutants because they cannot be degraded, accumulating in the environment and potentially contaminating food [2]. Heavy metals can enter the body through food, beverages, respiration, and skin [3]. The occurrence of heavy metal exposure in living things is difficult to avoid. Plants and animals easily accumulate heavy metals that enter their bodies and will enter the human body through bioaccumulation and biomagnification [4].

The bioindicator concept is one of the methods to assess the presence of heavy metals as pollutants in the aquatic environment [5]. In general, heavy metals' content can be predicted using potential metal biomonitors, organisms that live and settle in a certain area [6]. [7] explained that gastropods can indicate water quality determination because they have filter feeder properties that filter food directly from the water. Aquatic organisms with properties such as a filter feeder are the rice snail (*Pila ampullacea*).

The rice snail (*Pila ampullacea*) lives in lowland freshwaters, such as lakes [8]. Heavy metals more easily contaminate biota that lives in lakes than in open waters because lakes are limited habitats [9]. Rice snails are one of the sources of animal-based protein for humans [10]. However, consuming rice snails (*Pila ampullacea*) continuously can be toxic if it contains levels of heavy metal contamination exceeding the maximum threshold [11].

Cadmium is one type of non-essential heavy metal that is harmful to living things [12]. Cadmium is the 7th most toxic heavy metal based on the Agency for Toxic Substances and Disease Registry ranking [13]. Cadmium (Cd) contained in the aquatic environment will enter the body of aquatic biota and accumulate continuously due to long-term exposure [14]. The maximum level of cadmium (Cd) contamination allowed in processed food in gastropods is 0.30 mg/kg, according to the Food and Drug Administration Regulation (BPOM) No.9/2022 [15].

Taliwang is a city located in West Sumbawa Regency [16]. In Taliwang, there is a lake called Lebo Lake or Rawa Taliwang Lake. Rawa Taliwang Lake is a freshwater area located in West Sumbawa Regency with an area of 819.20 ha. This area is included in Taliwang sub-districts and Seteluk sub-districts [17]. Taliwang City has the second-largest gold and copper mining company in Indonesia, namely PT Amman Mineral Nusa Tenggara [18]. Pollution environment by heavy metals can occur if industries that use these metals do not pay attention to environmental safety, especially when disposing of their waste [19].

Environmental Knowledge is a science that studies the protection of the environment from potential causes of human activities, the protection of society from adverse effects, and the improvement of environmental quality for health and a decent life for humans. Environmental

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pollution is mostly caused by chemical substances, such as toxic heavy metals, so it is necessary to understand that heavy metal pollution in the environment, especially in aquatic environments, can create problems both for the organisms that live in it and for humans who consume biota contaminated with these heavy metals. By understanding environmental knowledge, we can preserve the environment by avoiding various activities that harm the environment [20]. According to PP No. 28 of 2001, concerning Water Quality, the maximum level of cadmium heavy metal contamination allowed in waters is 0.01 mg/L [21].

Research on The Evidence of Cadmium (Cd) Heavy Metal in Apple snails (*Pila ampullacea*) was conducted in the Batu Kuta Village Narmada District [6]. The results showed that cadmium (Cd) content in the rice snail (*Pila ampullacea*) exceeded the predetermined threshold of 0.554 ppm. It is due to the disposal of household waste in rice field irrigation systems, farmers' use of organic fertilizers, and the continuous spraying of pesticides. Similar research was also conducted on different organisms from Rawa Taliwang Lake [16]. The results showed cadmium content in Headsnake fish (*Channa striata*) exceeded the 0.1405 mg/kg threshold. It is due to the waters of Rawa Taliwang Lake being contaminated with heavy metals that accumulated in the body of the biota living there. Another study was also conducted on Lae-Lae Island [22]. The results showed that heavy metal cadmium (Cd) contained in squid (*Loligo sp*) at station I was as much as 0.19 mg/kg, station II as much as 0.045 mg/kg, and station III as much as 0.06 mg/kg. These results indicate that squid (Loligo sp) does not exceed the SNI quality standard of 1.0 mg/kg, according to the Food and Drug Administration of the Republic of Indonesia (BPOM) of 0.5 mg/kg. It is still safe for consumption. The presence of heavy metal cadmium in squid meat (*Loligo sp*) is thought to be due to the location of Lae-late Island close to residential areas, shipyards, and industries that use heavy cadmium metal.

Considering the high potential of rice snails as food and the effects of cadmium heavy metal that enters the body of rice snails sourced from various pollution activities around the lake will result in unfavorable consequences when consumed by humans, and the results of the research obtained can be used to enrich Environmental Knowledge lecture materials, it is necessary to conduct research on the analysis of cadmium (Cd) heavy metal content in rice snails (*Pila ampullacea*) from Rawa Taliwang Lake to enrich Environmental Knowledge lecture materials.

RESEARCH METHODS

This research was conducted over ten months, from August 2022- June 2023. The location of the research station was in the body of water in Rawa Taliwang Lake, which was determined by topographical considerations using the Global Positioning System (GPS). Station 1 is on the east side with coordinates 8º42’44” South latitude and 116º51’25” East longitude, and station 2 is on the West side with coordinates 8º42’46” South latitude and 116º51’32”East longitude.

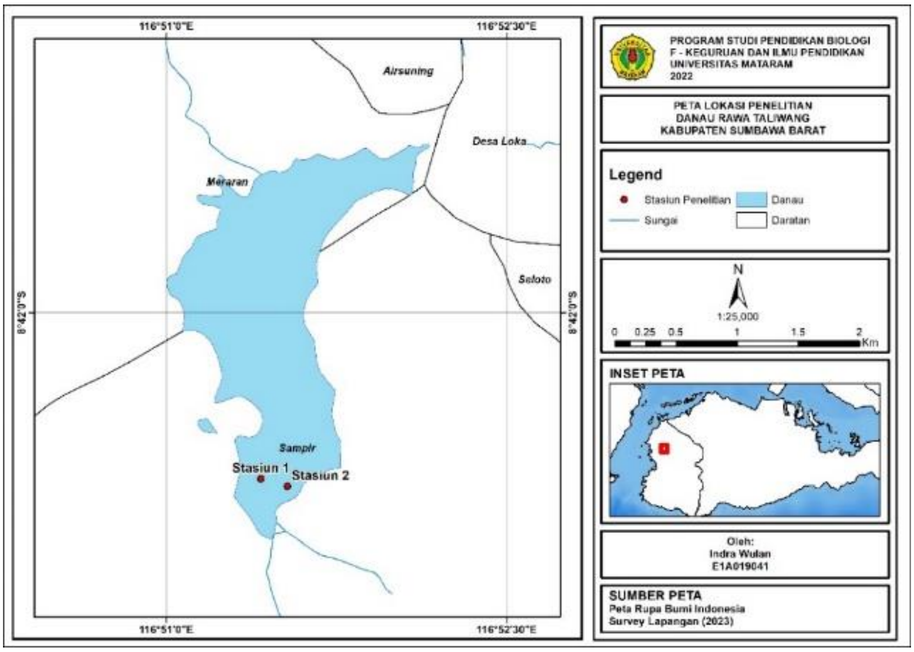

Figure: 1. Research location map

ISSN 1907-1744 (Print)
ISSN 2460-1500 (Online)

Data collecting 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 phenomenon of the study. The criteria in question are female, 12-13 months old, and 20-30 mm size suitable for consumption. Environmental conditions were also recorded with the help of a pH meter for pH measurement, a thermometer for temperature measurement, and a salinometer for salinity measurement to determine the effect of environmental parameters on heavy metal accumulation in rice snails in lake waters. Rice snails at the research station were captured using a net. Samples of rice snails were taken in as many as two heads at each station. The part that was sampled was the meat of the rice snail. The samples obtained were then stored in a box filled with water, tied, and left slightly open so air could enter. Furthermore, the samples were deconstructed at the Analytical Laboratory of Mataram University and for the analysis carried out at the NTB Provincial Environmental Laboratory.

Data processing method

Samples of rice snails totaling four were cleaned by brushing the shells and washed using aquadest. Then separate the shell from the flesh and internal organs. The part to be used as a sample is the flesh cut into small pieces. Pieces of rice snail flesh were weighed about 0.5 grams on an analytic scale and recorded the weight.

The sample was deconstructed by taking catalyst 1 g, sample 0.5 g, and added H2SO4. Then the samples were pipetted 50 ml and put into Erlenmeyer 100, and then add 5 ml of concentrated HNO3 and closed it using a funnel. Then heat slowly until the remaining volume of 15-20 ml; if it is not clear, add 5 ml of concentrated HNO3, close it using a funnel, and heat again to a volume of 15-20 ml (until the sample is obtained). Then the funnel was rinsed, and the rinse water was put into an Erlenmeyer. Then the test sample was transferred into a 50 ml volumetric flask, filtered, and added aquadest to the limit.

The sample standard solutions are put in a test tube available on the AAS device. Set the settings on the user's AAS computer, and turn on the flame and cathode lamp of the AAS; the position of the lamp is also set to obtain maximum absorption. Then the standard solution is aspirated into the site in air flame; the measurement reading designation must be zero. Consecutive standard solutions were analyzed using AAS. The measurement results of atomic absorption were recorded and calculated to get the metal concentration in the sample. In addition to the analysis results in heavy metal concentrations in the samples of rice snails, the results of the AAS device readings also contain environmental conditions during water sampling, including temperature, pH, and salinity.

Data analysis method

Data obtained in the form of cadmium content in samples of rice snails from Rawa Taliwang Lake are expressed in milligrams/kilogram (mg/kg). Data were analyzed using the Atomic Absorption Spectrophotometry (AAS) method and processed descriptively then narrated in the form of tables and graphs, and then compared with the threshold value of cadmium (Cd) heavy metal in accordance with BPOM Regulation No.9/2022 regarding the Maximum Limit of Heavy Metal Contaminants in Processed Food. The formula for determining the concentration of Cd heavy metal in mg/kg is as follows:

$$\text{Cd concentration} = \frac{(D-E) \times Fp \times V}{W}$$

Description:
D : sample concentration of rice snails (mg/l)
E : sample blank concentration (mg/l)
Fp : dilution factor
V : final volume of prepared solution (l)
W : sample weight (kg) [23].

RESULTS AND DISCUSSION

The results of the analysis of cadmium (Cd) heavy metal content in Rice Snails (Pila ampullacea) from Rawa Taliwang Lake using the Atomic Absorption Spectrophometry (AAS) method at the Environmental Laboratory of NTB Province showed that the flesh of rice snails (Pila ampullacea) was detected to contain cadmium (Cd) heavy metal on average ranging from 0.18 mg/kg to 0.19 mg/kg. Based on these results, the cadmium (Cd) heavy metal content in the flesh of rice snails (Pila ampullacea) from Rawa Taliwang Lake is still below the maximum threshold of heavy metal contamination in processed food according to BPOM regulation No.9 of 2022 regarding the Maximum Limit of Cadmium (Cd) Heavy Metal Contamination allowed in Processed Food in Gastropods, which is 0.30 mg/kg.

However, the presence of cadmium (Cd) heavy metal in such small amounts should still be considered by people around Rawa Taliwang Lake who consume rice snails (*Pila ampullacea*). It is because cadmium (Cd) heavy metal is toxic, accumulative, and non-degradable, and if consumed continuously, it will accumulate in the body and endanger human health. Therefore, the surrounding community needs to pay attention to Rawa Taliwang Lake's condition for the biota's survival and safety.

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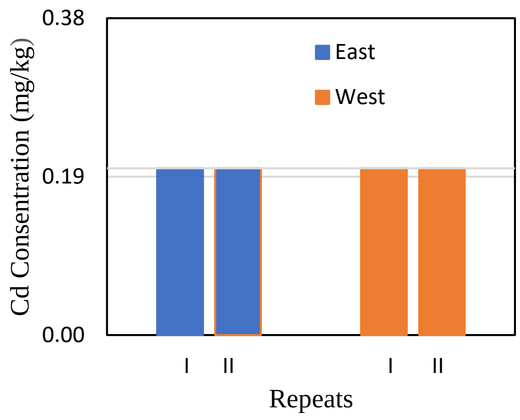

Figure: 2. Cadmium (Cd) Heavy Metal Concentration in Rice Snails from Rawa Taliwang Lake

Source of Cadmium in Rawa Taliwang Lake

Heavy metal cadmium (Cd) in the waters of Rawa Taliwang Lake is derived from the activities in the hilly areas around the lake. These activities affect the accumulation of heavy metals in the waters of Rawa Taliwang Lake [18]. Remnants of cadmium and other heavy metals used in rocks to extract gold can be carried by water into the waters of Danau Rawa Taliwang, accumulating heavy metals in the water and aquatic organisms living in it.

Based on observations made by researchers, another activity that contributes to the accumulation of heavy metal cadmium in the area is agricultural activities around Rawa Taliwang Lake. Farmers' activities that use chemical fertilizers and pesticides to enhance growth and control plant pests and diseases can pollute lake waters. It is supported by research [24], which states that farmers' habits in using fertilizers for various agricultural crops, such as fungicides, insecticides, herbicides, and other types of poisons, can contribute to heavy metals in the area. The fertilizer commonly used by farmers for their crops is phosphate fertilizer [25]. Phosphate fertilizers contain heavy metal elements as by-products, such as Pb, Cd, Cr, Co, Hg, Ni, and As. In the long term, excessive use of fertilizers and pesticides can increase the content of heavy metal cadmium as a stabilizing agent, which, if not absorbed by plants in agricultural land, can be carried into the Rawa Taliwang Lake [26].

In addition, because Rawa Taliwang Lake is located in a water catchment area sourced from several rivers in West Sumbawa Regency, it increases the risk of Cd metal pollution due to human activity waste such as household and industrial waste. Cd metal pollution can come from household, livestock, human, and wood industry waste [17]. These wastes can enter lake waters and pollute the biota that live in them.

Many cases of heavy metal pollution have been studied in water bodies in Indonesia as informed by the research results by [27], which found heavy metal Cd contamination in Gonggong Snails in Bukit Bestari Waters, ranging from 0.031-0.036. It proved that the average measurement of cadmium metal levels had stayed within the predetermined quality standards. On rice snails obtained from rice fields in the Rancaekek District area that Cu levels in each sample of rice snails (65.7 mm/kg, 3.5 mm/kg, 6.2 mm/kg, 5 mm/kg, 5.8 mm/kg, 6.2 mm/kg, and 4.9 mm/kg) did not exceed the maximum threshold for metal contamination in a food regulated by the Decree of the Director General of Drug and Food Control No.03725/B/SK/VII/1989) and also safe for daily consumption with a consumption limit of no more than one kilogram per day [11]. Similar results are also in line with [28] research but in different aquatic biota; it was found that there was a heavy metal Cu content in milkfish flesh of 0.621 mg/kg from Bima Bay milkfish farms. The Cu content is still below the threshold according to the Director General of POM Decree No.03725/B/SK/VII/89, which is 20.0 mg/kg. Similarly, [29] research conducted in Rawa Taliwang Lake found that the Cu metal content is still far below the threshold set by the Decree of the Directorate General of Food and Drug Control No. 03725/B/SK/89 concerning the threshold of metal contamination in fish and its processed products, which is 20 mg/kg. The Cu metal content is suspected of coming from agricultural activities because Rawa Taliwang Lake is located in an area surrounded by rice fields; the source of Cu pollution comes from the use of Phosphate fertilizers containing Cu metal by farmers.

Environmental Parameter

The accumulation of cadmium heavy metals in the flesh of rice snails can be found because it is influenced by several environmental parameters such as temperature, pH, and salinity. Temperature, pH, and salinity changes can make different levels of heavy metal bioaccumulation in water areas [30]. Temperature measurements at each location in Rawa Taliwang Lake were carried out using a thermometer. The measurement results showed that the water temperature obtained on the east and west sides of Rawa Taliwang Lake was 29ºC. The normal water temperature range is between 28-32ºC [31]. Therefore, the water temperature in Rawa Taliwang Lake is normal and does not affect the heavy metal content in the lake waters. If the water temperature rises, it will cause heavy metal accumulation in fish and snail tissues. An increase in temperature in waters can increase the rate of toxicity and accumulation of heavy metals [29].

Table: 1. Environmental Parameters

Location	Environmental Parameter		
	Temperature	Salinity	pH
East Side	29^{o}C	<0.5	7.9
West Side	29^{o}C	<0.5	7.8

pH will affect the concentration of heavy metals in the waters; in this case, the solubility of heavy metals will be higher at low pH, causing greater heavy metal toxicity [32]. pH measurements using a pH meter showed that on the east side, a pH of 7.9 was obtained, and on the west side, a pH of 7.8. The normal pH of good water for the survival of aquatic organisms ranges from 6-9 [33]. Therefore, the pH of the water in the waters of Rawa Taliwang Lake is normal and good for the survival of aquatic organisms there.

In contrast to pH, if salinity decreases, it will increase the accumulation of heavy metals in the body of organisms [34]. Salinity measurements were carried out using a salinometer, which showed that the salinity of water in both research locations was <0.5 ppt, which means that the dissolved salt content in the water at the research site is very low. It is in line with [35], which states that the value of freshwater salinity is below 0.5 ppt.

The results of this study are expected to be used to enrich the Environmental Knowledge course material. They can also be useful as information for people around Rawa Taliwang Lake who consume rice snails. Therefore, further research is needed related to heavy metal content in aquatic organisms in Rawa Taliwang Lake by further expanding the types of biota, types of heavy metals, sampling points, and the number of samples used.

CONCLUSION

The Cadmium content in the flesh of rice snails (*Pila ampullacea*) from Rawa Taliwang Lake was 0.19 mg/kg, which means that it is suitable for consumption because it is below the maximum threshold of cadmium (Cd) contamination allowed in gastropods which are 0.30 mg/kg according to the Food and Drug Administration Regulation No. 9 of 2022. These results can be used to enrich environmental knowledge lecture materials.

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