Heavy Metals Content in Tissues of Feather back Fish (*Notopterus notopterus*) from the Sail River, Pekanbaru

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Abstract. This study aimed to determine the concentrations of heavy metals (Cd, Cr, Pb, Zn, Fe, and Cu) in gills, muscles, kidney, bone, liver, and reproductive organs of *Notopterus notopterus* from the Sail River. The results showed that the concentrations of heavy metals in each tissue of fish were as follow: muscles > reproductive organs > liver > kidney > gills; liver > bone > kidney > muscles > reproductive organs > gills for Cd; liver > bone > kidney > muscles > reproductive organs > gills for Cr; gills > kidney > bone > muscles > liver > reproductive organs for Pb; gills > bone > reproductive organs > kidney > liver > muscles for Zn; gills > muscles > liver > kidney > reproductive organs > bone for Fe; bone > liver > kidney > muscles > gills > reproductive organs for Cu. Concentrations of Cr (95.62 mg/kg) was highest than 5 others heavy metals. The average of metal concentrations of Pb (35.62 mg/kg), Zn (88.47 mg/kg), and Fe (2.35 mg/kg) were highest in the gills. The estimated concentrations of Cd, Cr, Pb, Fe were higher and Zn, Cu were lower than the limits permitted.

Keywords: metal concentrations, essential metal, non-essential metal, *Notopterus notopterus*.

1. Introductions

Heavy metals in the waters are increasingly coming from industrial sources around the aquatic environment and domestic waste dumped into the waters [1,2,]. Heavy metals are toxic pollutants that are important for aquatic organisms [3] if it is accordance with quality standards. Heavy metal pollution is a serious environmental problem, widespread, and can accumulate fish and other organisms [4]. Iron (Fe), Copper (Cu), and Zinc (Zn) are essential metals, having an important role in biological systems [5]. Cadmium (Cd), Chromium (Cr), and Lead (Pb) are non-essential metals that are toxic in waters. Lead is not needed for biological functions of animals even at low concentrations [6].

Featherback fish (*Notopterus notopterus*) is one type of fish that is commonly found and caught in the Sail River. Fish is an indicator of pollution in waters [7,8,9,10]. Each fish organ has different metal concentrations [11] such as the gills, muscles, kidneys, bones, liver, reproductive organs and other organs. In the body of the fish, gills are indicators of water pollution [12].

Sail river is one of the largest Siak creeks among other creeks in the city of Pekanbaru. Along the Sail river there are residential areas and various society activities [13], such as agriculture, plantations, and other activities [14] which directly dispose of pollutants and enter the river. Pollution
of heavy metals in the waters will cause a decrease in water quality and the life of aquatic organisms will also be disrupted. However, there is still little research on the content of heavy metals in fish organs in the Sail River. This study aims to determine the content of heavy metals (Cd, Cr, Pb, Zn, Fe, and Cu) in the gills, muscles, kidneys, bones, liver, and reproductive organs of featherback fish in the Sail River Pekanbaru.

2. Material and Method

Featherback fish sampling. The research location is in the Sail River, Pekanbaru at coordinates 0°32'29.5044"N 101°28'5.988"E (Figure 1). The study was conducted by survey method. Fish samples (35 samples) were captured three times in December 2017 - February 2018 using trap-type fishing gear installed in the tidal area.

Figure 1. Sampling area

Sampling of featherback fish organs. Fish are categorized by size class (small, medium, and large). Then the fish was dissected and taken: gills and muscles (at least 5 g), kidneys, bones, liver, and reproductive organs (at least 2.5 g).

Analysis of heavy metal content in featherback fish organs. Analysis of heavy metal content is carried out through destruction, filtering, and making standard solutions. Pb solution was obtained from Pb(NO₃)₂, Zn was obtained from ZnSO₄, Cd was obtained from Cd(NO₃)₂, Cr was obtained from CrSO₄, Fe was obtained from Fe(NO₃)₂, and Cu was obtained from CuSO₄. Then the solution was diluted to 4 concentrations of 0.00 ppm, 0.05 ppm, 0.1 ppm and 1 ppm.

Calculation of heavy metal concentrations. Examination of heavy metal concentrations used the Atomic Absorption Spectrophotometer (AAS) brand of Perkin Elmer 3110. Calculation of heavy metal content of the sample was carried out according [15] formula:

\[
K = \frac{D \times B}{A}
\]

Where:
- \(K\) = The actual concentration of the sample (µg/g)
- \(D\) = The content is calculated based on the absorbance value (mg/L)
- \(B\) = Sample volume (L)
- \(A\) = Sample weight (g)

Data Analysis. The analysis was conducted descriptively by referring to the literature and compared with the quality standard values referring to the Decree of the Directorate General of Drug and Food Control (POM) of the Ministry of Health of the Republic of Indonesia No. 03725/B/SK/1989.
3. Results and Discussion

Results

The total sample of featherback fish caught were 35 fishes (7 males and 28 females). After measured the length of the class, the featherback fish are grouped into 3 size classes: small size 12.7 - 17.8 cm (13 samples), medium size 17.8 - 22.9 cm (12 samples), and large sizes 22.9 - 28 cm (10 samples). Heavy metals contained in the body of featherback fish differ in each organ (Figure 2). Based on the results of this study, the highest

![Figure 2. Histogram of the average heavy metal content in the organs of featherback fish](image)

and lowest heavy metal concentrations in each heavy metal are: the highest Cd in large fish muscle (2.95 mg/kg) above the quality standard (0.5 mg/kg) and lowest in large fish bones (0.39 mg/kg) is
below the quality standard (0.5 mg/kg). The highest Cr in large fish liver (95.62 mg/kg) is above the quality standard (20 mg/kg) and the lowest in large fish reproductive organs (11.78 mg/kg) is below the quality standard (20 mg/kg). The highest Pb in the gills of large fish (35.62 mg/kg) is above the quality standard (2 mg/kg) and the lowest in large fish muscle (1.75 mg/kg) is below the quality standard (2 mg/kg). The highest Zn in the gills of small fish (88.47 mg/kg) and the lowest in the muscles of large fish (40.43 mg/kg), is below the 100 mg/kg quality standard. The highest Fe in the gills of small fish (2.35 mg/kg) and lowest in the bones of large fish (0.69 mg/kg) is above the 0.5 mg/kg quality standard. The highest Cu in the bones of small fish (15.83 mg/kg) and the lowest in the reproductive organs of large fish (0.25 mg/kg) is below the quality standard of 20 mg/kg. For Cd, Cr, Pb, and Fe are above the quality standard while Zn and Cu are below the quality standard.

Comparison of heavy metal content in the body of featherback fish varies in each organ. Based on the results of this study, it is known that the order of the concentration of heavy metals contained in the body of featherback fish is as follows:

Cd: Muscle > reproductive organs > liver > kidney > gills and bones
Cr: Liver > bone > kidney > muscle > reproductive organs > gills
Fe: Gills > muscle > liver > kidney > reproductive organs > bone
Zn: Gills > bones > reproductive organs > kidney > liver > muscles
Pb: Gills > kidney > bone > muscle > liver > reproductive organs
Cu: Bone > liver > kidney > muscle > gill > reproductive organs

**Discussion**

The large number of female fish caught because in December to February when fish is in the spawning season. This is consistent with the statement [16], that the featherback fish spawning season is when the water is big or when it rains often (November - January). The number of fish caught as many as 35 samples and dominant females (28 samples) is not much different from the results [17] obtained by catching 50 samples (32 females) and also the size of fish that are relatively similar between 12 - 30 cm. Featherback fish are carnivores and cannibals [18].

The content of heavy metals in an organism can be caused by several factors, including differences in growth rate, speed of metabolism, the level of body sensitivity to the inclusion of certain heavy metals and physiological needs for metals [19]. It is also influenced by gender, age, size, eating habits, and environment [20]. Heavy metals in general have toxic and dangerous properties for living organisms, although they are in low concentrations [21].

The highest Cadmium (Cd) content in large fish muscle (2.95 mg/kg) is above the quality standard (0.5 mg/kg). [22] reported that, the solubility characteristics of Cd that easily settles in sediments and are numerous in the bottom of the waters. The high metal content of Cd is quite high due to the accumulative nature of metals in meat and tissues, so that in a long time heavy metals can accumulate and cause heavy metal content to increase [23]. Cd use consists of fertilizers, agricultural chemicals, agricultural land waste, contributing to water contamination [24].

Chromium (Cr) is an important nutrient needed for metabolism [25]. The highest metal accumulation is usually in detoxification (liver) and excretion (kidney) [26]. In this study, the highest Cr concentration in large fish liver (95.62 mg/kg). Fish assimilates Cr by swallowing or by gill absorption channels and accumulation in fish tissue, especially liver [27, 28].

Lead (Pb) is a persistent heavy metal that has been characterized as a hazardous substance [28]. Pb is present in various fish organs such as liver, kidneys, and spleen as well as the digestive tract and gills [29]. In this study, the highest Pb was in the gills of large fish (35.62 mg/kg). Same [30] that the highest Pb was found in gills. Usually Pb levels in fish are found highest in the gills, followed by the digestive tract and fish meat. This is in accordance with physiological processes in the body of fish [31]. According [32], Pb absorption in the body is very slow, resulting in accumulation and being the basis of progressive poisoning.

The highest Iron (Fe) in the gills of small fish (2.35 mg/kg) and lowest in the bones of large fish (0.69 mg/kg) is above the 0.5 mg/kg quality standard. Fe in waters can accumulate into the body
of organisms through the body surface, absorbed by gills and food chains. Heavy metals that enter the fish body cannot be removed anymore from the body, because heavy metals tend to accumulate in the body of the fish. As a result, Fe will continue along the food chain [33].

Zinc (Zn) is the second most abundant trace element after Fe and is an essential and micronutrient element in living organisms [28]. The highest Zn is in the gills of small fish (88.47 mg/kg). The main target of Zn toxicity through water is gills [34]. Zn is included in metals that do not accumulate in the body. Excess Zn in the fish's body will be excreted through the excretion system [35] so that the concentration of Zn is below the quality standard of 100 mg/kg.

Copper (Cu) is an important metal for cell metabolism in living organisms [36]. According [36], Cu is an essential metal for aquatic animals which is useful in the formation of blood system haemocyanins and in enzymatic aquatic animals. The highest Cu in the bones of small fish (15.83 mg/kg) and the lowest in the reproductive organs of large fish (0.25 mg/kg) is below the quality standard of 20 mg/kg. Same with the statement [37] that the highest content of heavy metal is in the gills, bones and scales.

In Pb, Zn, and Fe the highest concentration was in the gills. Gills are an important part of the entry of heavy metals [38]. Thus, gills in fish are more often recommended as environmental indicators of water pollution than other fish organs [39]. Heavy metals accumulate into the body of organisms through the body surface, absorbed by the gills and the food chain [40]. For Cd, Cr, and Pb the highest heavy metals accumulate in large fish due to a longer lifespan in the waters, similar [32] which states that fish that are longer and have a larger size have greater potential for the accumulation of higher levels of heavy metals in the body. The higher rainfall intensity, can affect the rate of decay of heavy metals in waters [41], this can affect the high accumulation of heavy metals in fish.

It is expected that sustainable management and efforts to monitor water quality and socialization to the society about limit consumption of featherback fish contaminated with heavy metals.

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