



Bioaccumulation of Selected Metals in Fresh Water Haruan Fish (*Channa striatus*) Collected from Pahang River Basin, Malaysia

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ABSTRACT

A study on Copper (Cu), Zinc (Zn) and Lead(Pb) concentration in fresh water fish *Channa striatus* -Haruan fish in Pahang, Malaysia was conducted. Three types of fish organs were studied. The organs were; liver, muscle and intestine. They were dissected and dried before the digestion process using HNO₃, H₂SO₄, H₂O₂ and HCL. Inductively Coupled Plasma Spectrometry (ICP-MS) was used for the detection of heavy metals. There was a significant variation in the concentration of zinc was observed between tissues of the studied fish ($P < 0.05$) while copper and lead showed no significant difference in accumulation between selected tissues. Nevertheless, the findings from this study revealed that all the heavy metals concentrations in the tissues were lower than the maximum permissible limit as recommended by The Malaysian Food Regulation and hence safe for human consumption. Long term monitoring study is needed to implement various fishery management plans to safeguard the quality of *C. striatus* wild stock.

Key words: Heavy metals ; *Channa striatus*; Pahang river, Bioaccumulation.

INTRODUCTION

Heavy metals are natural components of the earth's crust that cannot be degraded or destroyed. They are metallic elements that have a relatively high density, toxic and poisonous. According to many researchers (Blaber, (2000; Farombi, *et al.*, 2007; Ashraj, 2005; Brewer, 2010), heavy metals can cause contaminations that result in a long lasting effect on

the ecological balance of the environment and the diversity of the different aquatic species living in it. Mansour and Sidky (2002) stated that, among the aquatic species, fishes are the mostly endangered as they cannot escape from the effects of these pollutants. They can accumulate large amounts of heavy metals from the waters inside their body. Fishes are an essential source of nutrition, they are high in protein and a great source of omega-3 fatty

acids, vitamins and can reduce the risk of various diseases such as heart attacks, strokes, diabetes, Alzheimer's disease and sudden death. Although the consumption of fish can benefit its consumers and shape up their health, it can also raise some health concerns as it can be contaminated with toxic metals from the pollution of their aquatic environment (Kennish, 2001; Madhusudan *et al.*, 2003; Kojadinovic *et al.*, 2006). Despite the fact that most heavy metals such as mercury, cadmium and lead are toxic and dangerous, there are some heavy metals that are essential and must be taken in small quantities such as iron, copper, manganese and zinc (Vosyliene and Jankaite, 2006; Mohammad and Hossam, 2007; RinaSharlindaZabri, 2009).

Heavy metals accumulate in the tissues of marine organisms and fishes can easily absorb those heavy metals from the waters, and by measuring the levels of heavy metals accumulation; previous exposures can be known (Basa *et al.*, 2003; Ashraf, 2005). Even though there is a noticeable concentration on pollutions caused by heavy metals, there is still a shortage of data and researches on the accumulation of heavy metals in fresh waters commercial fish species in Malaysia.

Haruan is also known as snakehead fish belongs to the family *Channidae*. Haruan is available throughout the year in Malaysia. Due to its popularity and increasing consumption in Malaysia, there is an urgent need to know the existing status of heavy metals in the different organs of this fish and to know whether it is alarming to consume in the future. Thus, this research was conducted to determine the accumulation of selected metals such as copper, zinc and lead in one of fresh waters species (*Channa striatus* – Haruan fish) for this study.

MATERIALS AND METHODS

Sample collection and preparation

The fish samples (N=158) were collected from local fish market where the fish are caught from fresh waters areas in Pahang. The collected fishes were then placed in an icebox. After that they were transported to the laboratory and kept in at -20 °C freezer before further analysis. Firstly, all the fish samples were thawed to room temperatures after being excelled from the freezer. Then, they were

rinsed with distilled water to remove sands and debris possibly trapped in its organs. At the same time, acid-washed Petri dishes were prepared with labels before the dissection process took place. The liver, muscle and intestine of each fish were excised using sterile scissors and forceps and cleaned running tap water and then with sterile distilled water. The dissected parts were placed in the Petri dishes for drying purposes in the oven at 60°C for a week period. After the drying period, the samples were inspected for any moisture in accordance to the procedures described by (Rina, 2009). The samples were then kept in acid-rinsed containers for determining its constant weights.

Heavy metal analysis Open Digestion Method

Sample preparation and analysis were carried out according to the procedure described by (Kamaruzzaman *et al.*, 2011). Samples for heavy metal analysis (including SRM and blank) were digested in Teflon beakers containing 10ml of concentrated HNO₃, 2ml of concentrated H₂SO₄, 3ml of H₂O₂ and 2ml of HCL on the hot plate at 60 °C for about two hours to ensure complete digestion of all organic matters. When the digestion was completed, the solutions were left to cool down in ambient temperature. After cooling down, the digest were transferred into falcon tubes and were double washed with ultrapure water to ensure that the entire digest were transferred into the tube. The digest were made up to 50 ml by adding HNO₃ (5%). Clear solutions with no residues were obtained at this stage for samples as well as the blank and SRM. The digestion composition was then analyzed using a multi-element technique known as Inductively Coupled Plasma-mass Spectrometry (ICP-MS)

Data analysis

Calculation of Metal Content (µg/g dry weight) was carried out using following formula

$$\frac{\text{Metal Content (µg/g dry weight)} \times \text{constant weight}}{\text{constant weight} \times 1000}$$

and the Percentage Recovery was calculated using standard formula. One - way ANOVA was used to analyze the data obtained as it has the ability to test the quality of three or more means at one time by using variances. Analysis of Variance test was performed to determine the significant variation in the metal accumulation between the tissue samples.

RESULTS AND DISCUSSION

The results of calibration standards showed coefficient correlation (R) values greater than 0.995 which showed that the ICP-MS could produce acceptable data of the metals detected.

In addition, the percentage recovery values for the Standard Reference Material (SRM) which is oyster tissue 1566b were obtained in accordance to the heavy metals studied in this research. The values are well within the range of 96 % to 104 % (Table 1).

Copper (Cu) Concentration in Fish Organs

The concentration of copper observed in different parts of the fish is shown in Figure 1. The concentration of copper in different organs of the fish showed no significant variation ($p > 0.05$).

However, the observed copper concentration was higher in liver followed by muscle and intestine. Similar studies on other fresh water fish species conducted by (Alweher, 2008) showed significant difference in the accumulation of heavy metals in fish. The difference in findings can be due to the variation in the environment where the fish lives in, where several crucial factors such as temperature,

Table 1: Percentage Recovery of SRM 1566b Oyster Tissue

Metal	SRM 1566b Oyster Tissue		
	Analyzed Value	Certified Value	Recovery (%)
Cu	70.00	71.6 ± 1.6	97.77 %
Zn	1480.00	1 424 ± 46	103.93 %
Pb	2.60	0.308 ± 0.009	104.84 %

Table 2: ANOVA results of heavy metals in *Channa striatus* organs

		Sum of Squares	df	Mean Square	F	Sig.
Liver	Between Groups	111.558	2	55.779	3.415	.060
	Within Groups	245.021	15	16.335		
	Total	356.579	17			
Muscle	Between Groups	16.587	2	8.294	1.276	.308
	Within Groups	97.530	15	6.502		
	Total	114.118	17			
Intestine	Between Groups	8.989	2	4.495	1.183	.333
	Within Groups	56.986	15	3.799		
	Total	65.976	17			

Table 3: Maximum permitted levels in fish enforced by Malaysia

Country	Concentration (µg/ g dw)		
	Cu	Zn	Pb
Malaysian Food Regulation (1985)	30	100	2
Present study			0.031
Liver	5.843	4.535	
Muscle	2.237	1.824	0.012
Intestine	1.731	1.201	0.039

salinity, habitats can affect the accumulation of heavy metals. It might also be due to detoxifying ability of liver that tend to accumulate comparatively large amount of copper in liver tissue.

Zinc (Zn) Concentration in Fish Organs

The concentration of zinc observed in different parts of the fish is shown in figure 2.. Significant difference in Zn accumulation was observed between organs ($p < 0.05$). Similarly Yilmaz, (2009) stated that the liver had higher concentration of zinc compared with muscle in *Oreochromis niloticus*, *Anquilla anquilla* and *Mugil cephalus*. This was due to the fact that the liver

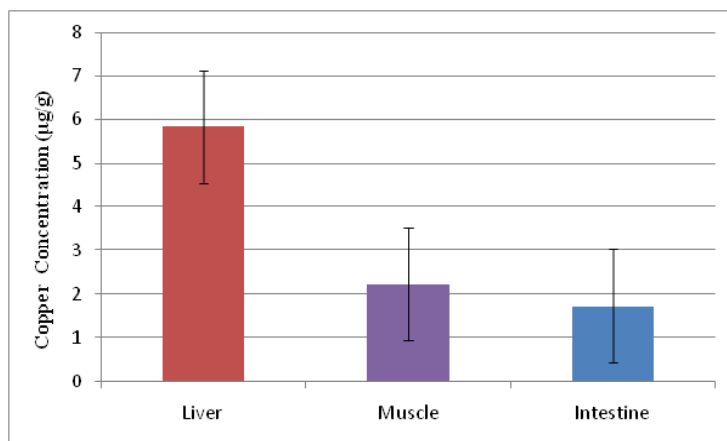


Fig. 1: Copper content in liver, muscle and intestine in *Channa striatus* - Haruan Fish. Bar with no letter are not significantly different ($p < 0.05$). Data are mean \pm standard deviation

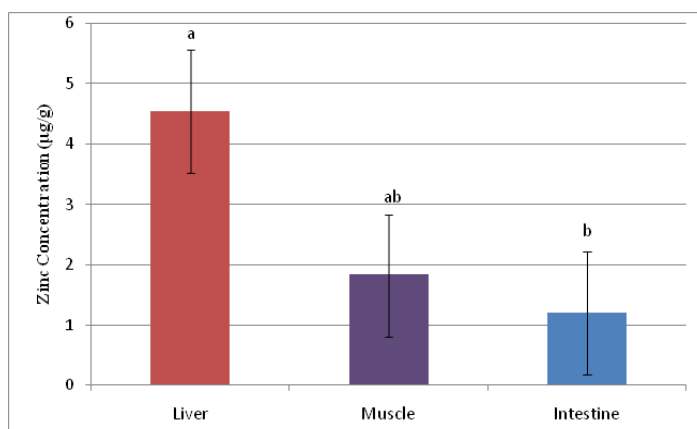


Fig. 2: Zinc content in liver, muscle and intestine in *Channa striatus* Haruan fish. Bar with no letter in common are significantly different ($p < 0.05$). Data are mean \pm standard deviation

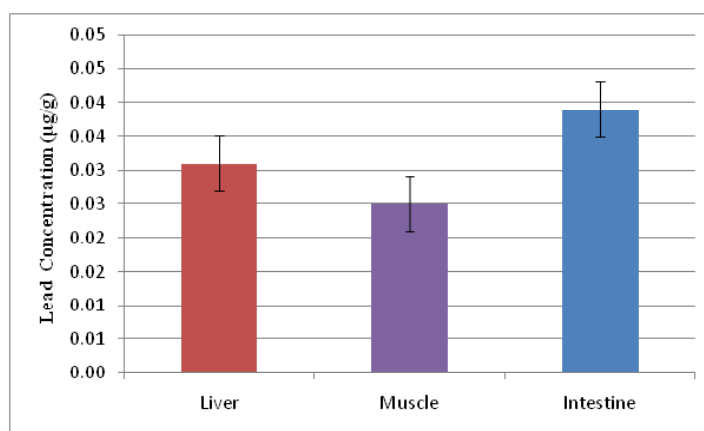


Fig. 3: Lead content in liver, muscle and intestine in *Channa striatus* Haruan fish. Bar with no letter are not significantly different ($p < 0.05$). Data are mean \pm standard deviation

is a target organ that accumulates a large amount of heavy metals because of its strong irrigation and extraction function. According to Yilmaz (2009), livers can also be indicators of the degree of pollution in the ecosystem. Meanwhile, muscle and intestine showed lower values of zinc because they are not active tissues in accumulating heavy metals.

Lead (Pb) Concentration in Fish Organs

The concentration of lead observed in different parts of the fish is shown in figure 3. No significant difference in Pb accumulation was observed between organs ($p > 0.05$). However, the related study by Vinodhini and Narayanan (2008) showed that there was significant difference of lead in liver and muscle in *Cyprinus carpio* with a value. The variation between the findings might be due to the different types of species that were studied that have different ability in accumulating the lead. Another study conducted by Yilmaz (2009) showed variation in lead mean values in organs of different species which were *Oreochromis niloticus*, *Anquilla anquilla* and *Mugil cephalus*.

Comparison of heavy metals showed no significant difference in the liver, muscle and intestine of *Channa striatus* (Table 2). The results obtained are similar with the (Al-Weher, 2008) findings which showed that no significant difference in muscles between copper and zinc in *Oreochromis aureus*, *Cyprinus carpio* and *Clarias lazera*. The results obtained are low and well within the permissible limit that is stated by The Malaysian Food Regulation 1985 that is shown in Table 3. The results of the present study indicate no evidence of noticeable pollution of the fish from Pahang, Malaysia.

CONCLUSION

In conclusion, Copper and lead accumulation in selected organs were not significantly different while Zinc showed significant difference in bioaccumulation between organs ($P < 0.05$). The results obtained has clearly showed that the existing concentration of heavy metals in different tissues of *Channa striatus* lower than national maximum permissible limits and hence safe for consumption.

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