ANALYSIS ON THE CONTAMINATION OF TOXIC METALS IN THE MUSCLE OF SELECTED FISH SPECIES, WATER AND SEDIMENT FROM KAUNG-HMU-DAW IN (LAKE), SAGAING TOWNSHIP

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Abstract

A total of five fish species; two herbivores (*Labeo rohita* and *Oreochromis* sp.), two carnivores (*Glossogobius giuris* and *Channa striata*) and one omnivore (*Trichopodus pectoralis*) from Kaung-hnu-daw In (Lake), Sagaing Township, Sagaing Region was selected to assess the toxic metals such as lead (Pb), cadmium (Cd) and arsenic (As) during the study period from February 2019 to January 2020. Samples of fish muscles, water and sediment were collected on seasonal basis and analysed by Flame Atomic Absorption Spectrometer (FAAS) in Universities' Research Center (URC) at University of Yangon. The concentration levels of studied fish species except *T. pectoralis* was observed to be lower than that of FAO/WHO (2001) maximum permissible limits. Arsenic (As) concentration of *T. pectoralis* was found to be higher than the maximum permissible limit in cold season. Moreover, Cd, Pb and As concentration levels of water and sediment were detected far exceed than the FAO/WHO (2001) permissible limit.

Keywords: toxic metal, herbivore, carnivore, omnivore, permissible limit

Introduction

Nearly one billion people, most of them in developing countries, currently depend on fish for their primary source of protein (Toth *et al*., 2012). Fish is an important part of the human diet because of its high nutritional quality (Sioen *et al.,* 2007).

At present, the pollution has become a serious threat, and has brought hazards to the growing population as well as the environment. The speedy urbanization and industrialization has led to increase disposal of pollutants like heavy metals, radio nuclides, and various types of organic and inorganic substances into the environment (Praveena *et al.,* 2013).

Heavy metals refer to those metallic element which has density of about 5 gcm^3. Heavy metals such as copper, iron, chromium, zinc and nickel are essential metals since their play an important role in biological role in biological systems, whereas cadmium, lead, mercury and arsenic are non-essential metals, as they are toxic, even in trace amounts (Fernandes *et al.,* 2008). For the normal metabolism of the fish, the essential metals must be

taken up from water, food or sediment (Canh and Ath, 2003).

Toxic metals such as lead, mercury, cadmium and arsenic are biological contaminant of special concern due to a wide distribution in the environment and likely adverse effects for human health. The accumulation of toxic metals can have middle term and long term health risks and strict periodic surveillance of these contaminants is therefore advisable (Narvaes, 2002).

Water and sediment of the polluted sites contains various levels of heavy metals. Measurement of heavy metals in both water and sediment samples can show the condition of the ecosystem regard to heavy metal pollution. On the other hand, aquatic organisms are the target of heavy metal intoxication, which accumulate large volume of heavy metals in their tissues. Therefore, determination of heavy metals in the aquatic organisms' tissue may be valuable and informative (Saghali *et al.,* 2012).

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Kaung-hmu-daw In (Lake) is a seasonal lake formed by the flooding of Ayeyawady River during the rainy season of each year and is bound on the east by Phu-kan Lake, on the south by Myay-thin Lake, on the west by Maung-ma-kan Lake and on the north by Kaung-hmu-daw pagoda. Since the Ayeyawady River and Kaung-hmu-daw Lake are indirectly connected, this lake receives not only water but also most of the fishes from the river; this inturn serve these fish for local people.

The present study was conducted with the following objectives:

- to measure the levels of heavy metals such as lead (Pb), cadmium (Cd) and arsenic (As) in the muscle tissues of five fish species, water and sediment of Kaung-hmu-daw In (Lake)
- to assess whether levels of metals recorded in water conforms to the acceptable limits of heavy metals by FAO/WHO (2001) standard

Materials and Methods

Study area

Kaung-hmu-daw In (Lake) situated at 21˚ 55' 50" and 21˚ 54' 33" North latitudes and 95˚ 55' 12" and 95˚ 56' 45" East longitudes in Ayeyawady River in Sagaing Township, Sagaing Region, Central Myanmar were chosen as the study area to determine toxic metal concentration in some water and sediment and muscle of selected fish species (Fig. 1).

Study period

The present study was carried out from February 2019 to January 2020.

Collection of specimens

Five commercially important fish species were selected for determination of seasonal toxic metal concentrations in their muscles (Plate 1). Samples of water and sediment were also collected seasonally from the study area for analysis of toxic metals.

Fish sample preparation

Selected fish specimens were washed by tap water until the contamination on the body surface was runoff. Sample for each treatment consisted of 5 to 20 number of individuals fish from the study site. Total length (cm) and body weight (g) of specimens were measured. After that, the specimens were scaled by clean stainless steel knife. Only the edible parts (the muscles) of the fish species were used and samples were treated or prepared as though they were for human consumption. The muscle tissue was removed and weighed. Muscle samples were put in petri dishes to dry at 90 ˚C until reaching a constant weight in an oven and dried samples were weight and stored in airtight containers.

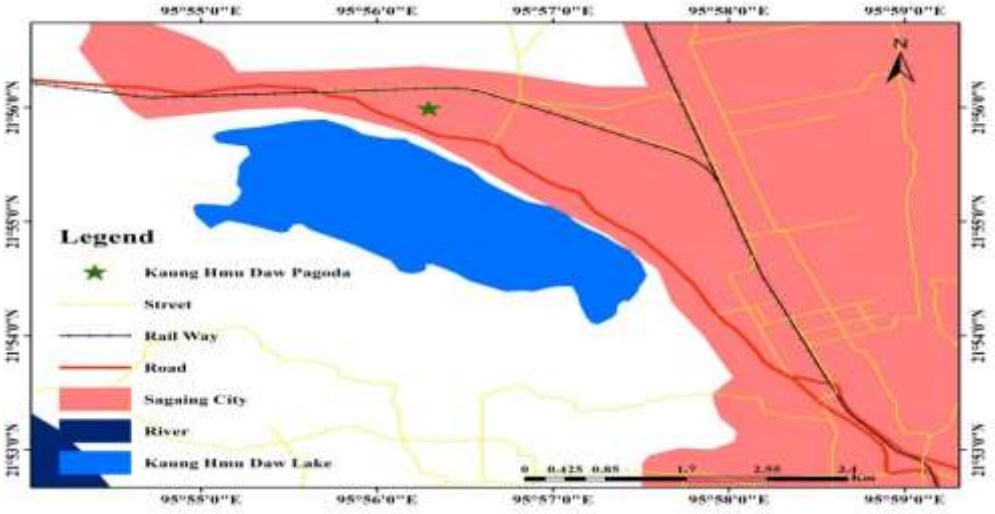
Water and sediment sampling

Water sample was seasonally collected with plastic bottle from the study site at depth of at least 35 cm depth. Metals analysis of water sample was filtered through a 0.45 micron Whatman filter. The samples were analyzed by FAAS.

The sediment sample was sun dried, grounded and sieved with 200 mm sieve to obtain a fine powder. The digested sediment sample was analyzed by FAAS.

Analysis of metals

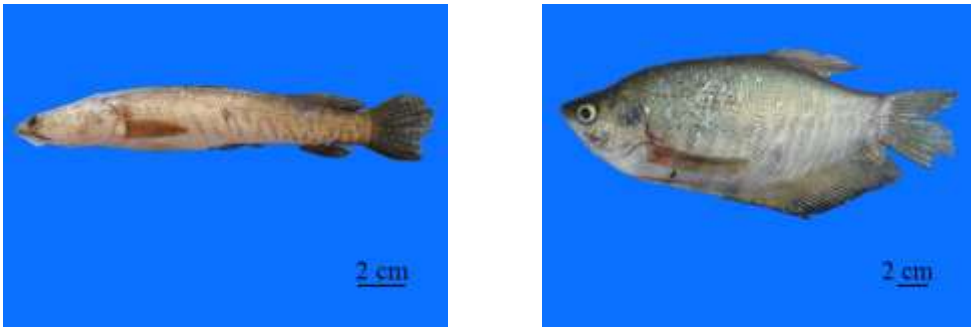
The concentration of metals in the fish samples, water and sediment were analyzed tri-replicates by Flame Atomic Absorption Spectrometer (FAAS) (Perkin Elmer AAanalyst 800 and Winlab-32 software) in Universities' Research Center (URC), Yangon. Seasonal variations of test results were compared with FAO/WHO (2001) maximum permissible limits.



Source: ArcGIS Software

Figure 1 Location map of the study area, Kaung-hmu-daw In (Lake)

A. *Labeo rohita* B. *Oreochromis* sp. C. *Glossogobius giuris*



D. *Channa striata* E. *Trichopodus pectoralis*

Plate 1 Selected study fish species

A. Muscle of fish sample

B. Dried fish muscle tissue

C. Pounder of the fish

D. Fish, water and sediment samples

E. Flame Atomic Absorption

Plate 2 Sample and apparatus used in sample analysis

Results

A total of five fish species from Kaung-hmu-daw In (Lake), Sagaing Township, Sagaing Region were selected to assess toxic metal contamination in the muscles. These selected fish species included two species of herbivores (*Labeo rohita*, *Oreochromis* sp.), two species of carnivores (*Glossogobius giuris*, *Channa striata*) and one species of omnivore (*Trichopodus pectoralis*) according to FishBase (2011). The selected fish species included three benthopelagic dwellers (*L. rohita, O.* sp. and *T. pectoralis*) and two bottom dwellers (*G. giuris* and *C. striata*) (Table 1).

In the present study, a total of 114 individuals comprising (30 individuals of two herbivorous fish species, 69 individuals of two carnivorous fish species and 15 individuals of one omnivorous fish species) were selected to test toxic metal contaminations in muscle tissue. The levels of metal content such as lead (Pb), cadmium (Cd) and arsenic (As): non-essential metals (toxic metals) were assessed in the muscle of the five species selected *(L. rohita, O. sp., G. giuris, T. pectoralis* and *C. striata*).

Lead (Pb) concentration levels of all studied species except *L. rohita* were higher in cold season than in other two seasons and Pb concentration 0.93 mg/kg of *L. rohita* in hot season. The levels of Pb in all studied fish species were below the maximum permissible limits (Pb in 1 mg/kg) established by FAO/WHO (2001) limits. Cadmium (Cd) concentration levels of all studied fish species were not detected in all seasons. In hot season, arsenic (As) concentration of 0.04 mg/kg recorded in *L. rohita*, 0.01 mg/kg in *G. giuris* and not detected in remaining three species. In rainy season, (As) was not detected in all studied fish species. In cold season, (As) concentrations of *T. pectoralis* was higher than FAO/WHO (2001) maximum permissible limits and not detected in other species (Table 2 and Fig. 2).

Lead, cadmium and arsenic concentrations of water environ was not detected in hot season. Lead and arsenic concentrations of water environ was found to be higher than those of FAO/WHO (2001) maximum permissible limit during rainy and cold seasons. Lead, and arsenic concentrations of sediment environ was observed to be higher than those of FAO/WHO (2001) maximum permissible limit in all seasons. Cadmium concentrations of sediment environ was observed to be higher than those of FAO/WHO (2001) maximum permissible limit in hot season but not detected in rainy and cold seasons (Table 4 and Fig. 4).

Table 1 Feeding types and habitats of studied fish species from Kaung-hmu-daw In (Lake)

Sr. No	Species studied	Feeding type	Habitats
1	*Labeo rohita*	Herbivore	Benthopelagic feeder
2	*Oreochromis* sp.	Herbivore	Benthopelagic feeder
3	*Glossogobius giuris*	Carnivore	Bottom feeder
4	*Channa striata*	Carnivore	Bottom feeder
5	*Trichopodus pectoralis*	Omnivore	Benthopelagic feeder

Table 2 Toxic metal contents (mg/kg) in the muscles of study fish species in hot, rainy and cold seasons compared with FAO/WHO (2001) limits

Species	Lead			Cadmium			Arsenic		
	Hot	Rainy	Cold	Hot	Rainy	Cold	Hot	Rainy	Cold
Labeo rohita	0.93	0.643	0.659	ND	ND	ND	0.036	ND	ND
Oreochromis sp.	ND	0.618	0.65	ND	ND	ND	ND	ND	ND
Glossogobius giuris	ND	0.607	0.657	ND	ND	ND	0.005	ND	ND
Channa striata	ND	0.601	0.639	ND	ND	ND	ND	ND	ND
Trichopodus pectoralis	0.1	0.615	0.637	ND	ND	ND	ND	ND	1.077
Mean	0.52	0.617	0.648	-	-	-	0.021	-	1.077
SD	0.6	0.016	0.01	-	-	-	0.022	-	-
FAO/WHO (2001) limits		1			0.2			0.26	

Table 3 Toxic metal contents in muscle tissues of studied fish species of different feedingtypes in hot, rainy and cold seasons

Feeding types	Species	Lead			Cadmium			Arsenic		
		Hot	Rainy	Cold	Hot	Rainy	Cold	Hot	Rainy	Cold
herbivore	*Labeo rohita*	0.93	0.643	0.659	ND	ND	ND	0.04	ND	ND
	Oreochromis sp.	ND	0.618	0.65	ND	ND	ND	ND	ND	ND
	Mean	0.93	0.631	0.655	ND	ND	ND	0.04	ND	ND
	SD	-	0.018	0.006	-	-	-	-	-	ND
carnivore	*Glossogobius giuris*	ND	0.607	0.657	ND	ND	ND	0.01	ND	ND
	Channa striata	ND	0.601	0.639	ND	ND	ND	ND	ND	ND
	Mean	ND	0.604	0.648	-	-	-	0.01	-	-
	SD	ND	0.004	0.013	-	-	-	-	-	-
omnivore	*Trichopodus pectoralis*	0.1	0.615	0.637	ND	ND	ND	ND	ND	1.077
	Mean	0.1	0.615	0.637	-	-	-	-	-	1.077

Table 4 Analysis of toxic metals in water and sediment of study area with the maximum permissible limits proposed by FAO/WHO (2001)

Sample	Toxic metalas	Hot season	Rainy season	Cold season	FAO/WHO (2001) guideline
Water	Lead	ND	0.633	0.615	0.5 mg/L
	Cadmium	ND	ND	ND	0.01 mg/L
	Arsenic	ND	6.043	3.694	0.01 mg/L
Sediment	Lead	30.75	0.768	0.682	0.5 mg/kg
	Cadmium	1.22	ND	ND	0.01 mg/kg
	Arsenic	0.089	10.12	16.8	0.01mg/kg

*ND = not detected

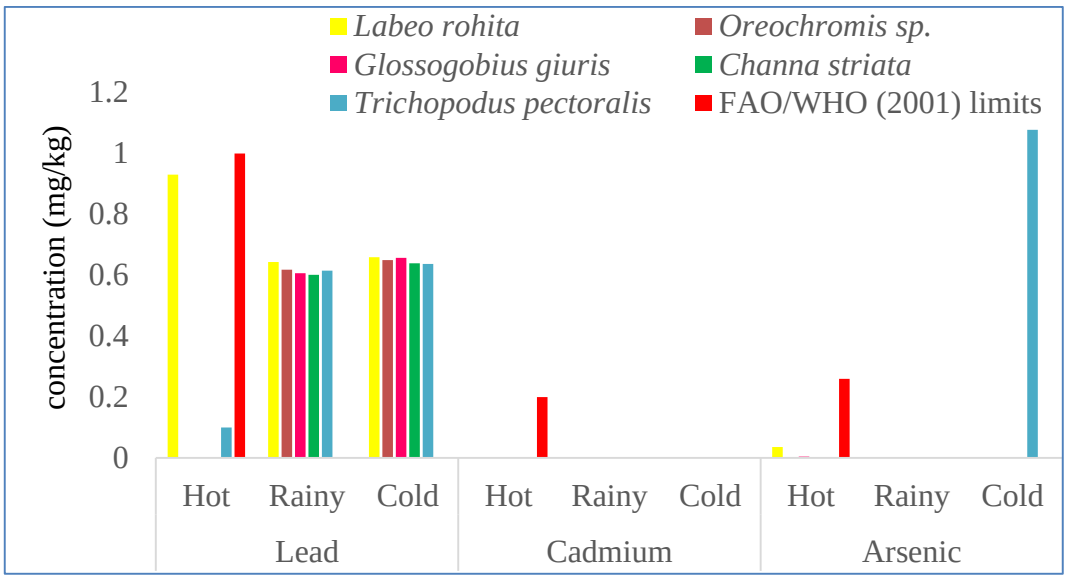


Figure 2 Comparison with FAO/WHO (2001) limits for toxic metal concentrations in studied fish muscles during hot, rainy and cold seasons

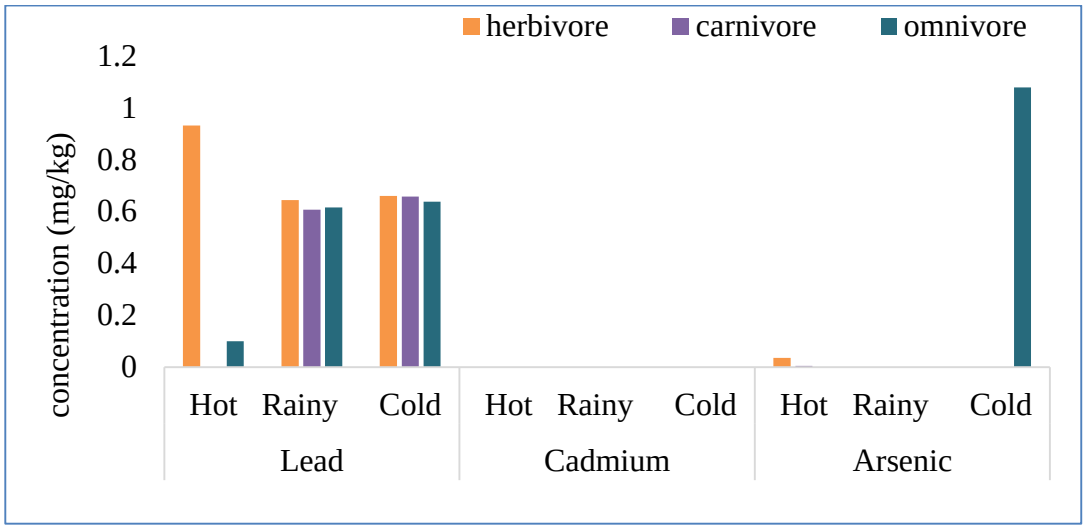


Figure 3 Toxic metal concentrations in studied fish species of different feeding types

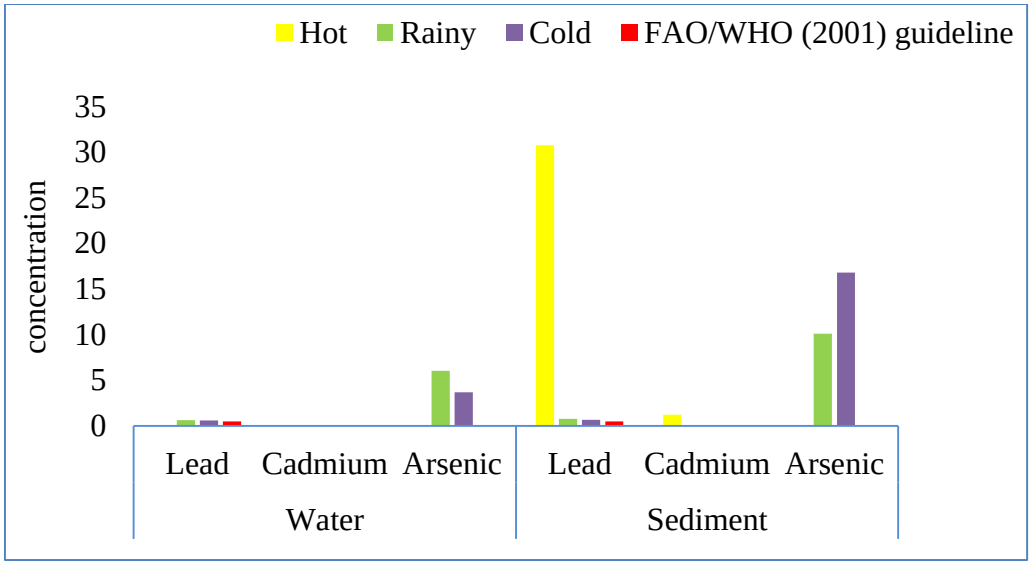


Figure 4 Toxic metal concentrations in water and sediment of study area compared with FAO/WHO (2001) limits during hot, rainy and cold seasons

Discussion

A total of selected five fish species; two herbivores, two carnivores and one omnivore fishes from Kaung-hmu-daw In (Lake), Sagaing Township, Sagaing Region were analysed for the presence of lead, cadmium and arsenic in the muscles during hot, rainy and cold seasons between February 2019 to January 2020.

Lead is toxic heavy metals. Lead can cause neurological and behavioral disorders, especially in children, anemia, impaired kidney and testicular function (Brazilay *et al*., 1999). In the present study, concentration levels of Pb were found below the FAO/WHO (2001) maximum permissible limits (1.0 mg/kg) in all seasons.

Nyein Chan San (2015) studied *Channa striata* from Chindwin River, Monywa Segment. He stated that Pb level far above the FAO/WHO permissible limits. The possible explanation for this could be difference in sizes and ages of fish species, sampling period and area conditions.

Cadmium is a non-essential element known to have a high toxic potential. Cadmium toxicity in human may affect some organs such as kidney, lung, bones, brain as well as central nervous system (Castro-Gonzalez and Mendez-Armenta, 2008). In present study, Cd was not detected in studied fish species Thus, consumption of fish from Kaung-hmu-daw In (Lake) could not pose any Cd induced health hazard.

Khin Myint Mar (2011) studied 25 fish species including *Oreochromis* sp. and *Channa striata* from Gaw Wein landing site of Ayeyawady River, Mandalay segment to determine for lead ,cadmium and mercury levels. She described that Pb and Cd concentration levels do not constitute a risk to human health. The results of the present study agreed with Khin Myint Mar.

Pandey *et al*. (2014) described that arsenic (As) can cause the cancer of skin, lung, liver, lymph, nasal passage, kidney, bladder, prostate and haematopoietic systems of humans. In the present study, arsenic (As) concentration of all species studied except one species, *T. pectoralis* were found below the maximum permissible limit. From the finding of this study, concentration levels of arsenic (As) in *T. pectoralis* was found to be over FAO/WHO (2001) permissible limit in cold season. The presence of arsenic (As) in fish species depends on the feeding types, habitat, age and development of fishes, and other physiological factors.

Sawyer *et al*. (2003) stated that arsenic is quite widely distributed in natural water and is often associated with geological sources, but in some locations anthropogenic inputs, such as the use of arsenical insecticides and the combustion of fossil fuels, can be extremely important additional sources. Most of the arsenic (As) compound is used in manufacture of agricultural products such as insecticides, herbicides, fungicides and algaecides.

Hakason (1984) described that the concentrations of toxic heavy metals (Pb, Hg, Cd) in fish is affected by many biological factors such as species, sex, age, feeding type and environmental factors, such as the season of the year, pH value of water, temperature, dissolved oxygen and salinity.

From the finding of this study, Pb and As concentration levels of water and sediment were detected far exceed than the FAO/WHO (2001) maximum permissible limits (0.5 mg/kg and 0.01 mg/kg) in all seasons. Cadmium concentration level of sediment was observed to be higher than FAO/WHO (2001) maximum permissible limit (0.01 mg/kg) in hot season. It may be due to the use of various agricultural fertilizers, insecticides and pesticides from the surrounding crop field near the area, farm animal wastes and industrial activities.

Therefore, the present results indicated that all the metal levels except arsenic (As) in all fish species studied were detected to be lower than the FAO/WHO (2001) maximum permissible limits. Especially, *T. pectoralis* of arsenic concentration was observed to be higher than those of FAO/WHO (2001) permissible limits. Therefore, Kaung-hmu-daw In (Lake) fishes except *T. pectoralis* are generally safe for the human consumption with respects to the levels of Pb, Cd and As do not constitute a risk for human health. However, water and sediment of study area were contaminated with toxic metal levels above FAO/WHO (2001) permissible limits. Therefore, these results further corroborate the idea that there is a potential for lead (Pb) and arsenic (As) pollution to occur because of the presence of paddy cultivation in Kaung-hmu-daw In (Lake) environ. Therefore, it was concluded that the fish are burdened with arsenic (As) yet, so a danger should be considered due to the agricultural and industrial development in this region threatening the aquatic environs with the effluent and pesticide usages were considerably polluted. Hence, Kaung-hmu-daw In (Lake) should be monitored periodically to assess the level of pollution and maintain the friendly nature of the In.

Conclusion

The contamination of toxic metals in muscle tissues of five studied fish species, water and sediment of Kaung-hmu-daw In (Lake), Sagaing Township were analysed. Except T. pectoralis, toxic metal levels of all studied fish muscle were detected within FAO/WHO (2001) maximum permissible limits. Although water and sediment of study area were detected with some toxic metals levels above FAO/WHO (2001) limits. Thus it was concluded that the water and sediment from study area were generally nor secure from toxic metal contamination. Therefore, the present study will be able to give valuable information.

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