ISSN No:-2456-2165

Bioaccumulation of Selected Element Concentrations in Cirrhinus mrigala (Hamilton-Buchanan, 1822) and Wallago attu (Schneider, 1801) from Ayeyawady River Segment, Magway Township

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Abstract:- A study was conducted from December 2017 to September 2018 to assess the concentrations of some elements (Cu, Zn, As, Cd and Pb) in the muscles of two fish species, Cirrhinus mrigala (herbivore) and Wallago attu (carnivore) from the Ayeyawady River segment, Magway Township. The mean values of selected elements in C.mrigala were -0.230 mg/L for Cu, 0.452 mg/L for Zn, -1.154 mg/L for As, 0.118 mg/L for Cd and -0.026 mg/L for Pb. In W.attu, the mean concentrations of selected elements were -0.264mg/L, 0.657 mg/L, -4.238 mg/L, 0.066 mg/L, and 0.865mg/L for Cu, Zn, As, Cd, and Pb respectively. Different species of fish showed interspecific variation of heavy metals. In this study, carnivorous fish (W.attu) was detected with elevated concentrations of Zn and Pb whereas herbivorous fish (C.mrigala) showed higher concentration of Cu, As and Cd. Relation between element concentrations and fish size demonstrated that significant negative relation occurred between body size (total length and body weight) and Cu, Zn concentration of C.mrigala, and between body weight and Cu concentration, between total length and As concentration of W.attu. Significant positive relation occurred only between body weight and Cd concentration of W.attu. Generally concentrations of element in studied fish species were found within the range of WHO/FAO permissible limit.

***Keywords**:- Elements, Cu, Zn, As, Cd, Pb, Cirrhinus mrigala, Wallago attu.*

I. INTRODUCTION

Ayeyawady River is the important aquatic resource of Myanmar and Fishery occupy a unique position in the agricultural sector of the Myanmar economy. In Magway area, a majority of freshwater fish for consumption offered at local markets are harvested from Ayeyawady River. The air and water may be polluted due to current stage of industrialization, the demand for improved quality of life and improper management of municipal and agricultural wastes in this area. Canli and Atli, 2003 [cited in 1] pointed out that the essential and nonessential heavy metals may appear as potentially harmful elements for most aquatic and terrestrial organisms at some concentrations of uptake. They also proposed the serious contaminants of elements due to their persistence and remarkable tendency to be concentrated in organism tissues.

Normally, metals occur in small amount of concentrations in aquatic ecosystems at the nanogram to microgram per liter level. In the present times, the rate of metal concentrations particularly the excess of heavy metals has become a problem of challenging concern. The rapid growth of population, increased urbanization, and expansion of industrial activities, exploration and exploitation of natural resources, extension of irrigation and other modern agricultural practices as well as the lack of environmental regulation cause increasing metals in waters [2].

According to Don-Pedro *et al*, heavy metals can cause high pollution due to their relative high toxicity and persistent nature in the environment. For that reason, the changing concentrations and distribution of heavy metals and their compounds in various compartments of the environment is a main concern for good environmental management programs all over the world [3] .

Iron, zinc, manganese and copper are the group of essential trace elements for maintaining cellular function and are components of numerous metal-containing enzymes. Essential metals may exert beneficial or harmful effects on plant, animal and human life depending on their concentration. Metals come into the aquatic environment from various natural and anthropogenic sources. Contamination of aquatic ecosystems by heavy metals can be tested in water, sediment and organisms [4].

Fishes are often considered the bioindicators of aquatic ecosystem because they occupy high trophic level and are important food source for human [3]. Metal contents in the tissues and organs of fishes were used as indicators of the metal concentrations in water and their accumulation in natural ecosystem [3]. Fishes are widely used as biological monitor variables to detect environmental levels of anthropogenic pollutants accordingly to their ecological characteristics, and their economic usefulness [5]. Furthermore, fishes are at the end of the aquatic food chain and may accumulate metals and pass them on to human beings when consumed as food, causing chronic or acute diseases [5].

ISSN No:-2456-2165

Information on trace metal concentrations in commercial fish and assessment of the possible risk of fish consumption for human health are important for environmental management. Different parts of fish such as gills, liver, kidneys and muscles have been widely investigated for heavy metals [6] .Although muscle is not active tissue for accumulating the heavy metals, except mercury, the study of potential metal accumulation in muscle is justified because it is the edible part of the fish for humans [7].

The objectives of the present study were:

- to investigate some elements (Cu, Zn, As, Cd and Pb) concentrations in the muscle tissue of, *Cirrhinus mrigala* and *Wallago attu* collected from the Ayeyawady river segment, Magway Township
- to record interspecific differences in the contents of these metals between study species of different feeding types
- to evaluate the relationship between fish size (length and weight) and heavy metal concentrations in muscle tissue of two fish species.

II. MATERIALS AND METHODS

Ayeyawady River segment, Magway Township situated at 20° 09' N and 94° 55' E was chosen as the study area to examine some element concentrations in two commercially important fish species (*Cirrhinus mrigala*, and *Wallago attu*) (Fig. 1). Study period lasted from December 2017 to September 2018. Ten specimens for each species were purchased for each test from fisherman who was fishing in the Ayeyawady River of study site. Feeding habits of target fish species were assigned in accordance with Talwar and Jhingran. [8] The length and weight of sample fish were recorded. Seven gram of dorsal muscles from each of five individuals in each species were extracted and integrated, then, placed in a purified petri dish. Each petri dish was dried to obtain constant weight of selected muscles. The prepared samples were sent to Universities Research Center (URC), Yangon for analysis of element concentrations. The concentrations for copper (Cu), zinc (Zn), arsenic (As), lead (Pb) and cadmium (Cd) were analyzed tri-replicates by Elmer Flame Atomic Absorption Spectrometer (FAAS) (Perkin AAanalyst 800 and Winlab-32 software).

Fig. 1:- Map of the study area (Ayeyawady River segment, Magway Township)
Source: Google Earth, 2018

III. RESULTS AND DISCUSSION

This study was carried out to investigate some elements (Cu, Zn, As, Cd and Pb) concentrations in the muscle tissues of two commercially important fish species (*Cirrhinus mrigala* and *Wallago attu*) from Ayeyawady River segment, Magway Township.

The total length of herbivorous fish (*C. mrigala*) ranged from 23.5cm to 47.3 cm, and that of carnivorous fish (*W. attu*) ranged from 20.6cm to 59.2cm. The body weight of herbivorous *C. mrigala* ranged from 120g to 510g while that of carnivorous *W. attu* ranged from 120g to 405g (Table 1).

Cu and Zn are vital element and are carefully regulate by physiological mechanisms in most living things. On the other hand they are regarded as potential hazards that can cause danger to both animal and human fitness. Knowledge of their accumulation in fish is important with respect to management of nature and human fish eating [10].

According to Monteiro *et al* ,Copper (Cu) is an essential trace metal as well as micronutrient for cellular metabolism in living organisms in consequence of being a significant component of metallic enzymes [11] .Although, Hernandez *et al* reported that it can be particularly toxic to intracellular mechanisms in aquatic organisms at high concentrations which exceed normal levels[11]. In the present work, copper concentration of *C. mrigala* ranged during -0.802 mg/L and 0.092 mg/L and in *W. attu*, it ranged from -0.786 mg/L to 0.003 mg/L. The levels of copper in the muscle tissue of studied fishes were far from the permissible limit (0.5 mg/L) set down by WHO / FAO guidelines (Table 2 and Fig 2). In 2012, Khin Nwe Yi investigated the level of selected metals (Fe, Zn, Mn, and Cu) *in Labeo rohita, Salmostoma sardinella, Mystus cavasius, Ompok bimaculatus, Wallago attu* and *Clupisoma prateri* from Ayeyawady river, Magway area . The highest accumulation of Cu (0.281 ppm d.w) in *O.bimaculatus* and the lowest (0.176 ppm d.w) in *M. cavasius* were observed in her study [12].

Ross *et al* stated that Zinc is a very important essential element for animals and almost 300 mammalian enzymes are related to Zn [13]. According to Eisler, although Zn is an essential element because it is carefully keeping up by physiological mechanisms in most organisms [14], it is also regarded as a possible risk that can endanger both animal and human health. Agency for Toxic Substance and Disease Registery suggests that ingesting high levels of zinc for several months may cause anemia, damage the pancreas, and decrease levels of high-density lipoprotein (HDL) cholesterol [14]. In the present study Zn values ranged from 0.329 mg/L to 0.533 mg/L in *C.mrigala*, and 0.373 to 0.836 mg/L in *W.attu*. Zn in the muscle tissues of studied species was lower than the permissible limit (30 mg/L) set down by WHO/FAO guidelines (Table 2 and Fig. 2). In this study the concentration of Zn was too high as compared with Cu level. Khin Nwe Yi (2012) recorded the lowest Zn values of 3.859 ppm d.w in *L. rohita* and the highest 7.567 ppm d.w in *S. sardinella* [12]. She also displayed that zinc was the second highest accumulated metal in the muscles of her studied species. Ambedkar and Muniyan stated that the highest amount of Zn in the selected organs of their five different fish were owing to the presence of agricultural activities finally find its way into the ambient media through leaching[15]. Also in this area, there are many agricultural activities around the study site.

Saha reported that arsenic is the most possible toxic heavy metals present in the environment and originates from both natural and anthropogenic processes [16]. In the present study, arsenic concentration in the muscle tissue of *C. mrigala* ranged from -3.440 mg/L to - 0.002 mg/L and, in *W. attu* it ranged from -11.86 mg/L to -0.004 mg/L. The concentration level of As in muscle tissue of fishes studied were found to lower the limitation range of WHO (0.26mg/L) (Table 2 and Fig. 2). In 2017, Cho Cho Thin studied the relations of some essential and toxic elements on different feeding types of some freshwater fishes along the Ayeyawady River segment, Salay environs. The lowest and highest concentration of As (-3.07mg/L in *Notopterus notopterus* and 4.89 mg/L in *Channa punctatus*) were mentioned in her study.

According to Waalkes, cadmium effect in kidneys to injuries and chronic toxicity, including destruction of kidney function, poor reproductive capacity, hypertension, tumours and hepatic disfunction[17]. Cadmium is highly non-essential heavy metal and it does not play in biological process in living organisms. Therefore, even in low concentration, cadmium could be risky to living organisms [15]. According to the results of the present study cadmium concentration of *C. mrigala* ranged from -0.001mg/L to 0.251mg/L and that of *W. attu* ranged from 0.025mg/L to 0.137mg/L. The level of Cd in muscle tissue of studied fishes were found below the limitation range of 0.5mg/L as proposed by the FAO (1983) (Table 3 and Fig. 2).[18] In all studied fishes of Theik Htet Aung (2014), the accumulation of Cd was not detected [19]. Cho Cho Thin (2017), observed the lowest and highest values of Cd (-0.07 mg/L and 2.151 mg/L) in her studied fishes.

Rompala *et al.* reported that lead is one of the most toxic heavy metals. The effects of lead include delayed embryonic development, suppressed reproduction and inhalation of growth, increased mucous formation, neurological problems, enzyme inhalation and kidney disfunction [20]. In this study, bioaccumulation of lead in *C. mrigala* ranged between -0.503 mg/L and 0.717 mg/L while that of *W. attu* was between -0.488 mg/L and 2.450mg/L. Only the highest Pb value (2.450mg/L) from *W. attu* was slightly above the (WHO / FAO) permissible limit (2 mg/L). However, the mean value of Pb (0.865mg/L) was below the permissible limit of WHO/FAO guideline. In 2014, Thike Htet Aung recorded the lowest and highest Pb values (1.39 and 2.03ppm) of his studied fish species (*Mystus cavasius*, *Mystus leucophasis* and *Wallago attu*) [19]. The lowest value (-4.09 mg/L) and the highest (7.252 mg/L) of Pb concentration were recorded in the investigations of Cho Cho Thin (2017) [3]. In present study, Pb value was slightly higher than records from Thike Htet Aung [19]. This may be due to the fact that the study area is located closer to the human activities, releases during the usages of pesticides and disposal of metal products.

During study period, mean values of element concentration were observed -0.230 mg/L (Cu), 0.452 mg/L (Zn), -1.154 mg/L (As), 0.118 mg/L (Cd) and -0.026 mg/L (Pb), in *C.mrigala* whereas -0.264 mg/L (Cu), 0.657 mg/L (Zn) -4.238 mg/L (As) , 0.066 mg/L (Cd) and 0.865 mg/L (Pb) in *W.attu* (Table 3).

In this study, the orders of element concentrations were found Zn> Cd > Pb > Cu > As for *C. mrigala* and Pb > Zn >Cd> Cu >As for *W.attu*. Heavy metal and trace elements differ in their accumulation levels and patterns depending on fish species as well as on a fish tissue (Rashed, 2001) [21]. There are variation of toxic heavy metal levels and patterns depending on fish species in present study.

The accumulation of metals in fish tissues depends on numerous factors such as environmental concentrations, environmental conditions (PH, water temperature, and hardness), exposure time, and species- specific living and feeding habits (Moore and Ramamoorthy 1984, Deram *et al*., 2006, Lalonde *et al*., 2011) [22]. Many studies attributed high metal accumulation to the feeding habit of the fish. Although Khaled (2004) argued that herbivore accumulated higher concentration of metals in the muscles than the carnivore [23], Moselhy *et al*., 2014, observed that the herbivore had the lowest concentration of metals in most cases of their study [24]. In present study, herbivore had lower bioaccumulation of Zn and Pb, however, Cu, As and Cd concentrations of carnivorous fish (*W.attu)* showed lower concentration than herbivorous fish (*C.mrigala).*

Species	Total length (cm)		Body weight (g)		No. of specimens
	Range	Mean	Range	Mean	
Cirrhinus mrigala	23.5 – 47.3	29.13 ± 5.75	120 – 510	226.26 ± 102.28	15
Wallago attu	20.6 – 59.2	40.74 ± 13.62	120 – 405	193.27 ± 66.64	15

Table 1:- Size of the sample fish species

Relation between selected element concentrations and fish size demonstrated that significant negative relation occurred between body size (total length and body weight) and Cu, Zn concentration of *C.mrigala, and* between body weight and Cu concentration, between total length and As concentration of *W.attu*. Significant positive relation occurred only between body weight and Cd concentration of *W.attu* (Fig.3-9). Remaining relationship between body weight, body length and selected element concentrations in the study species showed no significant. Scerbo *et al*. reported that the concentration of metal in fish tissue is generally related to the age of the fish and consequently, on size and length [25]. But the concentrations of selected metals in the current samples did not correlate mostly with fish size.

Analysis performed in this study revealed the existence of differences in concentrations of the assessed elements between the study species. The bioaccumulation of Cu, Zn, As, Cd and Pb in the muscle tissue of studied fish species were usually below the permissible limit of WHO/FAO guide lines, which indicates the meat of studied fish species should be safe for utilization in human diet.

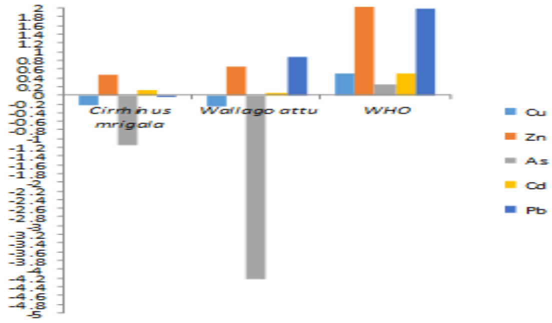

Fig. 2:- Heavy Metal Concentrations of the Studied Fish Species Compared with WHO Standards

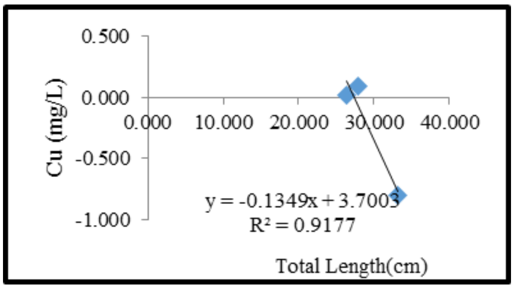

Fig. 3:- Relation between total length and Cu concentration in *Cirrhinus mrigala*

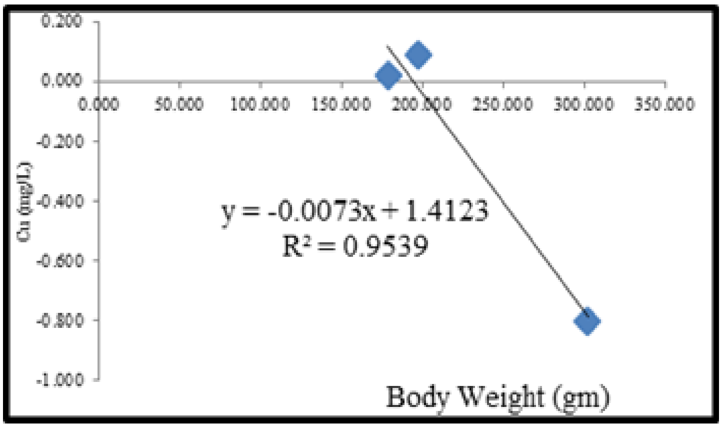

Fig. 4:- Relation between body weight and Cu concentration in *Cirrhinus mrigala*

Species Guide line	No: of sample	Cu (mg/L)			Zn (mg/L)			As (mg/L)			Pb (mg/L)			Cd (mg/L)		
		T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3
Cirrhinus mrigala	5	0.019.	0.092	-0.802	0.533	0.496	0.329	-0.019	-3.440	-0.002	-0.292	0.717	-0.503	-0.001	0.251	0.103
Wallago attu	5	-0.009	0.003	-0.786	0.836	0.763	0.373	-11.86	-0.851	-0.004	2.450	0.632	-0.488	0.036	0.025	0.137
WHO/ FAO		0.5			30			0.26			2			0.5		

Table 2:- Element concentrations of the studied fish species

ISSN No:-2456-2165

Species	Feeding type	Mean value of Heavy metal concentration				
		Cu(mg/L)	Zn(mg/L)	As(mg/L)	Cd(mg/L)	Pb(mg/L)
Cirrhinus mrigala	Herbivore	-0.230±0.49	0.452±0.10	- 1.154 ± 1.93	0.118 ± 0.13	- 0.026 ± 0.65
Wallago attu	Carnivore	-0.264± 0.45	0.657± 0.24	- 4.238 ± 6.61	0.066 ± 0.06	0.865 ± 1.48

Table 3:- Variation in total mean value of element concentrations in the muscle tissues of studied fish species in accordance with feeding type and habitat

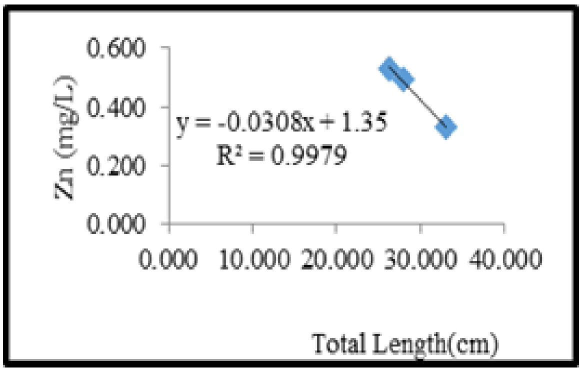

Fig. 5 Relation between total length and Zn concentration in *Cirrhinus mrigala*

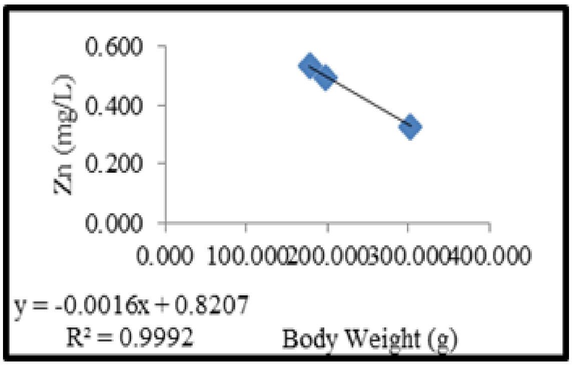

Fig. 6 Relation between body weight and Zn concentration in *Cirrhinus mrigala*

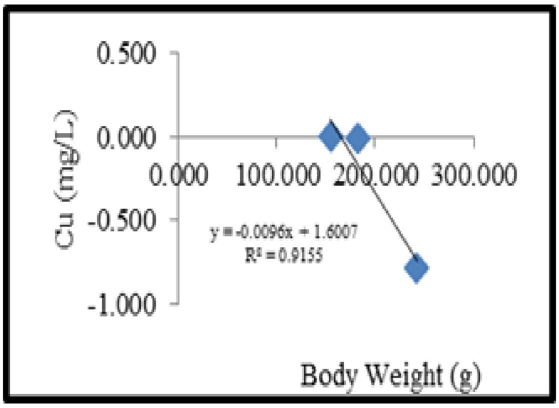

Fig. 7 Relation between body weight and Cu concentration in *Wallago attu*

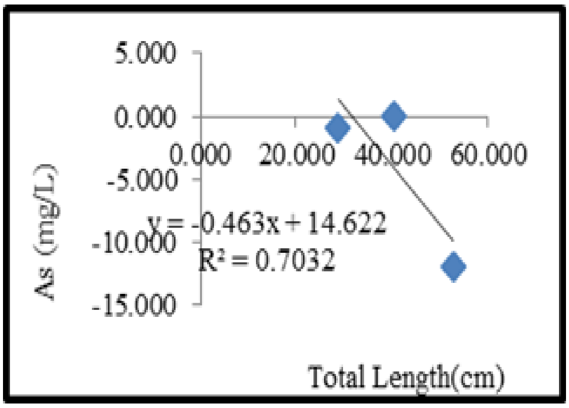

Fig. 8 Relation between total length and As concentration in muscle tissue

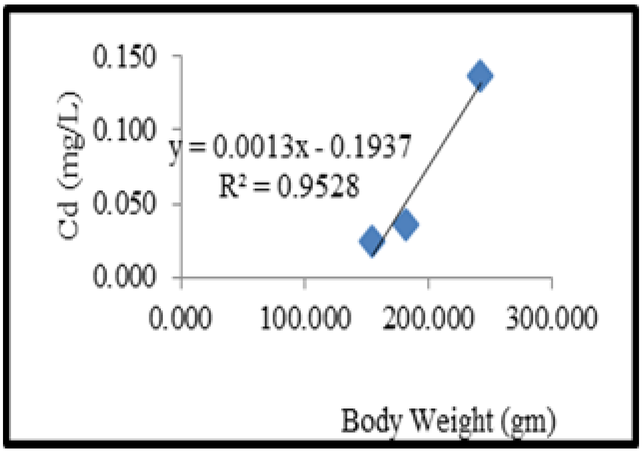

Fig. 9 Relation between total body weight and Cd concentration in muscle tissue of *Wallago attu*

IV. CONCLUSION

Although There are varying degree of chemical pesticides and fertilizers utilizations in the agricultural fields and waste disposals of domestic activities around the riparian land in the study area, the results of the present study showed that the levels of elements bioaccumulated in muscle tissues of *Cirrhinus mrigala* and *Wallago attu* usually did not exceed the permissible limit of WHO/FAO guide lines. Therefore, these fishes in this area of study did not pose any threat to human upon their consumption.

ACKNOWLEDGMENTS

The authors would like to thank Rector Dr Khin Maung Oo, University of Magway for his permission to conduct this research work. We also gratitude to Dr Htay Htay Sein, Professor and Head (Rtd), Department of Zoology, University of Magway for her invaluable suggestion on this research work.

REFERENCES

[1] A. Safahieh, F. Abdolahpur, M. Taghi, A.Savari and A. Abdolmajid, Determination of heavy metals (Cd, Co, Cu, Ni and Pb) in croacker fish (*Johnius belangerii*) from Musa estuary in the Persian Gulf. *International Journal of Environmental Science and Development*. 2(6):460-464, 2011.

[2] FAO , 1992. Committee for Inland Fisheries of Africa. Report of the third session of the Working party on Pollution and Fisheries Rome, *FAO fisheries Report* . V. 471. P.43-44.

[3] Cho Cho Thin, Relation of some essential and toxic elements on different feeding types of some freshwater fishes along the Ayeyawady River Segment, Salay Environs. *PhD thesis*, Department of Zoology, University of Yangon, 2017.

[4] K.Gebremedhin and T. Berhanu, Determination of some selected heavy metals in fish and water samples from Hawassa and Ziway Lakes. *Science Journal of Analytical Chemistry* 3(1): 10-16, 2015.

[5] C. C. Silene and M. H. Sandra, Evaluation of trace metals (cadmium, chromium, copper and zinc) in tissues of a commercially important fish (*Leporinus obtusidens*) from Guaiba Lake, Southern Brazil. *Braz.arch. biol.technol.* 52 (1): 241-250, 2009.

[6] J.M. Mwangi, Determination of concentration of selected heavy metals in Tilapia fish, sediments and water from Mbagathi and Ruiru Athi river Tributaries, Kenya. *M.Sc thesis*. Applied and analytical Chemistry, Kenyatta University, 2013.

[7] A. B. Yilmaz, , Levels of heavy metals (Fe, Cu, Ni, Cr, Pb and Zn) in tissues of *Mugil cephalus* and *Trachurus mediterraneus* from Iskenderun Bay. Turkey. *Environ. Res*. 92: 277-281, 2003.

[8] P. K. Talwar, A. G. Jhingran, *Inland fishes of India and Adjacent Countries*. Vol I and II. Oxford and IBH Publishing Co. PVT. Ltd. New Delhi, Bombay, Calcutta. 1158 PP, 199.

[9] J. Burger, and M. Gochfeld, Heavy metals in commercial fish in New Jersey. *Environ Res*., 99: 73-77, 2005.

[10] P.A. Amundsen, F.J. Staldvik, A.A. Lukin, N.A. Kashulin, O.A. Popova and Y.S. Reshetnikov, Heavy metal contamination in freshwater fish from the border region between Norway and Russia. *Science of the total Environment.* 201 (3): 211-224, 1997.

[11] M. Authman, M.S. Zaki, E.A.Khallaf and H.H. Abbas, Use of fish as Bioindicator of the effects of heavy metals pollution. *J. Aquac Res Development*., 6(4) : 1 – 13, 2015.

[12] Khin New Yi, Assessment on the level of selected metal in six fish species from Ayeyawady River, Magway area, *M.Sc thesis*. Department of Zoology, University of Magway, 2012.

[13] S.M. Fahad**,** M.J. Abedin, M.O. Rahman, M.A. Al Rony, F.A. Sabbir Ahamed and M.A. Hoq, Elemental study of Banglandeshi Fish Samples Using PIGE technique. *European Scientific Journal.* 14(18): 1857 – 7881, 2018.

[14] M. Javed and N. Usmani, Assessment of heavy metal (Cu, Ni, Fe, Co, Mn, Cr, Zn) pollution in effluent dominated rivulet water and their effect on glycogen metabolism and histology of *Mastacembelus armatus. http:// www. springerplus.com/content/*2/1/ 390, 2013.

[15] G. Ambedkar and M. Muniyan, Bioaccumulation of some heavy metals in the selected five freshwater fish from kollidal river, Tamilnadu, India. *Advances in Applied Science Research*., 2 (5) 221-225,2011.

[16] A. K. M. Atique Ullah, M. A. Maksud, S. R. Khan, L.N. Lutfa and S.B. Quraishi, Dietary intake of heavy metals from eight highly consumed species of cultured fish and possible human health risk implications in Bangladesh. *Toxicology Reports*. 4:574-579, 2017.

[17] Z. Zhang, L. He, L. Jin and W. Zhen, Analysis of heavy metals of muscle and intestine tissue in fish in Banan Section of Chongqing from three Gorges Reservior, China. *Polish J. of Environ. Stud*, 16(6): 949-958, 2007.

[18] FAO **(**Food and Agriculture Organization), Compilation of legal limits for hazardous substances in fish and fishery products. FAO Fishery Circular No. 764, FAO. Rome, Italy PP: 1-102, 1983.

[19] Thike Htet Aung, 2014. Analysis of the selected metals in some fishes and water samples from Ayeyawady River near the Salay Fertilizer Plant, Chauk Township, Magway Region. *M. Sc Thesis*, Department of Zoology, University of Magway.

[20] J. C. Akan, S. Mohmoud, B. S. Yikala and V. O. Ogugbuaja, Bioaccumulation of some heavy metals in fish samples from river Benue in Vinikilang, Adamawa State, Nigeria. *American Journal of Analytical Chemistry*. 3: 727-736, 2012.

[21] K. A. Abdulali. Taweel, M. Shuhaimi-Othman and A.K. Ahmad, Analysis of heavy metal concentrations in Tilapia Fish (*Oreochromis niloticus*) from four selected markets in Selangor, Pennisular Malaysia. *Journal of Biological Sciences*, 12: 138-145, 2012.

[22] D. Usha and R. Vikram, Heavy metal bioaccumulation in edible fish species from an industrially polluted river and human health risk assessment. *Arch.Pol.Fish.*, 21:19-27, 2012.
[23] A. Khaled, Seasonal determination of some heavy metals in muscle tissues of *Siganus rivulatus* and *Sargus sargus* fish from El-Mex Bay and Eastern harbor, Alexandria, Egypt. *Egypt Journal of Aquatic Biology and fish.,* 8(1):65-81, 2004.
[24] K. M. El-Moselhy, A.I. Othman, H. A. El-Azem and M. E. A. EL-Metwally, Bioaccumulation of heavy metals in some tissues of fish in the Red Sea, Egypt. *Egyptian Journal of Basic and Applied Sciences*. 1: 97-105, 2014.
[25] R. Scerbo, T. Ristrori, B. Stefanini, S. De Ranieri and C. Barghigiani, Mercury assessment and evaluation of its impact on fish in the Cecina river basin (Tuscany, Italy). Environ. pollut, 135: 179-186, 2005.