December 30, 2020

PharmacologyOnLine

Archives • 2020 • vol.3 • 1-6

DETERMINATION THE LEVEL OF HEAVY METALS IN DIFFERENT EDIBLE FISH SPECIES COLLECTED FROM THE LOCAL MARKET OF DHAKA, BANGLADESH

Sabreena Chowdhury Raka [1]*, Arofa Ratri Toma [1], Faria Mannan Mithi [1], Arifur Rahman [2,3]

[1]Department of Pharmacy, Faculty of Allied Health Sciences, Daffodil International University, Dhaka-1207, Bangladesh.
[2]Computational Biology Research Lab, Department of Pharmacy, Jagannath University, Dhaka-1100, Bangladesh.
[3]FDCC Testing & Research Lab, Department of Pharmacy, Jagannath University, Dhaka-1100, Bangladesh.

* raka.pharmacy@diu.edu.bd

Abstract

The presence of heavy metals was examined in three different fishes, which were collected from a local market in Dhaka, Bangladesh. After drying and crushing, the samples were treated with 70% HNO_3+65% $HClO_4$ (4:1), Conc. H_2SO_4+ conc. HNO_3 (mixture need to heat slowly on an oil bath, with the addition of ¾ drops of H_2O_2), 65% HNO_3+30%H_2O_2 at 80 ^{O}C, Tri-acid mixture (HNO_3: $HClO_4$: H_2SO_4= 6:5:6.2) until a clear solution appears. After filtering and dissolving with distilled water solution are analyzed by atomic absorption spectroscopy. The amount of heavy metals means concentrations in the fish muscles expressed Cr (60.22ppb), Cu (51.11ppb), As (5.57ppb), and Zn (1.08ppm) respectively. Heavy metals have the tendency to accumulate in various organs of marine organisms, especially fish which in turn may enter into the human metabolism through consumption causing serious health hazards. The study has shown that Cr was the most and Zn was the least accumulated metal in the studied fish muscles by using the method of AAS analysis. From the human health point of view, this study showed that there are so many possible health risks to consumers due to the intake of studied fishes under the current consumption rate.

Keywords: *Heavy metals, Atomic Absorption Spectroscopy, Rui (Labeo rohita), Tilapia (Oreochromis niloticus), and Shing (Heteropneustes fossilis).*

Introduction

Bangladesh is a country with thousands of rivers and ponds and is notable for being a fish-loving nation, acquiring the name "Machh-e Bhat-e Bangali" which means, "Bengali by fish and rice".

Heavy metals are potentially accumulated in marine environments including water, sediments & fish & subsequently transferred to human beings through the food chain. Heavy metal pollution in fish has become an important worldwide concern, not only because of the threat to fish but also due to the health risks associated with fish consumption. For example, lead causes renal failure and liver damage, while cadmium injures the kidney and causes symptoms of chronic toxicity, including impaired kidney function, poor reproductive capacity, hypertension, tumors, and hepatic dysfunction.

Some other metals, for instance, chromium, zinc & copper cause nephritis, anuria, and extensive lesions in the kidney. Chromium does not normally accumulate in fish and hence low concentrations were reported even from the industrialized part of the world. The rate of uptake was higher in young fish but the body burden of Chromium was declined with age due to rapid elimination. Copper is an essential part of several enzymes and is necessary for the synthesis of hemoglobin. However, a high intake of Copper has been recognized to cause adverse health problems [1]. Copper is acutely toxic (lethal) to freshwater fish via their gills in soft water at a concentration ranging from 10-20 ppb.

However, the arsenic tissue residues were found of 1.3mg/kg fresh weight in freshwater fish as the criterion for human man health protection [2]. Arsenic is widespread in the environment due to both anthropogenic and natural processes. The US Food and Drug Administration indicated that fish and other seafood account for 90% of the total exposure [3].

Therefore, the problem of heavy metal contamination in fishes is increasing global attention. This subsequently indicates the concentrations of metals in water and their accumulation in the food chain. Besides, fishes are well known for their ability to concentrate heavy metals in their muscle. However, the amount of heavy metals in a fish depends on the environment, water, and food of fish. But in many cases, the amount of metal uptake remains uncertain.

This research was performed to determine the amount of toxic metals such as arsenic, chromium, copper, and zinc levels in three fishes collected from the local market of Dhaka, Bangladesh.

Methods

Collection and preparation of sample

The samples were collected from a local market situated in Dhaka city, Bangladesh. There were mainly three types of fishes which include Rui (*Labeo rohita*), Tilapia (*Oreochromis niloticus*), and Shing (*Heteropneustes fossilis*). As these three types of fishes mainly live in the three-layer of the river, so these fishes were selected for the experiment which could find out the best possible results. After collection fish samples were washed thoroughly with DM water in order to remove mud or other fouling substances and put in a clean polythene bag to transport the fish samples into the analytical laboratory of Jagannath University (JNU), Bangladesh.

After transportation to the laboratory, the fish samples were allowed to reach room temperature and its non-edible parts were removed with the help of a steam cleaned stainless steel knife. The edible portion of the knife samples was then washed with distilled water and cut into small pieces using the cleaned knife over a clean polyethylene sheet. The samples were then air-dried to remove the extra water. Finally, the muscle tissues were oven-dried samples were powdered in mortar pastel, sieved, and stored in airtight plastic vials inside desiccators (see figure 1).

Digestion of sample

The dried fish samples were digested, the finely powdered fish was taken in a digestion apparatus, and 2.5ml of conc. H_2SO_4 and 4ml conc. HNO_3 was introduced when the initial vigorous reaction subsided, the mixture was heated slowly on an oil bath, with the addition of 3/4 drops of H_2O_2. This step was repeated till the solution became clear. The mixture was heated for an additional 20 min at 150^{o}C and allowed to cool at room temperature. The content was diluted with deionized water and filtered quantitatively into a 50ml volumetric flask [4, 5, 6, 7, 12] (see figure 2).

Analytical method

The solutions were analyzed for As, Cr, Cu, Zn by atomic absorption spectrophotometry. Analytical conditions for the measurement of the heavy metals in aqueous solution using AAS-Graphite. The results were expressed as ppb or ppm of dry weight. All glassware and containers were thoroughly cleaned, finally rinsed with double distilled water several times, and air-dried prior to use for each time (see figure 3).

Results

The presence of heavy metals on fish was determined by applying AAS-method (see Table 1).

This evaluation indicates the concentrations of four heavy metals As, Cr, Cu, Zn in muscle tissue of three species from the local market of Dhaka, Bangladesh. It revealed that the ranking order of mean concentrations of the heavy metals in the fish muscles was Cr (60.22ppb)>Cu (51.11ppb)>As (5.57ppb)>Zn (1.08ppm).

In the present study, the level of Cr was (9.25ppb-60.22ppb). The western Australian Food and Drug regulations stated a concentration of 5.5mg/kg for Cr which was higher than our values [8]. This experiment also reveals that the presence of Cu was (26.16ppb-36.29ppb). According to the UK food standards Committee Report, Cu concentration in food should not exceed the value of 20mg/kg as wet weight. Furthermore, it also indicated that Zn amount was (0.65ppm- 1.08ppm). The amount of Zn determined in all the fish samples were far below the standard of 1000mg/kg set by ANHMRC [8,9].

Discussion

Heavy metals have the tendency to accumulate in various organs of marine organisms, especially fish which in turn may enter into the human metabolism through consumption causing serious health hazards. Thus the presence of some selected trace metals was estimated and compared with the recommended values to assess the metal levels found in fish samples from the local market, Dhaka, Bangladesh. This study was conducted only for the fish muscle as the tissue is the most important part consumed by human consumption. Estimated Daily Intake (EDI) values for the examined fish samples were compares with the recommended values [10, 11, 12] including health risk associated with the intake studied heavy metals. Zn, Cr, Cu, As which are so much harm to our health, when they cross their maximum levels. It is well known that muscles are not an active site for metal biotransformation and accumulation. But in a polluted aquatic habitat, the concentration of heavy metals in fish muscles may exceed the permissible limits for human consumption and imply severe health threats. All the examined fishes carried on heavy metals that do a significant threat to the health of human consumers.

The data in this paper suggests that the heavy metal concentration found in the fish muscles sampled from local market Dhaka, Bangladesh was significantly high. It should be noted that the concentration of Cr was found considerably higher among all four heavy metals examined of three species. However, these results can be used to provide baseline information for risk assessment. Therefore, it includes that these metals should pose any health threat to consumers resulting from the consumption of studied fish. Further study can be performed to determine other potential health risks.

Acknowledgments

All individuals listed as authors have contributed substantially to the design, performance, analysis, or reporting of the work.

References

1. Gaetake, L. M., & Chow C. K. (2003). Copper toxicity, oxidative stress, and antioxidant nutrients. Toxicology. 189(1-2), 147-163.

2. Burger, J., & Gochfeld, M. (2003). Heavy metals in commercial fish in New Jersey. Environmental Research. 99(3), 403-412.

3. USFDA 1993. Guidance document for as in shellfish (pp25-27). Washington, DC: US Food and Drug Administration.

4. Olsen, S., Pessenda, L. C., Ruzica, J., & Hansen E. H. (1983). Combination of flow injection analysis with flame atomic-absorption spectrophotometry: determination of trace amounts of heavy metals in polluted seawater. Analyst. 108(1289), 905-917.

5. Medeiros, R. J., dos Santos, L. M. G., Freire, A. S., Santelli, R. E., Braga, A. M. C., Krauss, T. M., & Jacob, S. D. C. (2012). Determination of inorganic trace elements in edible marine fish from Rio de Janeiro State, Brazil Food Control. 23(2), 535-541.

6. Kris-Etherton, P. M., Harris, W. S., & Appel, L. J. (2002). Fish consumption, fish oil, omega-3 fatty acids, and cardiovascular disease. Circulation. 106(21), 2747-2757.

7. Yılmaz, F., Özdemir, N., Demirak, A., & Tuna, A. L. (2007). Heavy metal levels in two fish species Leuciscus cephalus and Lepomis gibbosus. Food Chemistry. 100(2), 830-835.

8. Plaskett, D., & Potter, I. C. (1979). Heavy metal concentrations in the muscle tissue of 12 species of teleost from Cockburn Sound, Western Australia. Marine and Freshwater Res. 30(5), 607-616.

9. Bebbington, G. N., Mackay, N. J., Chvojka, R., Williams, R. J., Dunn, A., & Auty, E. H. (1977). Heavy metals, selenium, and arsenic in nine species of Australian commercial fish. Marine and Freshwater Research. 28(3), 277-286.

10. National Research Council. 1989. Recommended dietary allowances. National Academies Press.

11. Rahman, M. S., Molla, A. H., Saha, N., & Rahman, A. (2012). Study on heavy metals levels and its risk assessment in some edible fishes from Bangshi River, Savar, Dhaka, Bangladesh. Food Chemistry. 134(4), 1847-1854.

12. Meche, A., Martins, M. C., Lofrano, B. E., Hardaway, C. J., Merchant, M., & Verdade, L. (2010). Determination of heavy metals by inductively coupled plasma-optical emission spectrometry in fish from the Piracicaba River in Southern Brazil. Microchemical Journal. 94(2), 171-174.

ISSN: 1827-8620

Sample ID	Result			
	As	Cu	Cr	Zn
Sample 1	4.30 ppb	36.29 ppb	23.64 ppb	0.89 ppm
Sample 2	5.57 ppb	29.27 ppb	12.13 ppb	1.08 ppm
Sample 3	5.57 ppb	29.30 ppb	17.77 ppb	1.02 ppm
Sample 4	4.67 ppb	31.12 ppb	34.80 ppb	0.99 ppm
Sample 5	4.41 ppb	27.58 ppb	17.53 ppb	0.82 ppm
Sample 6	7.27 ppb	51.11 ppb	60.22 ppb	0.69 ppm
Sample 7	4.09 ppb	26.16 ppb	9.25 ppb	0.65 ppm
Method	AAS-Graphite	AAS-Graphite	AAS-Graphite	ASS-Flame

Table 1: Heavy metals determination from fish on applying AAS-method

Figure 1: Collected sample (fishes) from the local market

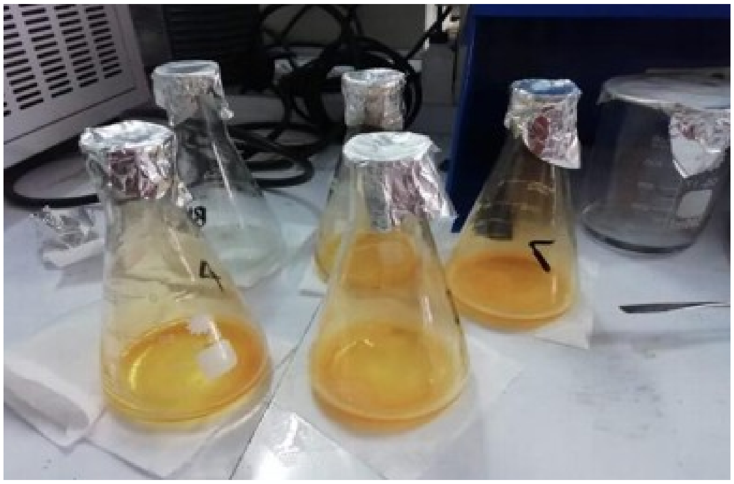

Figure 2: Prepared samples

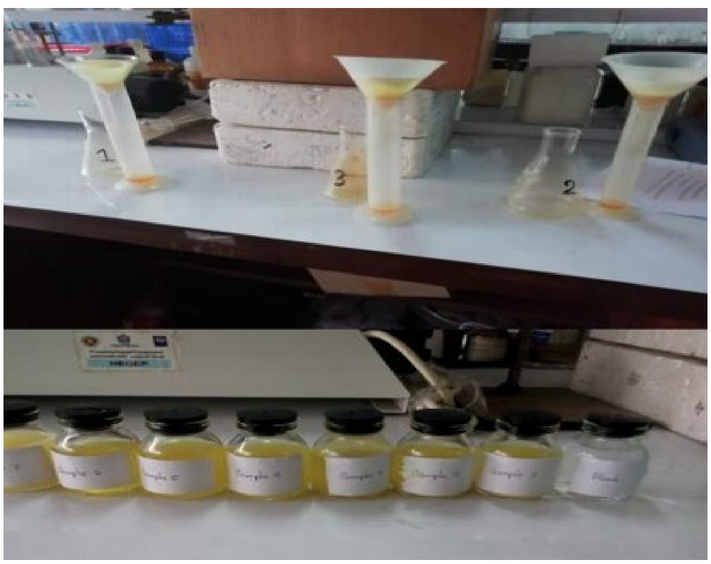

Figure 3: Collected samples for analytical test