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E-mail: bjsir07@gmail.com

Trace Element Concentrations Present in Five Species of Freshwater Fish of Bangladesh

M. Nurul Amin*[a], A. Begum[b] and M. G. Kibria Mondal[c]

[a]Department of Applied Chemistry and Chemical Engineering, University of Dhaka, Dhaka 1000, Dhaka [b]Department of Zoology, University of Dhaka, Dhaka 1000, Dhaka and [c]Department of Chemistry, Jagannath University, Dhaka, Bangladesh.

Abstract

In the present study, the edible portions of whole fish excluding viscera and bone of five different freshwater fish species samples are analysed for lead, manganese, nickel, zinc, copper and iron by atomic absorption spectrophotometry (AAS). The relative standard deviations (RSD) were found below 5%. The accuracy of the methods was confirmed by certified reference materials. The concentrations of trace elements in the edible portions of other fish comply with the international standards for human consumption.

Key words: Trace element; Gumti river; Freshwater fish; Atomic absorption spectrophotometry (AAS); Metal contamination

Introduction

Concern about the effects of anthropogenic pollution on the freshwater ecosystems is growing. Heavy metals from man-made pollution sources are continuously released into aquatic ecosystems. The contamination of heavy metals is a serious threat because of their toxicity, long persistence, bioaccumulation and biomagnification in the food chain (Eisler, 1988). Fish samples can be considered as one of the most significant indicators in freshwater systems for the estimation of metal pollution level (Barak *et al.* 1990; Evans *et al.* 1993; Rashed 2001). In recent years, much attention has been directed to the concentrations of some inorganic elements in freshwater fish and other aquatic organisms (Farkas *et al*. 2003; Mansour *et al*. 2002; Moiseenko *et al.* 2001). The commercial and edible species have been widely investigated in order to check for those hazardous to human health.

Under certain environmental conditions, heavy metals may accumulate to toxic concentrations and cause ecological damage (Jefferies *et al.* 1984). Fishes are often at the top of the aquatic food chain and may concentrate large amounts of some metals from the water (Mansour *et al.* 2002). Furthermore, fish is one of the most indicative factors in freshwater systems, for the estimation of trace metals pollution and risk potential of human consumption (Barak *et al.* 1990; Papagiannis *et al.* 2004). The contaminated fish from freshwater environment may become a public health concern. Hence, it is important to determine the concentrations of heavy metals in commercial fishes in order to evaluate the possible risk of fish consumption (Cid *et al*. 2001*).*

In the present work, the concentrations of trace elements (lead, manganese, nickel, zinc, copper and iron) in edible portions of five different freshwater fish species are reported.

Materials and Methods

Sample collection

The freshwater fish species were sampled in May 1, 2005 and May 3, 2006 by a professional fisherman at two stations (Gumti river), located in Daud Kandi, Comilla. Although a variety of freshwater fish species inhabits this river, the generally edible ones, *Corica soborna* (Kachki), *Clupisoma pseudeutropius atherinoides* (Batashi), Gudusia chapra (Chapila), *Trypauchen vagina* (Lal-Cheu) and *Mystus vittatus* (Tengra), were chosen for the present work. The fish samples were put in plastic bag/containers and transported to the laboratory on the same day. The internal organs, heads

* Corresponding author: E-mail: nurul34@hotmail.com

and tails of fish, which people do not consume, were removed and the edible portions (muscle) were washed with distilled water. After cutting into small pieces with a cleaned stainless steel knife, the small pieces were cleaned several times with demineralized pure water. The samples were dried in an oven at 65 ^{o}C for 48 h and were homogenized with a mortar. The powdered samples were dried again at 105 ^{o}C in the oven to a constant weight. Finally, the fine samples were preserved in clean and dry polyethylene bottles.

Chemical analysis

Accurately weighted fish samples (about 2 g) were treated with 10 ml of 14 M nitric acid, 5 ml of 13 M perchloric acid and 5 ml of demineralized pure water in a Teflon decomposition vessel. The vessel was put in a stainless steel container and heated for 2 h at 150 ^{o}C in an electric oven. After decomposition, the solution was evaporated down to about 5 ml in a Teflon beaker by heating with a hot plate. Finally, the solution was transferred to a 100 ml volumetric flask and diluted to volume with demineralized pure water. The elemental concentrations in the solution were measured with a Pye Unicam SP-2900 flame atomic absorption spectrophotometer. The standard solutions were prepared in 0.1 N perchloric acid.

The analytical performance was evaluated using standard reference materials, fish flesh homogenate MA-A-2 (TM), from the international laboratory of marine radioactivity of IAEA, Monaco. The elemental concentrations determined in standard reference materials were in good agreement with the certified values, as shown in Table I.

Table I: Analytical results of standard reference materials MA-A-2 (TM) from IAEA

Metal	Concentration (µg/g-dry wt)		Relative variance (%)
	Observed	Certified value	
Pb	0.60 ± 0.03	0.58 ± 0.07	+3.5
Mn	0.80 ± 0.01	0.81 ± 0.04	−1.2
Ni	1.08 ± 0.03	1.10 ± 0.20	−1.8
Zn	33.5 ± 0.5	33.0 ± 1.0	+1.5
Cu	4.13 ± 0.03	4.0 ± 0.1	+3.3
Fe	52.3 ± 0.8	54.0 ± 1.0	−3.2

n = 3.

Results and Discussion

Although many researchers have presented the elemental contents in various tissues, such as liver, kidneys, gills, gonads and muscles, of fish (Moiseenko & Kudryavtseva, 2001; Mzimela, Wepener, & Cyrus, 2003), but in the present work only fish muscles were evaluated for the elemental concentration since local people do not habitually consume other parts. Table II presents the elemental concentrations in muscle tissues of freshwater fish in Gumti river (Daud Kandi, Comilla). Lead levels in all fishes examined are in the range 0.1 mg/kg to 0.84 mg/kg (average 0.31 mg/kg) on the wet weight basis, considering the conversion factor of 4.8 for fresh weight. This value is below the provisional tolerable intake of total lead (7.1 µg/kg body wt/day) by human being (National Research Council, 1989; WHO, 1973; FAO/WHO, 1972-1987; FAO/WHO, 1984). The rough content orders were: iron > zinc > manganese > copper > nickel > lead. These sequences were the same as those obtained in similar freshwater fishes, Bangladesh (Sharif *et al.* 1993).

In order to evaluate the elemental concentrations in the freshwater fish muscle tissues in Gumti river, we tried to compare the measured values with those in muscle tissues obtained at other places, as shown in Table III. The elemental concentrations in the freshwater fish of different rivers in Bangladesh were investigated in 1993 (Sharif *et al*. 1993). The results were similar to our values. However, the concentrations of iron, zinc, manganese, copper, lead and nickel in the freshwater fish in Gumti river was much higher than those in Lake Kasumigaura, Japan (Alam *et al.* 2002).

However, the European Communities (EC, 2001), followed by the European Union (EU), released a commission regulation, setting maximum levels for certain contaminants in foodstuffs, which included 0.2 mg/kg wet weight lead level for the muscle meat of fish. Since, the lead content in the muscle of freshwater fish corresponded to 0.31 µg/g-wet

Table II: Trace metal concentration in freshwater fish samples

Sample No	Scientific name	Local name	Pb	Mn	Ni	Zn	Cu	Fe
Sampling date: May 1, 2005								
1	*Corica soborna*	Kachki	4.05±0.27	51.67±1.00	6.50±0.42	186.9±1.31	21.30±0.23	107.2 ±9.8
2	*Clupisoma pseudeutropius atherinoides*	Batashi	1.09±0.07	8.7 ±0.03	2.10±0.14	64.96±1.51	3.60±0.40	94.4 ±2.64
3	*Gudusia chapra*	Chapila	0.7 ±0.03	6.3 ±0.06	6.50±0.63	38.34±1.50	2.48±0.45	77.26±3.60
4	*Trypauchen vagina*	Lal-Cheu	0.9 ±0.05	5.7 ±0.05	3.50±0.42	31.4 ±3.1	1.80±0.03	63.88±6.2
5	*Mystus vittatus*	Tengra	0.58±0.03	4.76±0.00	2.80±0.00	38.01±1.51	3.6 ±0.4	110.58±6.2
Sampling date: May 3, 2006								
1	*Corica soborna*	Kachki	4.32±0.3	41.67±0.72	8.40±0.54	135.5±1.51	18.90±0.32	129.02±4.9
2	*Clupisoma pseudeutropius atherinoides*	Batashi	1.1 ±0.1	10.29±0.14	2.10±0.34	52.9±2.15	3.30±0.42	99.43±7.2
3	*Gudusia chapra*	Chapila	0.75±0.12	6.11±0.02	6.50±0.63	38.34±1.70	1.48±0.40	77.26±7.2
4	*Trypauchen vagina*	Lal-Cheu	0.93±0.09	6.11±0.07	3.80±0.45	34.08±1.51	1.80±0.23	83.88±4.50
5	*Mystus vittatus*	Tengra	0.5 ±0.04	4.1 ±0.00	1.80±0.48	36.01±1.64	4.37±0.3	110.98±7.50
		Range	0.5 – 4.05	4.1 – 51.67	1.80 – 8.40	31.4 – 186.9	1.48 – 21.30	63.88 – 110.98
		Mean	1.49	14.54	4.4	65.64	6.26	95.39

Unit: µg/g dry weight

Table III: Comparison of metal concentrations in freshwater fish muscle.

Metal	Metal concentration (µg/g dry wt)									
	Gomti River (present work)	River[a] Bangladesh	Kola Region[b] (Russia)	Duy Minh[c] (Vietnam)	Ataturk Dam Lake[d] (Turkey)	Nasser Lake[e] (Egypt)	Kolleru Lake[f] (India)	Malibu Lagoon[g] (California)	Lake Kasumigaura[h] (Japan)	Ogba River[i] (Nigeria)
Pb	1.49	2.66	–	0.25	BDL	–	1.09	0.3-4.1	0.03	0.05-0.95
Mn	14.54	15.7	0.78-2.77	2.6	0.10-16.4	0.03	12.14	2.1-22.0	0.24	0.65-1.04
Ni	4.4	2.43	0.69-1.95	0.3	BDL	0.06	–	0.3-1.0	0.04	0.04-0.79
Zn	65.64	76.8	20.0 -34.0	29.0	2.06-27.8	0.63	38.24	3.2-66.0	5.44	4.27-7.06
Cu	6.26	5.34	1.58-2.40	1.8	0.05- 4.29	0.26	2.37	1.7-6.0	0.29	3.81-6.28
Fe	95.39	133.0	–	51.0	0.23-29.4	2.18	94.35	23.0-90.0	3.43	–

Conversion factor (wet/dry weight): 4.8

–, Not available data;

BDL, below detection limit.;

[a] Sharif *et al.* (1993).;

[b]Moiseenko and Kudryavtseva (2001).;

[c]Wagner and Bomam (2003).;

[d]Karadede and U¨ nlu¨ (2000).;

[e]Rashed (2001).;

[f]Sekhar *et al.* (2003).;

[g]Moeller *et al.* (2003).;

[h]Alam *et al.* (2002).;

[i]Obasohan *et al.* (2008).

weight, careful attention should be paid to edible freshwater fish species in Bangladesh.

The concentrations of trace elements in edible freshwater fish species in Gumti river, Bangladesh were investigated. The elemental lead contents (Table II) in the freshwater fish muscle tissues were close to the range of international standards of fish (Sharif *et al.* 1993; Moiseenko and Kudryavtseva 2001; Wagner and Bomam 2003; Karadede and Ünlü 2000; Rashed 2001; Sekhar *et al*. 2003; Moeller *et al.* 2003; Alam *et al.* 2002 and Obasohan *et al.* 2008). The pollution level of Gumti river seems to become worse as Bangladesh becomes more industrially developed. Information on the levels of metals in the common fish species will be needed to the effective monitoring of both environmental quality and the health of organisms inhabiting the river ecosystem.

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