Occurrence and Distribution of Trace Elements in Fish Liver: Example from the Khorramabad River, Lorestan Province, Iran

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Abstract: - Thirteen trace elements were distinguished in liver of various species of fish that have been sampled from 15 sites in restricted area of Khorramabad River Watershed in Lorestan province, west of Iran. Sites sampled represent agricultural, mining, mixed, and urban/recreation land uses and background conditions. In the analyzed fish samples, Vanadium and iron reach minimum and maximum concentrations respectively, but lithium and silver are absent. Cadmium, selenium, and zinc were selected for a more detailed analysis. In the Khorramabad River Watershed area, trace element concentrations in fish liver indicate highest cadmium at mining sites, maximum selenium at agricultural sites and highest zinc at mixed land use sites. The trace elements concentrations in fish liver is related to the concentration of these elements in food, water and sediment that are being consumed by fish, as well as, the rate of bioaccumulation.

Key-Words: geochemical occurrence, watershed, trace element concentrations, physiographic area, bioaccumulation

1. Introduction

The National Water Quality Assessment (NIWQA) program is a perennial program designed to produce a comprehensive assessment of the quality of the Nation's stream and aquifer resources [1]. Ten NIWQA study units were divided into three groups across Iran. Investigations in the study units use an integrated approach to assess the status and trends of water quality in the major river basins of the Nation. During 2003, as part of this assessment of water quality, a study was done to examine the occurrence and distribution of trace elements constituents in biological tissues on a watershed wide scale. The NIWQA program emphasizes the use of consistent protocol methods for a nationwide approach [2]. The program also strives for consistency of selected target taxa within and among study units.

Trace elements in aquatic systems may be attributed to natural geologic sources or to past and present land uses. Although trace elements originate from natural sources, human activities such as mining, agriculture, and urbanization can affect their concentration and distribution [3]. Characterizing the geographic distribution of trace element constituents with regard to background conditions and sources is one goal of the assessment. Measuring concentrations of trace elements in fish liver offers a more complete description, than just one sampling medium, of the occurrence and distribution of trace elements in the catchment area [4]. This report identifies the occurrence and distribution of selected trace elements in fish liver at sampled sites and determines the relation of trace elements in fish liver to natural and human factors.

2. Sample collection and analysis

Collection and field processing of fish liver samples for analysis of trace elements followed established NAWQA (US National Water Quality Assessment) protocols [5]. Fish samples were collected at 15 sites throughout the Khorramabad River Watershed (KHRW) study unit (Fig.1). Fish collection was done by electro fishing a stream reach that was 300 to 410 ft long at wade able sites and 1,500 to 3,000 ft long at non-wade able sites. The fish taxa collected for analysis was selected mainly from bottom feeding fish and non-migrating game fish. Trace elements in fish liver were analyzed at the Laboratory complex of Islamic Azad University, Science and Research Campus, Tehran [6]. Results of selected trace element analysis for fish liver are listed in table 1. Triplicate samples were collected for fish liver for quality assurance/quality control. The difference between field triplicate samples for fish liver ranged from 10 to 30 percent. Therefore, more variability in analysis was associated with the fish liver samples.

3. Results and Discussion

Trace elements in water or sediments may enter the aquatic food chain and in high concentrations, pose a threat to the health of fish, wildlife, and eventually humans. Bioaccumulation of some elements, notably Hg, in the food chain makes human consumption of contaminated fish unsafe [7]. Because fish livers rather than the edible portion (fillet) were analyzed in this study, the values reported are appropriate for human health risk assessment.

Thirteen of the selected trace elements were detected in most sites. Lithium and silver were not detected at any site. Relating trace element concentrations in fish liver to land use is more difficult than the streambed sediment, probably because not the same species (such as trout) are present at all sites. Cadmium, selenium, and zinc were selected for a more detailed analysis. Individual samples show highest cadmium concentration in sampling media of mining land use sites, whereas selenium was highest sampling media of agricultural land use sites. Zinc was highest in fish liver at mixed land use sites. The highest median concentration of cadmium, selenium and zinc were found in spotted mullet fish liver samples at different sites, but the highest concentration of cadmium was at site 10, a mining land use site, in the Khorramabad River Watershed physiographic area (Fig.1). The highest concentration of zinc is in a mullet (spotted) liver sample at site 9, a mixed land use site in the most downstream site in the catchment area. High concentration of zinc in liver samples is due to fish needs for this minor nutritional element especially in the early days of growth. Medium frequency of selenium in fish samples (spotted mullet) is relatively high, as a result of joining industrial and agricultural waste waters to the main waterway of the region. Comparison of selected trace element concentrations in fish liver among the different taxa at the sampling sites indicates that trace element bio-concentration may be species dependent. Salmon liver samples at sites 1, 3, 7, 13 and 14 generally had higher concentrations of cadmium, selenium, and zinc than spotted mullet liver samples. The minimum concentration of trace elements in fish liver of the watershed belongs to vanadium and the maximum concentration belongs to iron. Vanadium is one of the important elements in porphyrins organometallic compounds [8], but its consumption by fish is very low. Poor concentration of mercury and arsenic in fish liver tissue is the consequence of entering agricultural poisons and drainage waters of marginal farms into the surface waters of the study area. Low concentration of alkaline trace elements, Na and K, in analyzed liver samples is the result of low dissolved salts in surface waters and the strong absorption of these major invariable elements on clay mineral surfaces. The concentrations of trace elements in fish liver is related to concentrations of trace elements in ingested food, water, and sediment, along with the rates of bioaccumulation and depuration; these factors differ for different trace elements and fish species [9].

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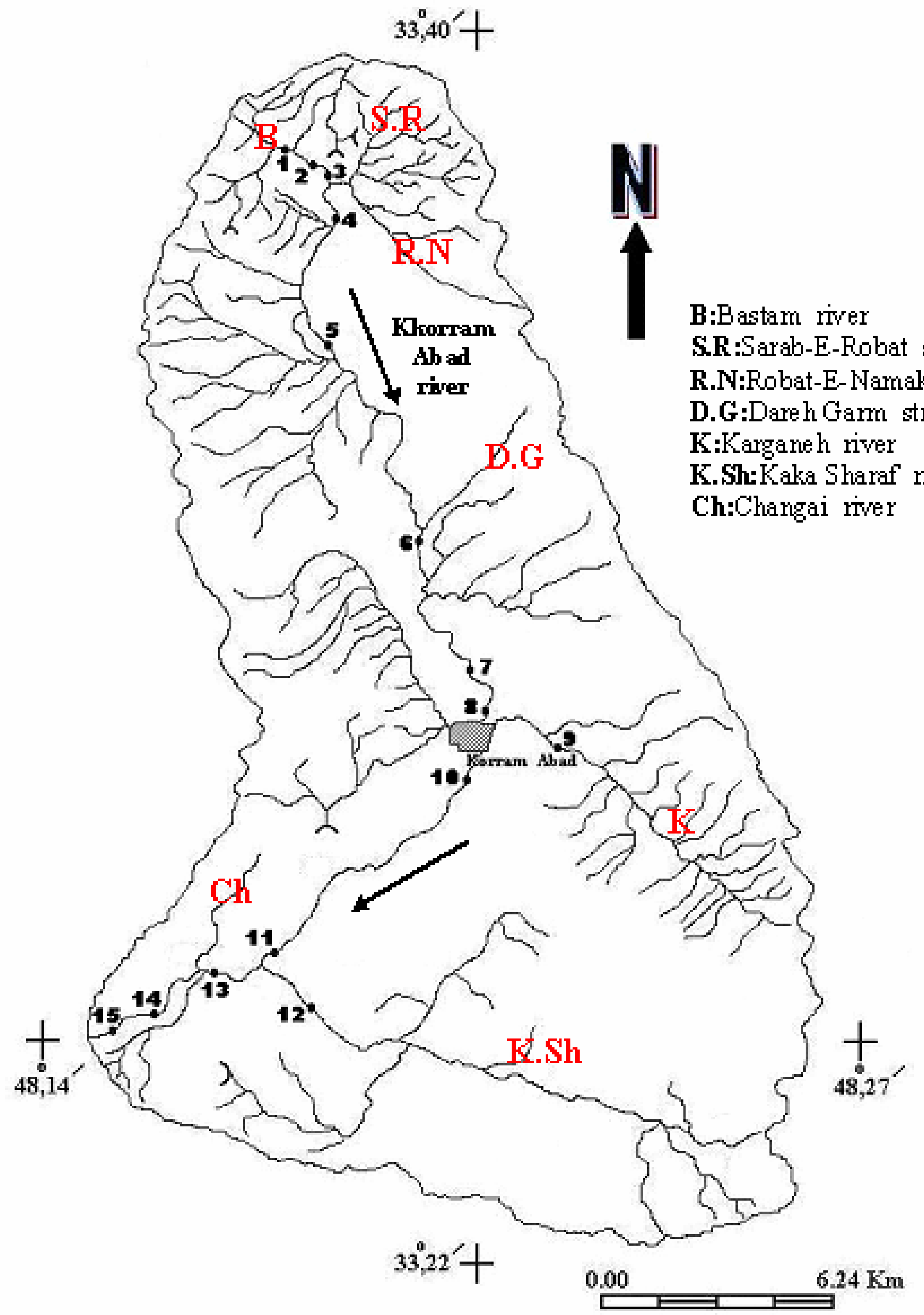

Fig 1. Location of sites for collection of fish samples in the Khorramabad River Watershed.

Table 1. Concentrations of trace elements in fish liver samples collected from selected sites in the Khorramabad River Watershed study unit[Values in ppm; - , lower than the detection limit for AAS].

Sample No.	Cd	Mn	Fe	Ni	Pb	Zn	Co	V	As	Hg	Se	K	Na
F_1	-	10.2	750	1.3	-	36	5.5	0.05	0.3	0.35	51.8	0.08	15.5
F_2	3.5	6.6	810	2	0.5	17	10.5	0.04	0.2	0.25	13.9	0.06	14
F_3	4	4.7	861	17	0.8	86.05	16	0.04	-	0.14	32.2	0.08	8
F_4	2	3.7	967.5	17	0.4	129.4	8	0.03	0.3	-	38.8	0.05	20
F_5	4	5.7	228	7.5	0.6	11.85	12	-	0.2	0.3	31.8	0.08	24.5
F_6	2.5	4.2	831	13.5	0.5	112.15	0.5	0.02	-	0.2	32.2	0.08	1
F_7	2.7	4.5	915.5	9	0.5	89.5	1.6	0.02	1.3	0.2	63.2	0.07	1.5
F_8	3	6.8	910	8.5	0.3	94.3	2	0.04	0.8	0.1	6.1	-	2
F_9	1	4	65.5	8	0.6	307	4.5	0.05	0.4	0.13	66.5	0.1	4
F_{10}	5	6	125	12.5	0.3	138	9	0.03	-	-	4.2	0.08	12
F_{11}	4	4.5	103.5	18	0.5	131.15	13.5	0.02	0.2	0.17	3.1	0.06	20
F_{12}	3	9.4	610.5	30	0.7	63	17	0.01	1.1	0.14	7.2	0.08	0.5
F_{13}	4.5	5.2	338	16.5	0.8	79.85	19.5	0.02	1.3	0.13	8.9	0.04	14
F_{14}	1.5	6	939.5	-	1.5	170.8	3	0.02	0.7	0.14	11.1	0.07	5
F_{15}	3	6.6	862.5	17.5	0.4	97.55	3.5	0.03	0.5	0.15	14.2	0.05	4