Heavy Metal Concentration in Biotic and Abiotic Samples of Industrial Wastewater

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***Abstract*—**In the present study, some heavy elements (Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Br, Sr, Pb) in sediment, water and their accumulation in some Hydrophilidae (Coleoptera) species organs (total body) were investigated. For this purpose, samples were collected from two industrial area in Erzurum (Turkey). Heavy elements levels in sediment, water and insect samples were analyzed by Energy Dispersive X-Ray Fluorescence (EDXRF) spectrometer. This study was firstly aimed to find out the level some heavy elements as the element pollution in selected stations, and secondly if Hydrophilidae (Coleoptera) species can be used as a biomonitor. The results pointed out that the insects were contaminated by the sediment and water, therefore hydrophilid beetles accumulate higher concentration of elements than their environment.

***Keywords*—**Biomonitor, EDXRF, Heavy element, Hydrophilidae.

I. Introduction

CHEMICALS are part of our daily life. All living and inanimate matter is made up of chemicals. The pollution of the aquatic environment with heavy metals has become a worldwide problem during recent years, because they are indestructible and most of them have toxic effects on organisms [1]. Heavy metal concentrations in aquatic ecosystems are usually monitored by measuring their concentrations in water, sediments and biota [2], which generally exist in low levels in water and attain considerable concentration in sediments and biota [3]. Aquatic insects and other benthic invertebrates are the most widely used organisms in freshwater biomonitoring of human impact [4; 5], but studies on aquatic insects often focus on their larvae. Family Hydrophilidae, one of the largest families of Coleoptera, has wide distribution, well known taxonomy and its larvae require different environmental conditions, which makes these insects' good biomonitor for heavy element. The purpose of this study is a preliminary survey of the effect of anthropogenic activity on water, sediment and Hydrophilidae species and to certify the potential of these species as biomonitor for heavy element pollution in Erzurum.

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II. Materials and Methods

A. Collection of samples

All samples were collected Cement and Sugar Factory wastewater. Insects were sampled from two sites, along with contiguous sediment and water. Insects were collected via 1 mm mesh aperture sieve and mouth aspirator. Three different species belonging to Hydrophilidae (Coleoptera) *Hydrobius fuscipes* (Linnaeus, 1758), *Enochrus* (*Lumetus*) *quadripunctatus* (Herbst, 1797) and *Berosus (Enoplurus) spinosus* (Steven, 1808) were determined. Sediments were taken from 30 cm depth benthic zone via plastic shovel, then stored in glass bottle and noted describing the information of the station. Before taking the water samples, the glass bottles were washed 4-5 times with the water in the study area. Location of the study areas were given in Table 1

TABLE 1: Description of the sample sites

Station Number	Altitude (m)	Location	Coordinates
I	1636	Cement Factory (Western front)	39°55'19N 40°40'01E
II	1759	Sugar Factory	39°57'03'N 41°05'24E

B. Elemental Analysis

An EDXRF spectrometer with 1 Ci ^{241}Am radioactive source and an HPGe detector with resolution ~180 eV at 5.9 keV was used to determine the heavy elements in all samples. All measurements were carried out under vacuum. Measurement time for water and sediment samples was 4 h and insect samples was 24 h. Insects were pulverised and then cellulose was added as a binder. Five tons of pressure applied to make 13 mm diameter pellets of each species. The concentration of elements in each samples were determined by Win AXIL software, which use Fundamental Parameters Method (FPM) for quantitative analysis.

III. Results and Discussions

EXRF analysis one of the best analytical techniques to perform elemental analysis in all kind of samples no matter if liquids, solids or loose powders, also major, minor, thin and thick samples of all sizes and forms of samples. In this study the concentrations of elements were measured by Energy Dispersive X-Ray Fluorescence (EDXRF) spectrometry. In general, determined heavy element are shown in Table 2. The concentrations of these elements were found to vary in water,

sediment and insects. Ti, Cr, Fe, Ni and Pb were measured in all samples of stations. It appears that Hydrophilidae species accumulated relatively more Mn, Fe, Co, Ni, Cu, Zn, As, Se, Br, Sr and Pb compared to their environment. As it seen Table 2 *E. quadripunctatus* accumulated relatively more Ti, V, Co, Ni, Cu, Zn, As, Se and Br compared to the other species. In addition, these elements were the highest concentrations in *E. quadripunctatus*. *B. spinosus* accumulated highest concentration of Cr, Mn and Fe; *H. fuscipennis* accumulated highest concentration of Sr and Pb. In water samples Ti and V had highest concentration. In sediment samples Cr was highest concentration. Generally the heavy element concentration were observed as hydrophilid>sediment>water. Ge, Ru, Rh, Pd, I, Cs, Ce, Pr, Nd elements were qualitatively detected in some samples but their concentrations were quantitatively not determined due to the detection limit of spectrometer.

The data presented in the paper showed that the aquatic beetles are capable of reflecting trace elements bioaccumulation in habitats with different levels.

TABLE II: CONCENTRATION OF HEAVY ELEMENTS IN WATER, SEDIMENT AND INSECT SAMPLES (PPM)

Heavy Element	**Water**	**Sediment**	**Station I** ***Hydrobius fuscipes***	***Enochrus quadripunctatus***	**Station II Water**	**Sediment**	***Enochrus quadripunctatus***	***Berosus spinosus***
Ti	443	2	130	133	242	1	15	1.5
V	87	0.380	22.5	24	48	-	3	-
Cr	20	855	22	20.5	11	487	0.7	582
Mn	6.5	-	8	8	3.5	-	0.2	190
Fe	3	0.205	3.20	3.23	2	0,133	0.18	430
Co	1	-	2.3	2.8	0.5	-	-	-
Ni	0.5	20	0.66	0.63	0.32	12	128	12.5
Cu	0.2	9.5	0.38	0.38	0.1	-	65	6.5
Zn	-	5	0.34	0.21	0.1	3	50	6
As	0.2	10	-	-	0.1	6	58.5	5.5
Se	-	10.5	0.43	0.43	0.1	6	69.5	6.5
Br	0.22	5.5	0.26	-	0.12	3.5	170	27
Sr	-	10	331	326	-	13	6	2
Pb	2	12	616	610	1	2	250	110

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