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Metals in Water from the River Nile Tributaries in Egypt

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Abstract The objective of this study was to evaluate the levels of Zn, Cu, Pb, Fe and Cd metals in water samples collected from different tributaries of the Nile River in Egypt. Samples were taken from El-Sarsawia, El-Bagoria, Bahr Shebin canals, in addition to three drainage canal sites El-Embaby, El-Menofi and Miet-Rabiha drain. According to the data, Fe has the highest concentration, followed by Pb, Zn, Cd and Cu. The mean Pb concentration ranged from 8.678 to 21.948 μg/L, in water samples collected from El-Sarsawia canal and El-Embaby drain, respectively. The Cu and Cd mean concentrations ranged from 0.67 and 0.500 to 4.908 and 5.650 μg/L, respectively, in water samples collected from Bahr-Shebin canal and El-Embaby drain, respectively. The water samples from all location sites are polluted by Pb according to EPA. Fe and Cu values are within the allowable limits.

Keywords Metals · Water · Pollution

Metals are natural trace components of the aquatic environment, but their levels have increased due to domestic, industrial, mining and agricultural activities (Kalay and Canli 2000). The most anthropogenic sources of metals are industrial sources as paints, rubber, dyes, batteries and petroleum contamination (Santoe et al. 2005). The agricultural drainage water containing pesticides and fertilizers and effluents of industrial activities and runoffs in addition to sewage effluents and the presence of decaying plant and animal residues supply the water bodies with huge quantities of heavy metals (Friberg and Elinder 1988). In spite of heightened concern and pollution programs, very little is currently known about the distribution, behavior, and effects of trace metals in the Nile River. The River Nile pass through agricultural and industrial fields, since most activities in Egypt are around the Nile, thus it is subjected to contamination with different pollutants. Drainage water is pumped into several major drains that finally discharged their waters into the river Nile or lakes. This study was aimed to evaluate the levels of metals (Fe, Pb, Cd, Cu and Zn) in water samples from the river Nile tributaries at El-Menofiya governorate, Egypt.

Materials and Methods

Stock Standard solution of Zn, Cu, Pb, Fe and Cd were obtained from Merck in concentration of 1000 mg/L (Merck, Darmstadt, Germany. Nitric acid (HNO_3) (density at 20°C: 1.4 g/mL) (95% purity) was obtained from SDS, Peypin, France. Water samples were collected every 2 month, during the period from June 2007 to September 2008 from six sites selected in El-Menofiya governorate. Samples were taken from El-Sarsawia, El-Bagoria, Bahr Shebin canals, in addition to three drainage canal sites El-Embaby, El-Menofi and Miet-Rabiha drain. Three of the study sites are used as water canals with which to irrigate fruit and vegetable gardens. One of this sites (El-Bagoria) are at the inlet of Menof water purification station. Farmer at such sites always uses these waters for domestic as well as agricultural purposes. 250 mL of well-mixed water samples were transferred to beakers. Five milliliters of HNO_3 were added in each sample. Then, samples were allowed to reach 80–85°C using hotplates to a final volume

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Table 1 Recovery percentage, relative standard deviation and method detection limits of metals in water

Name	Recovery	RSD (%)	LOD (ng L^{-1})
Fe	86	10	40
Pb	89	4	11
Cd	87	7	9
Cu	85	6	35
Zn	91	4	7

of about 10–20 mL before metal precipitation. The digestion procedure was repeated twice. The beaker walls were washed with metal free water and then the rinse water was filtered. The filtrate was then transferred to 25 mL volumetric flask (with addition of water) for end determination (APHA 1998). Quantitative determination of were conducted by using Thermo atomic absorption spectrometer with hallow cathode lamp and a deuterium background corrector, at respective resonance line using an air-acetylene flame. Recoveries were carried out by the addition of the standards of each element at different levels. Blanks were included in each batch of analysis. Calibration standards were regularly performed to evaluate the accuracy of the analytical method. These and blank solutions were also analyzed in the same way as for the digested samples (Table 1).

Data were statistically evaluated by one-way analysis of variance (ANOVA). All statistical analyses were done using the statistical package for social sciences (SPSS 16.0) program.

Results and Discussion

In Egypt and other developing countries, where environmental protection laws have not been enforced, industrial and domestic wastes are dumped indiscriminately into water bodies. These wastes have been reported to contain toxic and hazardous substances including metals. The contamination of water resources by trace metals is of important concern because of their toxicity, persistence and bioaccumulative nature (Ikem et al. 2003). The concentration of trace metals (Fe, Pb, Cu, Cd and Zn) in the water samples are shown in Table 2. According to the data, Fe has the highest concentration, followed by Pb, Zn, Cd and Cu. The mean concentration of Fe ranged from 52.132 µg/L in water samples collected from Bahr Shebin canal to 152.26 µg/L in water samples collected from El-Bagoria canal. The mean Pb concentration ranged from 8.678 to 21.948 µg/L, in water samples collected from El-Sarsawia canal and El-Embaby drain, respectively. The Cu and Cd mean concentrations ranged from 0.67 and 0.500 to 4.908 and 5.650 µg/L, respectively, in water samples collected

Table 2 Concentration ranges (µg/L) of metal in water samples (n = 8 for each sampling site)

Metal	El-Sarsawia canal	El-Bagoria canal	Bahr Shebin canal	El-Embaby drain	El-Menofi drain	Miet Rabiha drain
Lead (Pb)						
Min.	1.360	1.020	0.650	0.490	1.030	2.390
Max.	35.25	44.75	79.80	63.54	52.19	52.41
Mean	8.67	9.011	9.761	21.94	15.57	10.87
Iron (Fe)						
Min.	38.90	23.80	11.06	16.40	29.20	19.0
Max.	391.82	475.5	131.61	162.89	135.4	183.03
Mean	118.03	152.6	52.132	78.887	65.641	97.303
Copper (Cu)						
Min.	0.860	0.380	0.240	0.690	0.656	0.330
Max.	9.052	5.619	0.981	16.630	4.290	1.570
Mean	2.435	1.697	0.670	4.908	3.188	1.103
Cadmium (Cd)						
Min.	0.60	0.120	0.140	1.00	0.10	0.10
Max.	1.390	0.940	1.4339	1.278	1.664	14.10
Mean	0.501	0.514	0.500	0.565	0.725	2.461
Zinc (Zn)						
Min.	1.90	1.80	1.90	1.60	1.80	1.70
Max.	27.5	8.20	19.12	27.29	28.72	12.665
Mean	6.185	2.678	5.155	7.086	6.977	3.181

Table 3 Standard limits of drinking water parameters (mg/L) according to different criteria

Metal	WHO[a]	EPA[b]	ECS[c]
Fe	0.3	0.3	1
Cu	1	1	1
Zn	5	5	5
Cd	0.005	0.01	0.01
Pb	0.05	0.005	0.05

[a] WHO (1993)

[b] US-EPA (2001)

[c] ECS (1994)

from Bahr-Shebin canal and El-Embaby drain, respectively. The highest mean concentration of Zn (7.086 µg/L) was found in water samples collected from El-Embaby drain, while the lowest mean concentration (2.678 µg/L) was found in water samples collected from El-Bagoria canal. There is a tendency of all metals on water to show the highest concentration at all sampling sites Table 2. This probably may be due to the influence of sewage, industrial and agricultural discharge and due to the deposition of these metals from the atmosphere. Higher levels of lead often occur in water bodies near highways and large cities due to high gasoline combustion (Banat et al. 1998). A number of workers have discussed the sources of trace metals in water (Salomons and Forstner 1984; Furness and Rainbow 1990). It was found that, the higher population densities of urbanization and industrialization have led to quite high contamination of waters by metals. Such inputs could results from treated and untreated municipal, industrial wastes, agricultural run-off and from the atmospheric input (Abaychi and DouAbul 1985). The sources of trace metals mainly emanate from oil fields, industrial wastes and sewage effluents (Abdelmoneim 1995). However, the principal source of Pb contaminants in the marine environment appears to the exhaust of vehicles which run with leaded fuels. Also, lead reaches the marine environment by rain and windblown dust (Castro and Huber 1997).

The maximum permissible levels of trace metal in surface water recommended by US EPA are 11 µg/L for Cu, 1000 µg/L for Fe, 2.5 µg/L for Pb, 1 µg/L for Cd and 100 µg/L for Zn (US-EPA 1996). The Canadian maximum permissible levels of heavy metal in surface water are 300 µg/L for Fe and 30 µg/L for Zn (Environment Canada 1998). The water samples from all location sites are polluted by lead according to EPA. Iron and copper values are within the allowable limits according to WHO (1993), EPA (2001) and ECS (1994) three standards (Table 3).

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