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Cadmium and Lead Contamination in Tap Water Samples From Tokat, Turkey

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Traces levels of transition metals are widely distributed in the environment as a result of soil erosion and of a broad range of industrial and agricultural processes. There is always a possibility that metals will be taken up by plants such that they end up in the human food chain (Chen *et al.,* 1995; Gebeloglu *et al.,* 2004; Moawed 2004; Saqib and Jaffar 2004; Van Cauwenbergh *et al.,* 2004; Welch *et al.,* 2004). Because of these points, investigations of contamination of traces metal ion in drinking water samples have been continuously performed by the analytical chemists (Soylak *et al.,* 2002; Baytak and Turker 2004; Dey *et al.,* 2004). Cadmium and lead are classified as prevalent toxic metals which tend to be concentrated in environmental systems and humans. Lead is emitted into the biosphere in considerable amounts, owing to its increased industrial use and its application as a fuel additive. Lead accumulates in the vital organs of man and animals. Its cumulative poisoning effects are serious haematological damage, anaemia, kidney malfunctioning, brain damage etc. In natural water its typical concentration lies between 2 and 10 μg/l, whereas, the upper limit recommended by WHO is less than 10 μg/l (WHO, 1993). Cadmium is one of the most serious environmental pollutants. Cadmium enters the organism primarily via the alimentary and/or respiratory tract. The sources of cadmium are food, drinking water and air. Approximately 15,000 tones of cadmium are produced worldwide each year for nickel-cadmium batteries, pigments, chemical stabilizers, metal coatings and alloys. The maximum acceptable concentration of cadmium in drinking water is 5 μg/l. The presence of cadmium and lead in drinking water may represent a risk for public health especially for children. However their concentration in drinking waters is usually so low that they can not be directly determined by flame atomic absorption spectrometry (FAAS). A preconcentration treatment like liquid-liquid extraction, cloud point extraction, electrodeposition etc. thus is requisite (Soylak and Elci 2000; Arpa *et al.,* 2004; Yao *et al.,* 2004; Taher *et al.,* 2005). Solid phase extraction (SPE) is an efficient preconcentration technique, especially by use of polymeric artificial or natural polymers (Baytak and Turker 2004). Chromosorb resins have been also used for preconcentration of heavy metals from drinking water (Cai *et al.,* 2002; Saracoglu and Elci 2002).

Our present work aims at determining the lead and cadmium concentrations in samples of drinking water in various locations of the Tokat region of Turkey,

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using flame atomic absorption spectrometry after preconcentration procedure (Tuzen *et al.*, 2005) with Chromosorb 106 resin.

MATERIALS AND METHODS

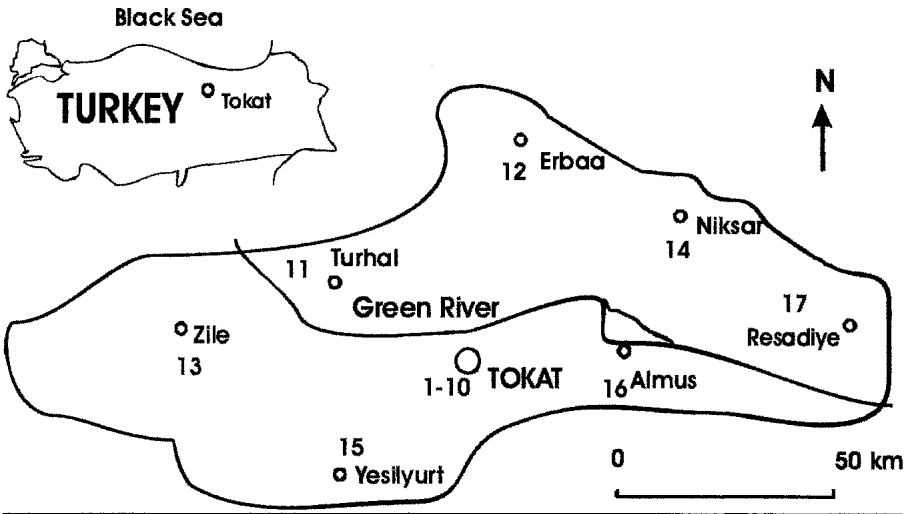
All the chemicals used in the present work acquired from E. Merck, Darmstadt were of analytical grade and were used as such from freshly opened bottles. No attempt was made to purify them further. Chromosorb 106 Resin (Sigma Chem. Co., St. Louis) was prepared with the washing steps as reported previously (Tuzen *et al.*, 2005).

The drinking water samples were collected in pre-washed (with detergent, doubly de-ionised distilled water, diluted HNO_3 and doubly de-ionised distilled water, respectively) polyethylene bottles from 17 stations in Tokat and villages around Tokat in May-June 2004 (Figure 1). First ten sampling point are different sites in the city center of the Tokat. Other seven sampling points were selected from the neighboring villages around the Tokat City.

The samples were obtained directly from the water pump after allowing the water to run for at least twenty min. The samples were filtered through a Millipore cellulose membrane with a 0.45 μm pore diameters. Then the samples were acidified to 1% with nitric acid and were stored in 1 L polyethylene bottles. The samples were subsequently stored at 4°C for as a short time as possible before the analysis to minimize changes of the physicochemical form of the metals (Soylak *et al.*, 2002).

A Perkin Elmer AAnalyst 700 atomic absorption spectrometer with deuterium background corrector was used in this study. A 10 cm long slot-burner head, a lamp and an air-acetylene flame were used. The operating conditions were as recommended by the instrument manufacturer. The atomic absorption signal was measured as a peak height mode against an analytical curve. A pH meter, Sartorius pp-15 Model glass-electrode was employed for measuring pH values in the aqueous phase. A glass column 100 mm high and 10 mm in diameter was packed with 600 mg of Chromosorb 106 resin.

For preconcentration-separation of lead and cadmium in the drinking water samples from Tokat, a 500 mL acidified water sample was neutralized and adjusted to pH 9 with an ammonia/ammonium chloride buffer. The Chromosorb 106 column was preconditioned by passing the buffer solution. Then 3.0 mL of the 1.10^{-2} M solution of 1-(2-pyridylazo) 2-naphtol (PAN) as chelating agent for cadmium and lead ions in natural waters was added. After 5-10 min, the metal-PAN solution was passed through the column. The flow of sample solution through the column was gravitationally performed. Then the column was rinsed twice with 10 mL water. The retained metal-ions were eluted with 7-8 mL of a 1 M HNO_3 solution in acetone. The eluent was evaporated over a hot plate to near dryness at 35°C in a hood and was diluted to 2 mL with 1 M HNO_3. The metal concentrations in the final solution were determined by flame AAS.



Sample No	Sample Location	Sample No	Sample Location
1	Niksar Street	10	Birth Hospital
2	Tokat Square	11	Turhal
3	SSK Hospital	12	Erbaa
4	İseri Petrol Station	13	Zile
5	Altiyuz Sites	14	Niksar
6	Bus Station	15	Yesilyurt
7	Industrial Area	16	Almus
8	Karsiyaka	17	Resadiye
9	Gumbet		

Figure 1. Sample locations

RESULTS AND DISCUSSION

Tokat is a developing industrial-agricultural city in the central Anatolia-Turkey and has a population of 114 000. It is famous for some industrial plants including textile, nutrition, sugar, etc.. The concentrations of cadmium and lead ions in drinking water samples from seventeen sites of Tokat and neighboring villages of Tokat-Turkey were determined by atomic absorption spectrometry, after preconcentration-separation procedure given by Tuzen *et al.* (2005). Mean recoveries of elements from fortified drinking waters were: 100±3% for Cd and 99±3 % for Pb. The detection limits (μg/L) were: 0.19 for Cd and 0.32 for Pb. The drinking water samples were analyzed in triplicate. The results were summarized in Figure 2.

A major source of environmental lead, particularly in urban areas, is due to the combustion of leaded petrol. In Turkey, unleaded petrol is not in widespread use because of its cost and because of the car age (Soylak *et al.*, 2000). Lead thus released in the atmosphere is ultimately fixed in soil, plants and water. Lead then enters the waterways from soil, thus affecting the levels of lead in natural water samples.

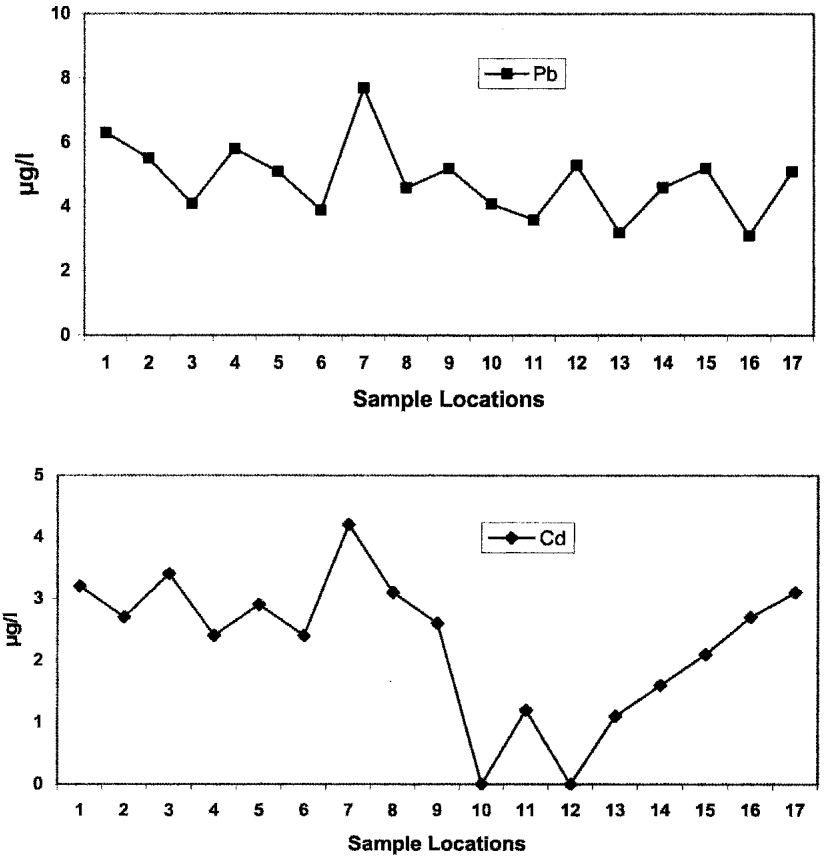


Figure 2. The levels of lead and cadmium in the drinking water samples from Tokat-Turkey

Lead in drinking water may be due to the use of lead pipes or of plastic pipes stabilized with lead compounds. The lead concentration range was 3.1-7.7 µg/l. The lowest level of lead was in the sample from Almus Station. The highest lead level was found in the drinking water sample from the industrial area of Tokat city. The mean level of lead in the drinking water samples from Tokat-Turkey was 4.85 µg/l. The concentrations for lead in drinking water samples are below the permitted levels of the World Health Organization (WHO) and the Water Pollution Control Regulation of the Turkish Authorities (WHO, 1993; WPCRTA, 1989).

Cadmium may enter surface waters as a consequence of industrial, mining and smelting operations. Metal and plastic pipes constitute an additional possible source of cadmium in natural waters. The mean level of cadmium in the drinking water samples from Tokat-Turkey was 2.58 µg/l. Cadmium values of nine samples were higher than the mean value. Cadmium concentrations were found to be below the detection limit of the method in only two samples (samples from

Erbaa and Birth Hospital of Tokat city). The highest cadmium level of drinking water samples from Tokat was found in the sample from the industrial area of Tokat city (4.2±0.3 μg/l) and the lowest in Zile station (1.1±0.1 μg/l). None of the drinking water samples analyzed for cadmium exceeded the limit of 5 μg/l permitted by WHO (WHO, 1993), which agrees with results obtained by other authors in other countries (Latino *et al.*, 1995; Asubiojo *et al.*, 1997; Soylak *et al.*, 2002).

The highest levels of cadmium and lead in the drinking water sample from industrial area of Tokat city may be related with industrial activities. This point is agreed with the values of drinking water samples from various cities around the world (Latino *et al.*, 1995; Soylak *et al.*, 2002).

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