Assessment of Some Heavy Metals in Drinking Water Samples of Tunceli, Turkey

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Received 10 May 2010; Accepted 20 July 2010

Abstract: The drinking water quality is associated with the conditions of the water supply networks, the pollution and the contamination of groundwater with pollutants of both anthropogenic and natural origin. In this study, water samples were taken from four different waterworks in Tunceli, Turkey and heavy metals concentrations (As, Cu, Cd, Cr, Pb, Ni and Hg) were measured. Four sampling sites were pre-defined in different locations of the city. The obtained results showed that, the heavy metals concentrations in water samples did not exceed the values of WHO (World Health Organization), EC (Europe Community), EPA (Environment Protection Agency) and TSE-266 (Turkish Standard) guidelines.

Keywords: Heavy metal, Drinking water, Health, Turkey.

Introduction

Safe and good quality drinking water is the basis for good human health. Water provides some elements, but when polluted it may become the source of undesirable substances dangerous to human health and cause disease such as, various cancers, adverse reproductive outcomes, cardiovascular disease and neurological disease¹⁻⁴. Therefore the heavy metal concentration in drinking water should be kept in the low ppb range.

One of the most hazardous trace metals found in drinking waters is arsenic (As) being both toxic and carcinogenic. Long term intake of arsenic may give rise to skin lesions⁵ at concentrations 50 mg L⁻¹. Cadmium (Cd) and lead (Pb) are the heavy metals more critical for the human health, also^{6,7}. Cd may be cause the diseases; hypertension, arteriosclerosis, cancer, etc^{8,9}. The World Health Organization (WHO) established as 3 µg L⁻¹ and Environmental

Protection Agency (EPA) established $5 \mu\text{g L}^{-1}$ the maximum permissible for Cd^{8,10} and WHO has established maximum allowable limits for Pb $10 \mu\text{g L}^{-1}$ for drinking waters¹¹. Chromium (Cr) is an essential trace metal in both human and animals but excessive amounts of chromium, particularly in the more toxic Cr(VI) valence state, are detrimental to health as it may be involved in the pathogenesis of some diseases such as lung and gastrointestinal cancer¹². Elevated copper (Cu) level in drinking water may have a neurotoxic potential and can produce mental diseases such as Alzheimer's¹³.

Although concentrations of some heavy metals have been measured in tap, surface and other water samples in Turkey¹⁴⁻¹⁸, but the consumed waters in Tunceli have not been investigated. The water demand in Tunceli is supplied by underground waters. A measurement of the concentration of heavy metals in different water supplies in Tunceli/or in other city is extremely important for proper assessment of the hazards associated with their intake.

In this study, water samples were taken in Tunceli from four different waterworks. The goals of the present study were to investigate concentrations of As, Cu, Cd, Cr, Pb, Ni and Hg in Tunceli's drinking water, to identify contamination sources and processes and to ascertain whether metals in household drinking water in Tunceli a risk to public health.

Experimental

Most samples were taken in October 2009. All data sets were obtained from the Health Directorate of Tunceli in order to estimate the exposure and risk levels for Tunceli population associated with ingestion of metals in drinking water. The water samples were acidified prior to analysis by addition of 1% (v/v) of nitric acid. All samples were kept in 1000 mL polypropylene bottles and stored at +4 °C until analyses. The sampling stations were shown in Figure 1 and Table 1.

Figure 1. Map of the sampling stations.

Table 1. List of the sampling stations

Station no	Station name
I	Esentepe quarter water reservoir
II	Esentepe quarter water supply
III	Cumhuriyet quarter drilling water
IV	Alibaba quarter water supply
V	Atatürk quarter water supply

Analysis of metals

The concentrations of elements (Cu, Pb, Ni, As, Cd and Cr) were measured using graphite furnace atomic absorption (GFAAS) spectrophotometer. Hg concentration in prepared sample was measured using atomic absorption spectrophotometer (AAS).

Statistical treatment

The data were analyzed using statistical software program (SPSS 12.0 for Windows). Data were compared using one-way analysis of variance. Results were expressed as mean $\pm$ SD for the three experiments.

Results and Discussion

The heavy metal content of the drinking water samples including As, Cu, Cd, Cr, Pb, Ni and Hg from Tunceli-Turkey were given in Table 2. Cadmium in the investigated water samples were found in the range of <0.05 - $1.67 \mu\text{g L}^{-1}$. Cd concentrations in unpolluted natural waters are usually¹⁹ below $1 \mu\text{g L}^{-1}$. Median concentrations of dissolved cadmium measured at 110 stations around the world were $<1 \mu\text{g L}^{-1}$, the maximum value recorded being $100 \mu\text{g L}^{-1}$ in the Rio Rimao in Peru²⁰. Contamination of drinking water may occur as a result of the presence of cadmium as an impurity in the zinc of galvanized pipes or cadmium containing solders in fittings, water heaters, water coolers and taps¹⁹. Mercury levels were detected below $0.02 \mu\text{g L}^{-1}$ at all stations. It was reported that the concentration range for Hg in drinking water was the same as in rain, with an average of about²¹ 25 ng L^{-1} . It was determined that Hg concentrations in investigated water were below this level. The WHO provisional guideline of $10 \mu\text{g L}^{-1}$ for As has been adopted as a national standard by most countries and by the European Union (EU). In our study, As content of the samples were in the range of <0.5 - $2.02 \mu\text{g L}^{-1}$. It was determined that as level measured in this study was under $10 \mu\text{g L}^{-1}$. The ranges for nickel (Ni) were <0.6 to $2.21 \mu\text{g L}^{-1}$ (Table 2). In Canada, the median Ni level in drinking water supplies was below $2 \mu\text{g L}^{-1}$, the maximum level observed²² was $69 \mu\text{g L}^{-1}$.

Table 2. Heavy metal content of the drinking water samples from Tunceli, Turkey

Station no	Elements*, $\mu\text{g L}^{-1}$						
	As	Cu	Cd	Cr	Pb	Ni	Hg
I	2.02 ± 0.92	0.40 ± 0.01	1.27 ± 0.04	0.30 ± 0.03	BDL**	0.88 ± 0.04	<0.02
II	1.20 ± 0.01	0.38 ± 0.02	<0.05	3.99 ± 0.56	0.31 ± 0.02	1.73 ± 0.46	<0.02
III	<0.5	<0.05	<0.05	<0.1	BDL	<0.6	<0.02
IV	1.22 ± 0.01	0.32 ± 0.02	1.67 ± 0.04	3.50 ± 0.45	BDL	2.21 ± 1.03	<0.02
V	0.98 ± 0.03	<0.05	<0.05	<0.1	BDL	<0.6	<0.02

*Means $\pm$ SD, $n=3$, BDL** = Below Detection Limit

The copper content of the samples were in the range of $<0.05\text{--}0.40\text{ }\mu\text{g L}^{-1}$. The highest values ($0.40\text{ }\mu\text{g L}^{-1}$) were in Esentepe quarter water reservoir. Cu was considerably below the limit of 1.0 mg L^{-1} permitted by WHO in drinking waters²³. It was reported that Cu concentrations of drinking water samples from Northern Mexico as $0.1\text{--}319\text{ }\mu\text{g L}^{-124}$. Manzoori and Bavili-Tabrizi²⁵ have reported that Cu concentration in water from Tabriz City, Iran, as $32\text{ }\mu\text{g L}^{-1}$. Consequently, no contamination due to copper exists in the drinking water samples from Tunceli. The levels of lead in the samples (I, III, IV and V stations) were BDL (Below Detection Limit). The highest values ($0.31\text{ }\mu\text{g L}^{-1}$) were in Esentepe quarter water supply. The action level for Pb recommended by EPA is $15\text{ }\mu\text{g L}^{-1}$. The lead levels in all stations were below this level (Table 2). A major source of environmental Pb, particularly in urban areas, is due to the combustion of leaded petrol. Lead is discharged by vehicles into air, then adsorbed from the air by environmental samples such as soil and plants^{26,27}. Lead then enters the waterways from soil, thus affecting the levels of lead in natural waters. The chromium content of the samples was in the range of $<0.1\text{--}3.99\text{ }\mu\text{g L}^{-1}$. The Office of Environmental Health Hazard Assessment (OEHHA)²⁸ has developed a Public Health Goal (PHG) of $2.5\times 10^{-3}\text{ mg L}^{-1}$ for total Cr. In this study Cr concentrations were found under this level.

Conclusion

The concentrations of the investigated heavy metals (As, Cu, Cd, Cr, Pb, Ni and Hg) in the drinking water samples from Tunceli/Turkey were found below the guidelines for drinking waters given by the WHO and the Water Pollution Control Regulation of Turkish Authorities. It was concluded that drinking waters in Tunceli contain low heavy metal levels. Because, there is no industrial zone in and around Tunceli city.

Acknowledgment

We are thankful to Yılmaz Arıcı for his suggestions and cooperation.

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