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Short Communication

Evaluation of Chemical and Microbiological Contamination Levels in Drinking Water Samples Collected from Towns in Tunceli, Turkey

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ABSTRACT

This study explored the chemical and microbiological contamination of drinking water from eight towns in Tunceli, Turkey. Polycyclic aromatic hydrocarbons and epichloridine were extracted by liquid solid extraction and analyzed by using HPLC, volatile organics were analyzed by GC-MS and acrylamide was analyzed by GC. *Escherichia coli* and total coliform detection followed a membrane filtration method. Enterococci were detected and numerated by membrane filtration method. Most commonly found chemical pollutants were benzene, benzo[*a*]pyrene (BaP), 1-2 dichloroethane, epichloridine, tetrachloroethane, trihalomethane and acrylamide. *E. coli*, total coliform and enterococci were also found in the drinking water. Our results indicate that generally chemical and microbiological contaminations were found below the guidelines for drinking waters given by the World Health Organization, because of the fact that in the sampling area there is not any contaminating source. So, according to results these water samples are fit for drinking. © 2010 Friends Science Publishers

Key Words: Drinking water; Microbiological contamination; Chemical contamination; Tunceli

INTRODUCTION

Drinking water is a potential source of human exposure to a variety of contaminants, which are microbiological, chemical or radiological (WHO, 2006). There are many sources of contamination of drinking water. Broadly, they can be divided in two categories: contaminants in ground and surface water; the sources for drinking water production; and contaminants used or formed during the treatment and distribution of drinking water. Contaminants in ground and surface water range from natural substances leaching from soil, run-off from agricultural activities, controlled discharge from sewage treatment works and industrial plants and uncontrolled discharges or leakage from landfill sites and from chemical accidents or disasters (Van Leeuwen, 2000).

Many chemicals and microbes have been reported as pollutants of drinking water. Commonly reported chemicals include benzene (Kirkeleit, 2006), polycyclic aromatic hydrocarbons (Menzie & Potokib 1992; Wilson & Joins, 1993), chlorinated aliphatic hydrocarbons (Westrick *et al.,* 1984), acrylamide (Arimitu *et al.,* 1975; Lande *et al.,* 1979) and trihalomethane (Bruchet *et al.,* 1987). These chemicals have been reported for their adverse effects on human health like cancer, hematotoxicity (Vogel *et al.,* 1987; Israel *et al.,* 1992; Menzie & Potokib 1992; Wilson & Joins, 1993; Kirkeleit, 2006; Kane & Newton, 2010), hepatotoxicity (Barisione *et al.,* 1993) etc.

Bacteria, fungi, yeasts, protozoa etc. (Hinzelin & Block, 1985) are systematically found in drinking water distribution systems, both in the water phase and on the pipe walls where they accumulate as biofilm representing a characteristic microbial ecosystem relatively difficult to eradicate.

Monitoring microbial pollution in aquatic environments is needed to maintain acceptable water quality standards and consequently, to protect human health from sanitary hazards. Enterococci, members of the group D fecal streptococci, are common components of the normal flora of the intestinal tracts of all warm-blooded animals. They can enter streams or coastal waters through animal inputs, worsening bacteriological quality. The ability of these microorganisms to survive for long periods in aquatic environments has been demonstrated for both *Enterococcus fecalis* and *E. faecium* (Lleó *et al.,* 2005).

In this paper, chemical and microbiological pollutants of drinking water in eight towns of Tunceli, Turkey have been reported.

MATERIALS AND METHODS

Drinking water dataset: The chemical and microbiological dataset of eight towns (Fig. 1) were obtained from the Health Directorate of Tunceli for this study.

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Microbiological quality analysis: *E. coli* and total coliform detection followed a membrane filtration method [TS 9308-1 (Anonymous, 2004)], Enterococci were enumerated according to ISO 7899-2 [TS 7899-2, (Anonymous, 2000)].

Chemical analysis: EPA 8240-B method was used for determination of benzene [EPA 8240-B (Anonymous, 1994)]. Epichloridine and PAH (polycyclic aromatic hydrocarbons) and BaP were determined according to EPA 550.1 method [EPA 550.1 (Anonymous, 1990)]. EPA 8240-B method (Anonymous, 1994) was used for determination of tetrachloroethane, THM and 1-2 dichloroethane. Acrylamide was determined according to EPA-8032A method [EPA-8032A (Anonymous, 1996)].

RESULTS AND DISCUSSION

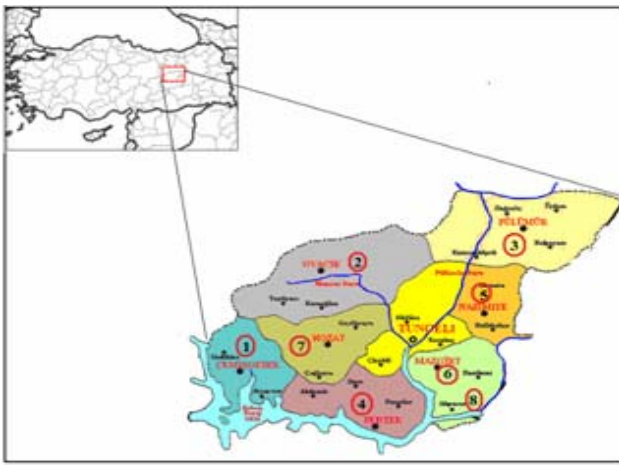
Chemical contamination in drinking water samples: Table I shows the chemical contaminant level in the drinking water collected from the eight different sites.

Benzene and epichloridine were not detected in either of the drinking water samples. Epichloridine limit concentration was detected 0.1 μg L^{-1} at human consumption regulation about waters in Turkey (Water Pollution Control Regulation of Turkish Authorities, 2005) BaP and acrylamide levels were below 0.00053 and 0.00025 μg L^{-1} at all towns, respectively. PAHs' levels (<0.008 μg L^{-1}) were same at the two localities i.e., Mazgirt and Hozat. The highest PAHs' level (0.559 μg L^{-1}) was found in drinking water collected from Pertek town, while the lowest value (0.008 μg L^{-1}) was found in Ovacik town. Tetrachloroethane was not detected in drinking water samples from Cemisgezek, Ovacik and Nazimiye towns. The highest tetrachloroethane level (0.2 μg L^{-1}) was found in drinking water collected from Pertek, Hozat and Akpazar towns, while the lowest value (0.1 μg L^{-1}) was found in Pulumur and Mazgirt towns. The highest THM level (29 μg L^{-1}) was found at Pulumur town, while the lowest value (11.3 μg L^{-1}) was found in drinking water collected from Akpazar town. The highest 1, 2-dichloroethane level (1.7 μg L^{-1}) was found at Pertek town, while it was not detected in drinking water samples from Ovacik (Table I).

Typical background levels of 1, 2-dichloroethane in non-industrialized areas are in general below 0.5 μg L^{-1} (De Rooij *et al.,* 1998). In a study on drinking water in Taiwan, mean concentrations of 1,2-dichloroethane were reported as 18 μg L^{-1} in tap water, 7 μg L^{-1} in underground water, 3 μg L^{-1} in mountain water and 59 μg L^{-1} in bottled mineral water (Kuo *et al.,* 1997).

Contamination of raw water supplies from natural and anthropogenic sources and leachate from coal tar and asphalt linings in water storage tanks and distribution lines contribute the major sources of BaP in drinking water. BaP in tap water is mainly caused by the presence of PAH-containing materials in water storage and distribution systems. The World Health Organization (WHO, 1996) has published drinking water guidelines for BaP of 7, 0.7 and 0.07 ppb (or 70 ppt). BaP was detected in the source drinking water collected from stomach cancer prevalent areas of Zanhuang County, HoPei Province, China, at 1.48 to 3.05 ppt (Zhang *et al*., 1995). BaP ranged from 0.01 to 0.95 ppt in Austrian mineral water and from 0.05 to 2.2 ppt in drinking water (Tiefenbacher *et al*., 1982). In this study, it is determined that BaP level was below of 0.00053 μg L^{-1} in all towns. Highest PAHs level was detected as 0.559 μg L^{-1}.

Fig. I: Map of locality of sampling



A survey of drinking-water in the USA in 1976–1977 detected tetrachloroethene in nine of 105 samples at levels ranging from 0.2 to 3.1 μg L^{-1} (mean 0.81 μg L^{-1}) (EPA, 1980). In other surveys of drinking-water supplies in the USA, it was found that 3% of all public water-supply systems that used well-water contained tetrachloroethene at concentrations of 0.5 μg L^{-1} or higher, whereas those that used surface water contained lower levels (USEPA, 1997). Tetrachloroethane levels (0.1-0.2 μg L^{-1}) detected in our study were below than this level (0.5 μg L^{-1}).

Chloroform is the most commonly occurring THM. Finished drinking-water collected in 1988–1989 from 35 US sources, 10 of which were located in California, in all four seasons contained median concentrations of chloroform ranging from 9.6 to 15 μg L^{-1}. The overall median for all four seasons was 14 μg L^{-1} (Krasner *et al*., 1989). Mean levels of chloroform in drinking-water in the Netherlands in 1994 ranged up to 8.9 μg L^{-1} (Versteegh *et al*., 1996). This level is higher than that found in the current study (29 μg L^{-1}).

The WHO (WHO, 1993) Guideline for Drinking Water Quality has established a guideline value of 0.5 μg L^{-1} for acrylamide in drinking water. In this study, acrylamide level was below 0.00025 μg L^{-1} in all towns, which is below than that considered safe by WHO.

Microbiological contamination in drinking water samples: Table II shows microbiological contamination values found in the drinking water collected from eight different towns of Tunceli.

Table I: Chemical contamination in drinking water samples collected from eight towns of Tunceli

Chemical parameters ($\mu g\ L^{-1}$)*	Towns							
	CEMISGEZEK	OVACIK	PULUMUR	PERTEK	NAZIMIYE	MAZGIRT	HOZAT	AKPAZAR
Benzene	ND*	ND	ND	ND	ND	ND	ND	ND
BaP	<0.00053	<0.00053	<0.00053	<0.00053	<0.00053	<0.00053	0.00053	<0.00053
Epichloridine	ND	ND	ND	ND	ND	ND	ND	ND
PAHs	0.008	<0.008	<0.513	0.559	0.546	<0.008	<0.008	0.066
Tetrachloroethane	ND	ND	0.1	0.2	ND	0.1	0.2	0.2
THM	26.7	17.3	29.0	23.2	20.4	14.7	15.7	11.3
1,2-Dichloroethane	0.2	ND	0.2	1.7	0.3	0.1	0.1	0.3
Acrylamide	<0.00025	<0.00025	<0.00025	<0.00025	<0.00025	<0.00025	<0.00025	<0.00025

*ND: Not determined

Table II: Microbiological contamination in drinking water samples collected from eight towns of Tunceli

Microbiological parameters (kob/100 mL)	Towns							
	CEMISGEZEK	OVACIK	PULUMUR	PERTEK	NAZIMIYE	MAZGIRT	HOZAT	AKPAZAR
E. coli	ND*	5	ND	ND	ND	55	5	ND
Total coliform	ND	5	ND	ND	ND	80	7	ND
Enterococci	ND	ND	ND	ND	ND	ND	ND	ND

*ND: Not determined

The highest *E. coli* value (55 kob/100 mL) was found in drinking water collected from Mazgirt town, while no *E. coli* was detected in samples collected from Cemisgezek, Pulumur, Pertek, Nazimiye and Akpazar towns. The presence of *E. coli* is indicative of a fecal contamination and the highly probable presence of pathogens. The absence of *E. coli*, however, is no guarantee for the absence of these pathogens, as the retention and survival of *E. coli* and pathogens in many environments, e.g. drinking water distribution systems, is not adequate (Ashbolt *et al.,* 2001).

Enterococci were not detected in either of the drinking water samples. Total coliform levels were 80, 7 and 5 kob/100 mL in drinking water samples collected from Mazgirt, Hozat and Ovacik towns, respectively. Total coliform was not detected in samples from Cemisgezek, Pulumur, Pertek, Nazimiye and Akpazar towns. Their presence in drinking water must at least be considered as a possible threat or indicative of microbiological water quality deterioration. Usually, coliforms are found in small numbers in drinking water samples (McFeters *et al.,* 1986).

CONCLUSION

The concentrations of the investigated chemicals and bacteriological contamination in the drinking water samples from the eight considered towns in the Tunceli, Turkey are below the guidelines for drinking waters given by the World Health Organization (WHO); therefore, fit for human consumption. However, periodic monitoring of chemicals and microbiological pollutants is suggested.

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