Measurement of Fluoride Concentration in Semnan Drinking Water Distribution

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ABSTRACT

Background: The existence of fluoride ion in potable water has distinctive effects on human health. Fluoride is attracted by positively charged calcium in teeth and bones due to its strong electro-negativity which results in dental, skeletal, and non-skeletal forms of xuorosis and associated health complaints in children as well as adults.

Methods: Water samples from groundwater used for drinking were collected from different water sources (over 22) and fluoride levels were determined through spectrophotometer, DR/5000 (Hach).

Results: The mean fluoride concentration was 1.14 ppm. The maximum concentration of fluoride recorded was 1.78 ppm while the lowest was 0.85 ppm.

Conclusion: Semnan drinking water is suitable for consumption without any treatment.

Keywords: Drinking water, Fluoride, Monitoring.

INTRODUCTION

Fluorine is a member of the halogen family which is an extensively distributed element. It is naturally found in the rocks, coal, clay, and soil. In air it is found in the form of hydro fluoride gas. Drinking water, however, is generally the largest single supplier to daily fluoride intake (1). For a given individual, fluoride exposure (mg kg^{-1} of body weight per day) via drinking-water is determined by the fluoride level in the water and the daily water consumption (liters per day). Water consumption data are most readily available for countries such as Canada, the USA, and the UK. More newly national figures can be obtained or computed from various compendia of environmental and water supply statistics, such as World Bank (1994) and WRI (1996). However, national consumption figures, especially for developing countries, may be of limited use for this purpose because there are probably major differences between urban communities with fully piped supplies and rural communities using wells and boreholes with hand pumps. Therefore, data on exposure to fluoride are difficult to come by except for temperate regions (2). In the early 1930s, researchers began to notice that people who drank naturally fluoridated water had very few cavities. This low prevalence of tooth decay was also associated with teeth that were mottled in appearance, a condition we now refer to as dental fluorosis. From this observation came the idea of adding fluoride to water systems in which fluoride concentrations were not sufficient to protect teeth, while also seeking to minimize the risk of dental fluorosis. Since then, various studies and systematic reviews of the scientific literature have amply demonstrated the beneficial effects of water fluoridation (3). The optimum fluoride level in drinking water for general good health set by WHO is considered to be between 0.5 and 1.5 mg/l. Concentrations higher than this can lead to fluorosis. Fluorosis is caused by an excess ingestion of fluoride which caused serious health problems for the population. Severe forms of the disease typically develop only when the F^- concentration of drinking water is greater than 5–10 mgL^{-1}.Children metabolize a higher percentage of ingested F^- than adults and are, therefore, particularly susceptible to fluorosis. Several methods have been developed to remove fluoride and improve the

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quality of drinking water (4, 5). Some ground waters contain high levels of fluoride with concentrations well in excess of 1 mg/l as F. Reduction of fluoride may, therefore, be necessary. Defluoridation can be achieved by chemical precipitation, adsorption or by membrane desalination processes (6), chemical treatment, electro-chemical methods, dialysis, and ion exchange process (7). In this study, for first time in Iran, an attempt was made to measure fluoride concentration in Semnan drinking water distribution.

MATERIALS AND METHODS

Semnan is a city in Semnan Province, northern Iran, with a population estimated around 119,778 inhabitants (2005). This city is situated at 1,138 meters above sea level at the southern foot of the Alborz Mountains. A total of 794 samples of groundwater used for drinking were collected from different sources (over 22), during summer and autumn seasons from July to December, 2005. The samples were analyzed to assess various physicochemical parameters according to APHA (2007). The fluoride concentration in the samples was measured by using spectrophotometer, DR/5000 (Hach).

RESULTS

Table 1 shows fluoride concentrations in Semnan drinking water distribution which contains minimum and maximum concentrations of fluoride in Semnan drinking water distribution.

Table1. Fluoride concentration in Semnan drinking water distribution

Month	Min(mgL^{-1})	Max(mgL^{-1})	Mean(mgL^{-1})	SD
Jul.	0.92	1.56	1.15	0.20
Aug.	0.89	1.52	1.13	0.18
Sep.	0.87	1.78	1.16	0.23
Oct.	0.85	1.61	1.12	0.19
Nov.	0.93	1.45	1.15	0.15
Des.	0.89	1.45	1.14	0.15

Figure 1 shows the variation of mean fluoride concentration over this period.

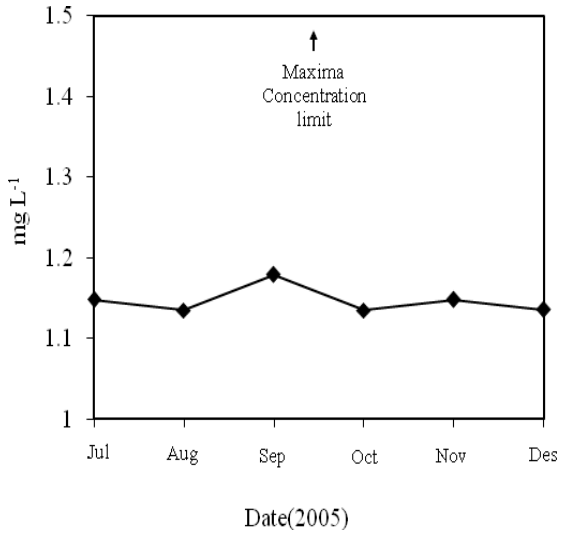

Figure 1. Variation of mean fluoride concentration from July to December

The percentage of groundwater drinking water sources containing fluoride in Semnan is presented in Figure 2.

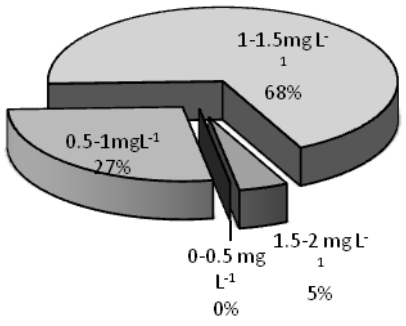

Figure 2. Percentage of ground drinking water sources containing fluoride in Semnan

The fluoride concentrations are between 0.5 and 2 mg L^{-1}.

Variation of fluoride concentrations in Semnan drinking water distribution in summer and autumn as a function of temperature are shown in Figures 3 and 4, respectively. According to these figures fluoride concentrations in autumn are higher than summer.

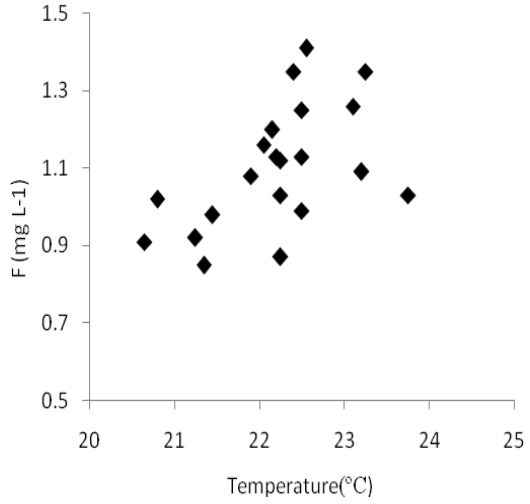

Figure 3. Variation of fluoride concentrations in Semnan drinking water distribution in summer as a function of temperature

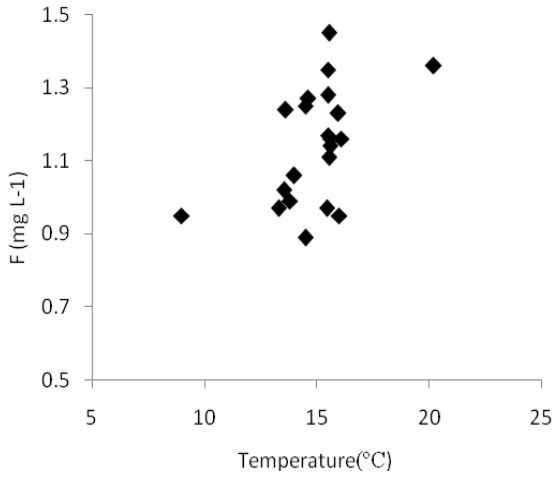

Figure 4. Variation of fluoride concentrations in Semnan drinking water distribution in autumn as a function of temperature

DISCUSSION

The findings presented in Table 1 showed that minimum and maximum concentrations of fluoride in Semnan drinking water distribution are 0.85 and 1.78 mgL^{-1}, respectively. Although the concentrations in September and December are higher than the maximum contamination level (MCL), the mean fluoride concentration in both summer and autumn seasons is lower than MCL (1.5 mgL^{-1}). Figure 1 presented the variation of mean fluoride concentration in the months investigated. According to this figure groundwater samples contain different amounts of fluoride. The fluoride concentration ranged from the highest fluoride level in September to the lowest in October. Based on Figure2, 27% of ground drinking water sources had fluoride level between 0.5 and 1 mgL^{-1} while fluoride concentration in 68% of water sources was between 1 and 1.5 mgL^{-1}, and 5% of them had fluoride levels between 1.5 and 2 mgL^{-1}. Although all ground drinking water sources had varying fluoride concentrations and fluoridation was not necessary, because of the high level of fluoride in 5% of them (higher than 1.5 mgL^{-1}) defluoridation was necessary. Statistical analyses were performed using analysis of variance (ANOVA) to check for the influence of water temperature on fluoride concentration in drinking water distribution in both summer and autumn (α=0.05).According to Figures 3 and 4, temperature has a significant effect on fluoride concentration contained in water ($P<0.05$).

CONCLUSION

The ground drinking water distributions in both summer and autumn were evaluated in terms of their fluoride concentration. The mean fluoride concentration was 1.14 ppm. The maximum concentration in different sources (over 22) of fluoride recorded was 1.78 ppm while the lowest was 0.85 ppm. The results indicate the ground water used for drinking in Semnan is suitable for consumption and does not require any treatment.

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