

Original Article

Evaluation of Ground Water Fluoride Concentration in Hamadan Province West of IRAN (2012)

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Abstract

Background and purpose: Fluoride is one of the drinking water contaminants regulated by EPA. This ion, in low doses in the mouth reduces tooth decay without health risk and at much higher doses causes health complications and can be toxic. The major sources of exposure to fluoride are drinking water, food, dental products, and pesticides. The biggest contributor to exposure for most people in Iran is drinking water. This study was carried out to determine groundwater fluoride concentration of Hamadan province located in the west of Iran in 2012.

Materials and Methods: Ground water samples were collected from 192 sampling point, during dry and wet seasons. Fluoride concentration was determined in the water samples using UV-Spectrophotometry method (DR 5000) and SPADNS Fluoride Reagent Solution.

Results: The fluoride concentration of ground water of examined regions varied between 0 to 1.78 mg/l. Mean concentration of fluoride samples and standard deviation were 0.574 and 0.351 mg/l respectively. The results showed that 49% of fluoride concentration samples were less than the standard value according to National standards of IRAN and WHO guideline.

Conclusion: According to low level of fluoride concentration in this province, fluoride supplements such as mouth washes, consumption of fluoride containing foods and water fluoridation are recommended to reduce caries development.

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Key words: Fluoride Concentration, Ground Water, Hamadan, Iran.

1. Introduction

Fluoride is a chemical element, known as a vital mineral, which exists naturally within many rocks and the soil of the earth's crust (1-2). Invested fluoride during tooth development incorporates into the dentin and enamel of unerupted teeth and makes them more resistant to acid attack. Fluoride also has post-eruptive effect on tooth structure: therefore it has a significant effect on reduction of dental caries. On the other hand, ingestion of excess fluoride, most commonly through drinking water, can cause fluorosis of teeth in moderate amounts and might lead to potentially severe skeletal problems by long-term exposure to larger amounts (3). It is accepted a defined amount of fluoride in drinking water is essential and beneficial (4). According to WHO guideline, maximum concentration level (MCL) of fluoride in drinking water is 1.5 mg/l(3). Also, the optimal fluoride range is considered to be between 0.7-1.2 mg/l. The range is based on average ambient air temperature of 50 to 90 F° (5). Since people drink more water in hot weather, higher annual average temperatures require lower dosages. In the areas with a high fluoride concentration, people tend to develop mottled teeth (6). Groundwater as the major source of fresh water on the earth contains dissolved ions such as fluoride (7,8). High fluoride concentrations have been observed in India, Pakistan, West Africa, Thailand, China, Sri Lanka, Southern Africa, Iraq, Iran, Sudan, Ethiopia, Uganda, Kenya and the United Republic of Tanzania (9,10) With regard to importance of daily fluoride

intake, many researchers have been done for evaluation of fluoride content of water and black tea (11,12). The normal concentration of fluoride in groundwater is related to the geological, chemical and physical characteristics of aquifer, porosity and acidity of rocks and soil, temperature, action of other chemical elements, and depth of aquifer (9). In order to be able to make correct recommendation on the amount of required fluoride supplements for caries prevention and prevent fluorosis, the main objection of this study was to determine fluoride concentration of groundwater in Hamadan province, Iran.

2. Materials and Methods

This descriptive and cross-sectional study was carried in eight regions of Hamadan province in west of Iran in 2012. Study regions included Hamadan, Malayer, Nahavand, Asadabad, Razan, Bahar, Kaboodarahang, Tuyserkan. Ground water samples were collected in clean polyethylene bottles of 1L capacity (washed-up before sampling with deionized water and again prior to each sampling with the rinse of the sample)(13). Water samples were collected from 192 wells located in these eight regions during dry and wet months. Totally, 384 ground water samples were collected in this study. The samples were analyzed in the water and wastewater laboratory of Vice-Chancellor for Health, Hamadan University of Medical Sciences. Fluoride concentration was analyzed through SPADNS colorimetric method and UV-vis spectrophotometry.

This approach of fluoride determination involves reaction of fluoride with a red zirconium-dye solution. In this regard, 2 ml of the SPADNS reagent was added to 10 ml of sample and mixed completely (14). Fluoride reacts with zirconium to make a colorless complex; hence, bleaching the red color is in an amount proportional to the fluoride value (14). Finally, a spectrophotometer (Hatch-Long DR-5000, USA) set at wavelength of 580 nm is utilized to determine the specific concentration of fluoride. Temperatures of examined regions in this study was collected from synoptic (for Hamadan) and climatologic stations (for other regions) of Hamadan province. Collected data were analyzed by means of SPSS 16 software.

3. Results

Fluoride concentration of ground waters of eight regions in Hamadan province of Iran, in 2012 is shown in Table 1. From the 384 samples evaluated in this study, 51 percent of samples showed acceptable levels of fluoride and therefore were appropriate for drinking water supply. Fluoride concentrations in the rest of the samples were lower than the acceptable range. Also, temperature of these eight regions is mentioned in Table 2, which can be useful for estimation of optimal fluoride concentration in drinking water on basis of Annual Mean Maximum Temperature (AMMT).

Table1. Fluoride concentration of ground waters in Hamadan province, Iran-2012

Sampling region	Fluoride concentration (mg/l)					Number of high con. samples	Number of low con. samples
	Samples	Maximum	Minimum	Mean	SD		
Hamadan	33	1.04	0	0.497	0.247	0	25
Malayer	58	1.63	0.23	0.855	0.277	0	10
Nahavand	59	0.67	0.08	0.397	0.24	0	28
Asadabad	37	1.25	0	0.325	0.26	0	30
Razan	23	1.28	0.09	0.586	0.29	0	12
Bahar	37	1.74	0.09	0.653	0.345	0	17
Kaboodarahang	36	1.78	0.42	0.9	0.38	0	9
Tuyserkan	30	0.91	0.04	0.38	0.215	0	23

Table 2.Temperature of Hamadan province, Iran-2012

Station	Station type	Temperature (°C)		
		T _{max}	T _{mean}	T _{min}
Hamadan	Synoptic	18.3	10.7	3.1
Malayer	Climatology	20	12.5	6
Nahavand	Climatology	20.5	13.5	5.9
Asadabad	Climatology	21.8	14	2.7
Razan	Climatology	17.8	10.6	4.3
Bahar	Climatology	19.1	11	2.9
Kaboodarahang	Climatology	19.3	10.9	2.5
Tuysarkan	Climatology	19.6	12.8	5.6

4. Discussion

As it is shown in table 1, the fluoride concentration of ground water of these eight regions varied between 0 to 1.78 mg/l. Mean concentration of fluoride samples and standard deviation were 0.574 and 0.351 mg/l respectively. The highest concentration of fluoride in studied regions was observed in Kaboodarahang with 1.78 mg/l where had low AMMT. While, Asadabad with 0 mg/l fluoride concentration had the lowest fluoride level and the highest AMMT among investigated regions. According to the Iranian standard organization, the acceptable range of fluoride concentration in drinking water is from 0.5 to 1.5 mg/l (13). Thus, if the concentration of fluoride in ground water is less or more than this range, it is not suitable for drinking purpose (15). Fifty one percent of samples evaluated in this study showed acceptable levels of fluoride and therefore were appropriate for drinking water supply. Fluoride concentrations in the rest (49%) of the samples were lower than the acceptable range. The fluoride level of ground water has been evaluated in different areas in several studies. In a study by Mandinic et

al., in 2010, the amount of fluoride content in well water of four Serbian municipalities were shown to be 0.10, 0.15, 0.79 and 11 ppm. Actually in one of these regions, fluoride level in well water was above value of 1 ppm, recommended by WHO (16). The status of fluoride in groundwater of Qaemshahr city was assessed in a period from 2006 to 2012. The results of this study showed that the Fluoride level in 100% of deep well water samples were lower than standard (17). The fluoride concentration of the drinking waters was below the permissible limit of fluoride (18). In a study by Maleki, the fluoride concentration of four groundwater resources in Sanandaj, was determined. The results of this study showed that fluoride concentration in these resources (0.31 mg/l) tend to be less than the recommended standard (19). Groundwater fluoride level of four sub regions in the Shush aquifer, Khuzestan, was evaluated. Fluoride concentrations in this study tend to exceed WHO recommended standard level (20). According to the biogeochemical influences of fluoride on bones and teeth, water plays a

vital role to provide fluoride required by the human body (6). Thus, the low and high levels of these ions in drinking water can cause discoloration of teeth and skeletal fluorosis whereas low levels output in decreasing caries reduction (15). Regarding to WHO, recommended daily concentration of fluoride intake is 0.05 mg/kg/day (3). The amount of recommended fluoride intake from drinking four cups of tea for an adult with an average weight of 70 kg is about 14.7% to 50.2% of the recommended daily dose of fluoride (21). Children receive a part of their daily fluoride intake from fluoridated water and a part from dietary sources which would include food and other beverages. Recently in developed countries shortage of fluoride in drinking water can be compensated through adding fluoride sodium to drinking water (6). Hence, according to low value of fluoride in groundwater in this area, we suggest to add fluoride to children's diet and encourage them to use fluoride mouthwashes.

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