American-Eurasian J. Agric. & Environ. Sci., 6 (3): 324-327, 2009
ISSN 1818-6769


# Determination of Fluoride in Bottled Water Sold in Tehran Market, Iran

*M. Ghaderpoori, Gh. R. Jahed Khaniki, M.H. Dehghani, M. Shams and A. Zarei*

Department of Environmental Health Engineering, School of Public Health,
Tehran University of Medical Sciences, Tehran, Iran

**Abstract:** Fluoride is a necessary element for human health and it can intake from drinking water and food, but the high intake of it can not be useful. The aim of this study is evaluation of fluoride in existing bottled waters in Tehran market and compare with the stated value on the label. In general, thirteen brands collected in various markets in Tehran. Determination of fluoride concentration was done according the standard SPANDS method by using a Spectrophotometer DR/5000. The obtained results showed that the mean (± SD) fluoride concentration of the bottled drinking water samples was 0.29 (± 0.159) mg/L with a range of 0.06-0.67 mg/L. The fluoride concentration was compared to water bottled international standards and results were indicated that in all samples fluoride concentration was lower than permissible level.

**Key words:** Bottled water · Fluoride · Trace elements · Water safety · Standards

## INTRODUCTION

The Sources of drinking water in Iran are springs, rivers and ground waters. Most of bottled water in Iran is provided from springs and ground water. Mineral water generally contains inorganic, trace elements and other materials [1]. The city of Tehran has more than 6.7 million people and it has an annual domestic water consumption over 800 million cubic meter [2]. There are more than 100 registered manufacturers which provide and pack drinking water in bottles. The consumption of bottled water has been increased particularly in urban population and travelers in Iran during the recent years [3]. Bottled water sometimes can be contaminated to chemical and biological agents [4]. Fluoride ($F^-$) is found in the environment as fluorides in various mineral sources including; Fluorspar (mineral fluorite, $CaF_2$), Cryolite ($Na_3AlF_6$) and Fluorapatite [$(Ca_5 (Po_4)_3F)$]. The concentrations of fluoride in water are often limited by the solubility of fluorite but in the absence of calcium, the concentration can be as high as 20 mg/L, however more typically rivers, lakes and groundwater have fluoride concentrations of less than 0.5 mg/L[5]. Fluoride is one of the necessary elements for live creatures, that it exists in tissues and body liquids of all humans and animals under measurable rates [6]. The intake of excess fluoride can cause fluorosis which affects the teeth and bones. Moderate amounts lead to dental effects, but long-term ingestion of large amounts can lead to severe skeletal problems. Low levels of fluoride intake can help to prevent dental problems. Most of bottled waters may not have a sufficient amount of fluoride, which is important for good dental health. Some bottled waters contain fluoride and some do not. Fluoride can occur naturally in source waters that used for bottling or can be added, but more bottled waters contain fluoride at levels that are less than optimal for dental health[7]. Optimum concentration of fluoride depends on climate conditions and water consumption. The WHO guideline for fluoride is 1.5 mg/L [8], which is the same as EEC guideline [9], U.S. EPA, also it has determined maximum concentration 4 mg/L to prevent bone fluorosis [10]. Some of studies on measuring of fluoride concentration in bottled water were conducted in different parts of the world [7, 11-15]. The aim of this study is to determine the concentration of fluoride in commercially existing bottled waters that is distributed in different parts of Tehran City and was to report the accuracy of the labeling of fluoride concentration on the bottle.

## MATERIALS AND METHODS

Thirteen commercial brands of bottled drinking water that included Damavand, Koohdasht, Damash, Zam Zam, Nestle, Polour, Koohrang, Hobab, Bidestan, Dasani, Siva, Vata and Lubon were collected randomly

**Corresponding Author:** Gholam Reza Jahed Khaniki, Department of Environmental Health Engineering, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran

from supermarkets, grocery stores and health shops in the city of Tehran. Collected samples were stored in a dark place in room temperature in their original closed plastic containers until the fluoride analysis was made. For determination ion fluoride concentration the standard SPANDS method was performed by using a Spectrophotometer DR/5000 (HACH Company, USA). The SPANDS method for fluoride determination involves the reaction of fluoride with a red zirconium-dye solution. The fluoride combines with part of the zirconium to form a colorless, thus bleaching the red color was in an amount proportional to the fluoride concentration. Test results are measured at 580 nm[16]. The index was used for correlations between the specimens and fluoride levels. All statistical analyses were performed using the software SPSS, version 11.5. Analysis of variance ANOVA was employed after logarithmic conversion when necessary to detect significant differences among means. A probability level of $P< 0.05$ was considered statistically significant.

## RESULTS AND DISCUSSION

Thirteen commercial brands of bottled drinking water were examined for determination of fluoride level in bottled drinking water of Tehran market. The ion fluoride concentrations in bottled drinking waters sold in the city of Tehran are shown in Table 1. The mean (± SD) fluoride concentration of the bottled water samples was 0.29 (± 0.159) mg/L with a range of 0.06-0.67 mg/L. The highest mean concentration was found in bottled water from Bidestan, which had a measured mean fluoride concentration of 0.6 (± 0.058) mg/L. The quality of the labeling of bottled drinking water showed that 10 of 13 brands (76.9 percent) of bottled waters state the fluoride concentration on the labels. Eleven brands (92 percent) were found with a fluoride concentration between 0.06-0.52 mg/l and one was measured 0.67 mg/l. As results of the ANOVA test, the association between bottled water brands and labels was not statistically significant at level of $P<0.05$.

One of the most important sources of water consumption in babies and children is bottled water and the level of fluoride to both preventing of dental caries and fluorosis is an important factor. Lack of fluoride in children nutrition can lead to failing of healthy teeth and bones production, whereas fluorosis is an chronic disease that due to excess fluoride uptake and exhibit with mottling and yellowish or brownish teeth[6]. In this study, the concentration of fluoride in bottled waters sold from local markets was found to vary between 0.06 to 0.6 mg F/L. This variation was generally in agreement with previous studies [11-13]. The results of this study are compared with studies in other countries in relation to fluoride levels in mineral and bottled waters (Table 1). Fluoride concentration of this study was lower than related studies in other countries.

In our study and also in Dobaradaran study for determination of fluoride concentration in existing bottled waters in Iran, the following five brands were same (Damash, Damavand, Koohrang, Dasani and Vata), that The fluoride concentration in all these five brands were close to our findings [12]. Wienberger found the accuracy of the printed concentrations of fluoride to be doubtful in 16 of the 17 bottled tests in a Canadian study[15]. In England, Toumba reported that only 3 of 7 tested labeled brands were in agreement with the results of their study [14]. In another study, Macfadyen in UK [17] reported that only 6 of 26 bottled tested had

Table1: The concentration of Labeled and measured fluoride in bottled waters sold in Tehran market

| | | Fluoride concentration in sample (mg/L) | |
|---|---|---|---|
| Brands | Fluoride concentration on the label (mg/L) | Range | Mean ± SD |
| Damavand | 0.2 | 0.26-0.37 | 0.31 ± 0.023 |
| Koohdasht | 0.09 | 0.19-0.27 | 0.23 ± 0.015 |
| Damash | <0.2 | 0.05-0.08 | 0.06 ± 0.006 |
| Zam Zam | *NL | 0.24-0.36 | 0.30 ± 0.025 |
| Nestle | 0.07 | 0.16-0.66 | 0.41 ± 0.101 |
| Polour | 0.07 | 0.13-0.37 | 0.23 ± 0.042 |
| Koohrang | 0.23 | 0.06-0.09 | 0.07 ± 0.006 |
| Hobab | 0.38 | 0.43-0.46 | 0.45 ± 0.006 |
| Bidestan | *NL | 0.46-0.75 | 0.60 ± 0.058 |
| Dasani | 0.6-1.1 | 0.14-0.66 | 0.40 ± 0.106 |
| Siva | 0.35 | 0.37-0.47 | 0.42 ± 0.20 |
| Vata | 0.11 | 0.10-0.12 | 0.11 ± 0.006 |
| Total | | 0.05-0.75 | 0.29 ± 0.159 |

*NL: Not labeled

Table2: Fluoride concentration in bottled waters in various countries with national and international standards.

| Country | N | Fluoride (mg/L) | Reference |
|---|---|---|---|
| Sao Paulo | 35 | 1.02 | [16] |
| Ohio | 5 | 1.05 | [13] |
| Greece | 22 | 0.35 | [11] |
| North-East of England | 25 | 0.08 | [19] |
| India | 6 | 0.30 | [20] |
| Iran, Tehran (Present study) | 13 | 0.29 | - |
| IBWA standard (2003) | | 0.80-1.70 | [21] |
| FDA standard (2003) | | 1.50 | [22] |
| Iran standard (1996) | | 0.70-1.20 | [23] |

the fluoride concentrations printed on their labels. Also, Ahiropoulos founded that in 50 percent of the bottled water samples, there was a significant difference between the measured fluoride concentration and that marked on the label [11]. Dobaradaran *et al.,* in 2007 referred that the fluoride concentration determination in 6 of 17 brands agreed with the fluoride concentration on the labels [12]. At present study, the value of fluoride found in the analysis different from those stated on the label in 10 of 13 brands and only 3 brands, of examined samples was agreed with the fluoride concentration on the label.

Fluoride concentration in bottled waters in various countries with national and international regulation and standards has shown in Table 2. The measured fluoride concentrations were compared with International Bottled Water Association (IBWA), US Food and Drug Administration (FDA) and Iranian water bottled standards. The results of present study indicated that fluoride levels was lower than permissible concentration in all examined samples and the mean fluoride concentration of all bottled waters was below International and Iranian standards. A lack of agreement between the measured fluoride concentration and that printed on the label was observed in more than 70 percent of brands. It was concluded that due to increased water consumption, the fluoride concentration is inevitably increased in the body and thus limits for fluoride concentration in water must be lowered to eliminate health risks associated with high fluoride consumption.

## REFERENCES


1. Ghafouri, M., 2003. Survey of mineral water and mineral springs in Iran. 2nd, Tehran university publications, pp: 17-20.
2. Karamouz, M., B. Zahraie, S.H. Araghi-Nejhad, M. Shahsavari and S. Torabi, 2001. An integrated approach to water resources development of the Tehran region in Iran. J. American Resources Association, 7: 1301-1311.
3. Mardani, M., L. Gachkar, S.N. Peerayeh, A. Asgari, B. Hajikhani and R.A. Amiri, 2007. Surveying common bacterial contamination in bottled mineral water in Iran. Iranian J. Clinical Infectious Diseases, 2: 13-15.
4. Armas, A.B. and J.P. Sutherland, 1999. A survey of the microbiological quality of bottled water sold in the UK and changes occurring during storage. Intl. J. Food Microbiol., 48: 650-659.
5. Parson, S. and B. Jefferson, 2006. Introduction to potable water treatment processes. Blackwell, pp:163-164.
6. W.H.O., 1996. Guideline for Drinking-water quality, 2 nd Edition, Vol. 2. World Health Organization (WHO), Geneva.
7. Buzalaf, *et al.,* 2004. Risk of fluorosis associated with infant formulas prepared with bottled water. J. Dent Child (Chic), 71(2): 110-113.
8. W.H.O., 1995. Guideline for drinking water quality. Vol. 1, World Health Organization (WHO), CEHA, Amman.
9. EEC, 1998. Directive 98/83 on the quality of water intended for human consumption. European Economic Council (EEC), EC official Journal.
10. USEPA, 1985. Final draft for the drinking water criteria document on flouride, criteria and standard Div, Washington D.C. EPA.
11. Ahiropoulos, V., 2006. Fluoride content of bottled waters available in Northern Greece. Intl. J. Paediatric Dentistry, 16: 111-116.
12. Dobaradaran, S. and A.H. Mahvi and S. Dehdashti, 2007. Fluoride content of bottled drinking water available in Iran. Flouride, 41(1): 93-94.
13. Lalumandier, J. and L. Leona, 2000. Fluoride and bacterial content of bottled water and tap water. Arch. Fam. Med., 9: 246-250.
14. Toumba, K.J. and M. Curzon, 1994. The fluoride content of bottled drinking waters. British Dental J., 176: 266-268.
15. Wienberger, S.J., 1991. Bottled water drinking water: are the fluoride concentrations shown on the bottled accurate? Intl. J. Paediatric Dentistry, 1: 143-146.

16. AWWA, 1995. Standard method for the examination of water and wastewater. AWWA.
17. Macfadyen, E., S. McNee and D. Weetman, 1982. Fluoride content of some bottled spring waters. British Dental J., 153: 423-424.
18. Grec, R., P. Moura and J.P. Pessan, 2008. Fluoride concentration in bottled water on the market in the municipality of Sao Paulo. Rev Saude Publica, 42(1).
19. Zohouri., F.V., A. Maguire and J. Moynihum, 2003. Fluoride levels in bottled water. British Dentel, 195(9): 507.
20. Babaji, P., N. Shashiran and S. Reddy, 2004. Comparative evalution of trace elements and residual bacterial content of different brands of bottled water. J. Iindian Soc. Pedo. Prev. Dent, 22(4): 201-204.
21. IBWA, 2004. A model for bottled water regulation, Link accessed October 2004 http://www.bottledwater.org/public/pdf/ibwa_model_code.
22. FDA, 2004. Requirements for Specific Standardized Beverages, Sec. 165.110, Bottled water.http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/CFRSearch.cfm.
23. ISIRI, 1997. Physical and chemical properties of drinking water Standards. Institute of Standards and Industrial Research of Iran (ISIRI), 5 Edition, Standard No. 1053.