

The Fluoride Content of Bottled Water Purchased at Metro Denver Area Supermarkets

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ABSTRACT

Purpose: This study is intended to inform dentists of the fluoride concentrations of 25 commercial, bottled drinking waters readily found in the metro Denver area.

Methods: Samples were analyzed using a Hach Pocket Colorimeter™ Fluoride Analysis System. In this method the water is drawn into a vacuum ampul containing a red zirconium dye. The ampuls are then placed into the colorimeter to determine the fluoride concentration. A triplicate analysis was performed on each sample.

Results: Fluoride concentrations of the bottled waters ranged from <0.1 ppm to 4.0 ppm. Five of the products tested had fluoride concentrations that differed from the manufacturer's reported value by $> \pm 0.1$ ppm.

Conclusions: The fluoride concentrations of the bottled water products tested were highly variable. The conflicting fluoride concentrations of five of the products tested are clinically significant. Dentists should be informed of the fluoride concentrations of the bottled waters their patients are using.

KEYWORDS: FLUORIDE CONCENTRATION, BOTTLED WATER

Introduction

In recent years, bottled water usage has become increasingly prevalent. This has long been thought to have implications on the dental health of the general public, especially children. Fluoride has been shown to have a caries-preventive effect on primary and permanent dentition when taken at optimal levels. *Fluoride is an essential mineral that inhibits demineralization of tooth enamel, enhances re-mineralization and inhibits plaque*

bacteria. Municipal water supplies in the U.S. are fluoridated according to guidelines set by the ADA and the United States Public Health Service. However, there are no minimum requirements for bottled water fluoride content, only an upper limit set by the FDA Safe Drinking Water Act of 4.0 ppm. The United States Environmental Protection Agency (USEPA) recommends a maximum fluoride level of 2.0 ppm, but it is not enforced.²

In addition, bottled water manufacturers are not required to list fluoride content on their product labels, and the vast majority does not. Some manufacturers do report fluoride concentrations on their labels; however, a study by S. J. Weinberger found the labeling to be inaccurate on 16 out of 17 bottles.⁶ Without accurate labeling of fluoride concentration, it is difficult for patients to know if they are receiving fluoride from their drinking water.

The purpose of this study was to provide dentists with this difficult to obtain information. This study has independently researched the fluoride content of 25 bottled water brands readily available in Colorado supermarkets and compared the results to values reported by each brand. The results are presented in a table that can be copied and posted within the dental office, or given to the patient for their own information.

Methods

Twenty-five brands of bottled drinking water were purchased from various supermarkets in the Denver metro area. The manufacturers of each brand were contacted at the telephone number

or Web address shown on the product label. A representative from each company was asked to provide information about the fluoride content, source and purification method of their water. In the case of a Web address, the site was searched for information about the source, purification method and fluoride content. If a telephone number was listed on the site, the manufacturer was contacted using that number.

The water samples were analyzed using a Hach Pocket Colorimeter™ Fluoride Analysis System. In this method, the sample is drawn into a vacuum ampul where fluoride from the sample reacts with a red zirconium-dye solution to form a colorless product. The color change is proportionate to the fluoride concentration within the sample, and is measured photometrically using a light emitting diode (580 nm) and a silicon cell detector. The method is accurate to 2.0 mg/L fluoride, and is approved by the USEPA.⁴ Although the colorimeter was factory calibrated, the accuracy of the instrument was ensured before each test using a 1.0 mg/L fluoride standard solution.⁴

A triplicate analysis was performed for each product and mean fluoride content was calculated. These values were compared to the concentrations reported by the manufacturers of each product. In one case, the concentration of fluoride was above 2.0 mg/L. Since the upper limit of the colorimeter is 2.0 mg/L, a 1:1 dilution with distilled water was used. The diluted sample was then tested and the results were multiplied by two.

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Table 1. Fluoride content of bottled water products

Product	F- Content	Source/Purification Method	Contact Information
A+ (Albertson's)†	<0.1	spring	albertsons.com
Aberfoyle	<0.1	spring/carbon-filtration	866-599-8980
Aquafina	<0.1	municipal/reverse osmosis	800-433-2652
Arrowhead	1.2	spring/carbon-filtration	800-873-7775
Big K (King Soopers)	1.4	artesian/carbon filtered	877-415-4647
Calistoga	<0.1	spring/carbon-filtration	800-365-4446
Crystal Geyser	<0.1	spring/micro-filtration	800-4-GEYSER
Cub Foods†	0.1	spring	cub.com
Dannon (Fluoride-to-go)	0.6	spring,fluoridated*/microfilt.	800-322-4616
Dasani	<0.1	municipal/reverse osmosis	800-788-5047
Deep Rock	1.5	artesian/micro-filtration	303-292-2020
Eldorado	0.2	spring/micro-filtration	eldoradosprings.com
Essentia	0.1	municipal/reverse osmosis	essentiawater.com
Evian	<0.1	spring/none	800-633-3363
Fiji	0.3	artesian/micro-filtration	877-H2O-FIJI
Glacéau Smartwater	<0.1	municipal/vapor distilled	800-746-0087
Iceland Spring	0.1	spring/none	800-274-9060
Infinity	0.2	artesian/micro-filtration	waiwera.co.nz
Kirkland Signature	<0.1	artesian/reverse osmosis	877-ITS-PURE
Odwalla	<0.1	spring/reverse osmosis	800-ODWALLA
Refreshe (Safeway)	<0.1	spring/reverse osmosis	888-SAFEWAY
Sam's Choice (walmart)	<0.1	municipal/reverse osmosis	888-260-3776
Trinity	4.0	spring/none	trinitysprings.com
Waiwera	0.1	artesian/micro-filtration	waiwera.co.nz
Wildoats	0.9	spring/micro-filtration	800-949-WILD

* Dannon fluoridates their water with NaF and suggests it contains up to 1ppm fluoride

† Indicates manufacturers that did not respond to inquiries about their product

Table 2. Fluoride concentrations

Product	Manufacturer (ppm)	Laboratory (ppm)
A+ (Albertson's)	N/A	<0.1
Aberfoyle	0.0	<0.1
Aquafina	0.0	<0.1
Arrowhead	0.8	1.2
Big K (King Soopers)	0.0	1.4
Calistoga	0.0	<0.1
Crystal Geyser	0.0	<0.1
Cub Foods	N/A	0.1
Dannon (Fluoride-to-go)	1.0	0.6
Dasani	0.0	<0.1
Deep Rock	1.4	1.5
Eldorado	0.3	0.2
Essentia	0.0	0.1
Evian	<0.1	<0.1
Fiji	0.27	0.3
Glacéau Smartwater	0.0	<0.1
Iceland Spring	0.2	0.1
Infinity	0.14	0.2
Kirkland Signature	0.0	<0.1
Odwalla	0.0	<0.1
Refreshe (Safeway)	0.0	<0.1
Sam's Choice (walmart)	0.0	<0.1
Trinity	3.6	4.0
Waiwera	0.4	0.1
Wildoats	0.17	0.9

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Results

Table 1 shows the fluoride concentrations of the bottled waters tested in this study. The fluoride concentrations ranged from <0.1 ppm to 4.0 ppm. Table 2 provides a comparison of the fluoride concentrations reported by the product manufacturers and the laboratory data. Five of the products had fluoride concentrations that differed from the reported value by $> \pm 0.1$ ppm. These differences are considered to be of clinical significance.

Discussion

It is apparent from the results presented in Table 1 that there is wide variation in the fluoride content of the bottled waters that were tested. These differences can be attributed to the source of the water, the method used to purify the water and the addition of fluoride by the manufacturer.^{1,3} The sources and purification methods of the bottled waters in this study are included in Table 1. In a few cases the manufacturer failed to respond to inquiries regarding source, purification method and fluoride content. These are indicated in Table 1 and Table 2 with N/A.

The source will determine the amount of fluoride naturally present in the water. It is important to note that spring and artesian waters may contain fluoride from as low as 0.0 ppm to above 4.0 ppm. The fluoride concentrations of the water from these sources depend on the mineral content at the source and are highly variable. They may also fluctuate seasonally.

The purification method employed by the manufacturer will have little to no effect on the fluoride content of the water, or it will reduce it to an undetectable level. Micro-filtration, carbon filtration and UV irradiation will not remove fluoride from water. Their purpose is to remove large particles ($>0.1\mu\text{m}$) and biological contaminants. Reverse osmosis is a commonly used purification method

that will reduce the fluoride content to a level that is undetectable.

The reasons for the clinically significant differences that were noted between the manufacturers reported fluoride content and the levels found by this study (Table 2) are difficult to ascertain. None of the products where a significant difference was found use a purification method that would remove fluoride from the water. Therefore, it is likely that the differences are due to fluctuation of fluoride concentration at the source. This fluctuation could be seasonal, or perhaps due to evaporation during filtration and bottling processes.

It is important for dental practitioners to regularly assess the patient's primary source of drinking water. This is especially important if the patient is taking fluoride supplements. It is also necessary for dentists to periodically update their information on changes in the fluoride content of bottled water products.^{1,5,7} This is important since the fluoride concentrations of bottled waters can change over time. This may be due to change in source, purification method or just random fluctuation.^{3,6} R.J. Mathewson and R.E. Primosch recommend using a Hach Colorimeter™ to independently determine fluoride concentration of water sources used by patients.⁷

Conclusion

There is a large amount of variation in the fluoride concentrations of bottled water products available at supermarkets in the Denver metro area. Clinically significant differences between the manufacturer's reported fluoride concentrations and those determined by this study were found in five of the products evaluated. The dentist needs to be aware of the differences in fluoride content of the bottled waters his/her patients are using as a primary source of drinking water. ■

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