

Estimation of Fluoride Concentration In Bottled Drinking Water And Common Beverages In Kerala, India.

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Abstract

Background: The optimum level of fluoride in drinking water is 0.7 to 1.2 ppm. Decreased fluoride concentration leads to increased risk of caries and increased concentration can lead to dental or skeletal fluorosis. The main source of fluoride is from drinking water and other beverages.

Aim: To estimate fluoride levels in various commercially available bottled drinking water and beverages available in Kerala, India.

Materials and Methods: Ten different brands of commercially available bottled drinking water and

beverages were purchased from three different batches. All the bottles were numbered and sent for fluoride content analysis using SPADNS colorimetric method.

Results: All the brands and batches which were analysed for the study had less than optimal fluoride content and there is variation in fluoride concentration of each brand and among different batches of same brand of bottled drinking water and beverages. The mean and standard deviation of fluoride content of bottled water and beverages were measured, which were found to be 0.42mg (± 0.16) F/L and 0.02mg (± 0.01) F/L respectively.

Conclusion: In viewing the results of the present study, standardization of fluoride levels in bottled drinking water and beverages and labeling of fluoride content should become mandatory.

Key words: Bottled Drinking Water, Beverages, Fluoride concentration, SPADNS Colorimetric Analysis, Kerala.

Introduction

Fluoride is naturally occurring substance which is present in water [1]. Fluoride when present in optimal quantities is known to prevent caries by various mechanisms but more predominantly by deposition of calcium fluoride crystals [2]. Several methods of fluoride delivery are available; either in the form of systemic fluoride or topical fluoride. Of all available methods, addition of fluoride to public drinking water has been identified the most economical and the safest delivery system [3]. The main source of systemic fluoride in children is from drinking water (tap + bottled), beverages and other juice drinks [4]. Worldwide, vast majority of consumers that include children are replacing their daily water intake by bottled water, probably attributed to the fear of less purity of natural water supply and the presence of contaminants such as micro-organisms or sand particles [5].

According to a commercial report, bottled water consumption in Greece increased during 1996 -1999 by 11.05% compared to the 1994 -1996 period. Since 1999, the consumption has increased further, with an annual increase of 12% such that in 2002, the bottled water consumption was 870 million liters. The rate of increase remained the same during the years 2003 -2004 [5]. The total annual bottled water consumption in India had tripled to 5 billion liters in 2004 from 1.5 billion liters in 1999. The global consumption of bottled water was nearing 200 billion liters in 2006 [6]. Although in India, there is no official regulation defining the limits of fluoride in bottled water or other refreshments, in other countries, the

fluoride levels have been set at certain levels according to their fluoride concentration in drinking water [7].

Change in lifestyle and urbanization have promoted the increased intake of drinks and beverages [8]. Fluoride dosage varies according to the age of the child and fluoride concentration of drinking water [9]. In 1986, the American Academy of Pediatrics stated that for optimal dental health benefits, the total daily intake should be 0.05 – 0.07 mg fluoride / kg body weight and to avoid the risk of dental fluorosis, the fluoride intake should not exceed a daily level of 0.10 mg fluoride / kg body weight [10]. Globally, the production, as well as consumption of beverages, has increased in India. Some investigations have suggested that increased consumption of carbonated soft drinks are a form of systemic fluoridation and have been implicated as risk factor for dental fluorosis in young children [11].

In a hot climatic state such as Kerala, consumption of water and beverages increases tremendously. Therefore it becomes imperative to estimate whether fluoride levels in drinking water and beverages are within the recommended and accepted levels to prevent dental caries and reduce the risk of dental fluorosis. To determine the fluoride content in bottled drinking water and commonly consumed beverages by children.

Hence, the aim of this study was to analyze the fluoride content in bottled drinking water and beverages that were commonly available in Kerala, India.

Materials and Methods

Fluoride content of 10 brands of bottled water and beverages in Indian market was evaluated. Ten brands of bottled water and 10 brands of cold beverages were purchased from different supermarkets in Thiruvalla, Kerala within expiry date. Three different batches of each brand were purchased, making a total of 60 samples. All samples were stored in a dark place at room temperature;

the drinking water and beverages were kept in their original closed plastic containers, until the fluoride analysis was made. This study was conducted in the Department of Public Health Dentistry, Pushpagiri College of Dental Sciences, Thiruvalla in association with Kerala Govt. Water Authority Department, Thiruvalla between January 2019 to February 2019.

The details of each bottle i.e. brand name, batch number, date of manufacture was recorded. All samples were number coded before fluoride analysis, so that the investigator was blinded to the samples being analysed.

Fluoride content was analysed using SPADNS colorimetric method. The SPADNS colorimetric test is an inverse colorimetric reaction where fluoride reacts with the Zirconium dye lake, dissociating a portion of it into a colorless complex anion and the dye. As the amount of fluoride increases the color produced becomes progressively lighter which is compared to fluoride standard solutions [12].

In the present study standard solutions were prepared in the range of 0 to 1.40 mg F-/L by adding 5.00ml each of SPADNS solution and Zirconyl acid reagent to each standard. The color of each standard was observed with a photometer, which is set to zero absorbance with the reference solution and absorbance reading of standards were obtained. Milligrams fluoride – absorbance relationship was plotted and a standard curve is obtained. The sample was pre-treated using 1 drop (0.05ml) sodium arsenic oxide solution to remove the residual chlorine. The prepared standard 0mgF-/L standard was used to set the photometer for testing the samples. Testing was performed on 50ml of the sample bottled water and beverage; the sample temperature was adjusted to that used for the standard curve. Five millimeters each of SPADNS solution and Zirconyl acid reagents were added and mixed well with each sample and the absorbance reading was

noted. The reading was compared with the standard curve. The fluoride concentration of the samples was obtained in triplicate. The mean value of the triplicate was taken as the fluoride content for each sample.

Results

The mean fluoride concentration of each sample was tabulated. The mean of three different batches of the same brand were calculated along with standard deviation.

Table 1 depicts the concentration of fluoride in 10 different types of bottled drinking water. The mean (\pm SD) fluoride content of the 10 bottled water was 0.42mg (\pm 0.16) F/L, with a range from 0.23 to 0.59mg F/L. None of the bottled water samples displayed the fluoride concentration and the labels. The highest mean concentration was found in Mazhavil bottled water, which had a mean fluoride content of 0.59mg (\pm 0.43) F/L; while the lowest fluoride concentration was noted in Areva bottled water with a fluoride concentration of 0.23mg (\pm 0.08) F/L. Not much difference was observed in the rest of the sample products.

Table 2 depicts the concentration of fluoride in 10 different beverages. The mean fluoride concentration of all the beverages was found to be 0.02mg (\pm 0.01) F/L, with a range from 0.02 to 0.08mg F/L. Almost six brands had fluoride concentration below detectable level. The highest mean concentration was found in B Natural Apple, which contained 0.08mg (\pm 0.01) F/L. The lowest fluoride concentration was noted in Tropicana Slice which contained 0.02mg (\pm 0.01) F/L.

Discussion

This study was designed to determine the fluoride levels in different brands of drinking water and beverages that were readily available in Thiruvalla, Kerala. Foods, beverages, carbonated soft drinks and dental products are considered as the main sources of fluoride intake for children above 1 year of age [8]. These drinks can affect

ones dental health in one of the following three ways: The child may receive an appropriate level of fluoride from the above mentioned products, allowing for optimal caries prevention, or receive suboptimal levels of fluoride, with a resultant increase in dental caries. Finally an elevated level of fluoride in a child's consumption would result in fluorosis [13].

In this study, the concentration of fluoride in bottled drinking water was found to vary between 0.23 to 0.59mg F/L. This variation was generally consistent with previous studies [13, 14]. However, none of the bottled waters stated the fluoride concentrations on their labels. Therefore, health professionals should be aware of the contents of bottled water before prescribing any fluoride supplements for the children [13].

When considering beverages, the concentration of fluoride was found to be 0.02 – 0.08mg F/. This finding is lower than that in the study conducted by Jimenez et al and [11] Martinez- Mier et al [15]. The difference between fluoride values found in this study, and those reported previously in literature suggest that the composition of the beverages is not uniform or necessarily consistent. This different fluoride concentration in beverages may be due to water from different sources containing different fluoride concentrations that were used in the manufacture of these beverages.

In order to measure the fluoride concentration, SPADNS colorimetric method was employed. The readings were calculated by comparing the test solution with a standard curve which was created with standard fluoride solutions. The study was carried out under controlled temperature as variation in temperature may also cause fluctuation in fluoride levels. In this study triplicate observations were made and the readings were measured using colorimeter that reduces relative human errors. SPADNS method was also employed by other investigators like Iraj Nabipour

and Dobaradaran et al [16, 17]. Though there are methods of analysis of fluoride has been developed [18]. We opted to use the SPADNS colorimetric analysis as it was both cost effective and accurate when impurities are removed and controlled temperature is maintained. Edelstein et al; has also suggested that the calorimetric method should be accepted as a clinically useful alternative to the electrode method [19].

Conclusion

The results of this study suggest the need for controlling the production of bottled drinking water and beverages with respect to fluoride concentration. In view of the differential level of fluoride, as shown in the present study results, it can be concluded that regulation of optimal range of fluoride in bottled drinking water and beverages should be drawn for the Indian scenario. Specific standardization of the product label is also needed, by obligating manufacturers to present clear information about fluoride concentration in the products .Because the widespread consumption of certain beverages along with other sources of fluoride intake could lead to an increase in the prevalence of dental fluorosis. Dentists should be aware of this variability in fluoride concentrations, which helps while prescribing fluoride as supplements.

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Legends Table

Table 1: Fluoride content (mg F/L) in different bottled waters

Bottled water brands	Batch 1	Batch 2	Batch 3	Fluoride concentration (mg F/L)
Green valley	0.42	0.43	0.41	0.42±0.18
Varsh	0.53	0.55	0.57	0.55±0.32
Aquafina	0.27	0.28	0.29	0.28±0.10
Mazhavil	0.60	0.58	0.59	0.59±0.43
Foster's	0.32	0.32	0.29	0.31±0.23
Bisleri	0.49	0.50	0.51	0.50±0.48
Basics	0.48	0.47	0.49	0.48±0.54
Mountain Valley	0.34	0.37	0.37	0.36±0.38
Areva	0.23	0.23	0.23	0.23±0.08
Bailey	0.52	0.50	0.51	0.51±0.45

Desirable limit of fluoride as per IS 10500:2012 is 1 mg/ litre

Table 2: Fluoride content (mg F/L) in different beverages

Beverage brands	Batch 1	Batch 2	Batch 3	Fluoride concentration (mgF/L)
Minute Maid Pulpy Orange	0.05	0.08	0.08	0.07±0.01
Tropicana Slice	0.02	0.01	0.03	0.02±0.01
Mango Live	BDL	BDL	BDL	BDL
Paper Boat Drinks & Memories	BDL	BDL	BDL	BDL
B. Natural Apple	0.10	0.06	0.08	0.08±0.01
Real fruit Litchi	BDL	BDL	BDL	BDL
Apply Apple Juice Drink	BDL	BDL	BDL	BDL
Maa Mango	0.07	0.04	0.04	0.05±0.01
Tropicana Apple Delight	BDL	BDL	BDL	BDL
Maaza Refresh	BDL	BDL	BDL	BDL

Desirable limit of fluoride as per IS 10500:2012 is 1 mg/ litre

BDL – Below Detectable Level