

Fluoride Content of Bottled Drinking Water in Chennai, Tamilnadu

SUJATHA SOMASUNDARAM¹, KARUNYA RAVI², K. RAJAPANDIAN³, DEEPA GURUNATHAN⁴

ABSTRACT

Context: 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. One crore liters of water is supplied to Chennai and surrounding areas through pouches and bottles which carters about one third of city population.

Aim: The aim of this study is to determine the fluoride concentration in top 10 bottled waters in Chennai and to check the accuracy of their labelling.

Materials and Methods: Top selling bottled waters, 6 multinational and 4 Non- multinational brands were selected for the study. Three different batches of each brand were

purchased. The labels of the bottled were removed after collecting the details regarding fluoride content. All the bottles were numbered and sent for fluoride content analysis using SPADNS calorimetric method.

Results: All the brands and batches which were analysed for the study had less than optimal fluoride content and there is a significant variation in fluoride concentration of each brand and among different batches of same brand bottled waters. The range of fluoride level in tested samples was between 0.27 to 0.59. Only one brand's label had information regarding the fluoride content.

Conclusion: Standardization of fluoride levels in bottled waters and labelling of fluoride content should become mandatory.

Keywords: Bottled water, SPADNS colorimetric analysis

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 which is more resistant to demineralisation [2]. Community water fluoridation began as early as 1945 and is considered as an effective way of preventing caries in children as well as adults [3]. The World Health Organisation has identified dental caries as a worldwide epidemic and also recommended to add fluoride to drinking water in naturally occurring water which has less than optimal fluoride levels. The optimal fluoride level in drinking water is 0.7 to 1.2 ppm [4].

The primary source of drinking is facing a paradigm shift from well or tap water to bottled water in Tamilnadu. According to a commercial report one third of the Chennai (India) residents rely on bottled water. The sale of bottled water has shot up to 6 million liters/day from 4 million liters/day in 2010, according to Tamilnadu packaged drinking water association [5]. One crore liters are supplied to Chennai & surrounding areas through bottles and pouches. City consumes 12 lakh liters/day during peak summer [6].

If bottled water is the primary source of drinking water then it is important to know the concentration of fluoride in bottled water, as increased concentration may lead to risk of skeletal and dental fluorosis and decreased concentration may lead to increase risk of caries and supplementation may be necessary [7].

Studies conducted in various countries across world showed variation of fluoride concentration in bottled water. Weinberger SJ, studied 17 bottled waters in London, Ontario, Canada and found great variation ranging from very low in distilled water to 4 ppm in mineral water [8]. Ahiropoulos, studied 22 bottled waters in Northern Greece found manufacturers labelling of fluoride concentration was inaccurate, only 18% of the brands tested mention the fluoride concentration on the label [9]. Conchrane NJ, tested 10 bottled waters in Australia, found that the fluoride concentration less in all brands [10]. Toumba KJ analysed fluoride content of 12 bottled waters in UK and found it to vary from 0.10-0.80 mg/l [7].

The aim of this study is to determine the fluoride levels in top 10 bottled waters that are currently available in Chennai city and to check the accuracy of their labelling.

MATERIALS AND METHODS

Fluoride content of top 10 selling brands of bottled water in Indian market was evaluated. This study was conducted in Department of Pedodontics, Saveetha Dental college, Chennai in association with RVN laboratories, Moappair East, Chennai between November to December 2014. The ten brands consisted of 6 Multinational companies (Acquafina, Bisleri, Bailey, Kinley, Tata Water Plus and Himalayan) and 4 non Multinational companies (Gangar, Diet Aqua, Sabols and Rail Neer). Three different batches of each brand were purchased, making a total of 30 samples.

The samples within expiry date were procured from different areas of Chennai city. Bottles that were collected were manufactured from same manufacturing units of the respective companies [Table/Fig-1]. The details of each bottle i.e. brand name, batch number, date of manufacture, label information on fluoride levels was recorded. All the samples were number coded before fluoride analysis, so that the investigators are blinded to the samples being analysed. The samples were stored in their original containers until fluoride analysis was done.

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 colourless complex anion and the dye. As the amount of fluoride increases the colour produced becomes progressively lighter which is compared to fluoride standard solutions [11].

In the present study standard solutions were prepared in the range of 0 to 1.40 mg F-/L by adding 5.00 ml each of SPADNS solution and Zirconyl acid reagent to each standard. The colour of each standard was observed with a Photometer which is set to zero absorbance with the reference solution and absorbance readings of standards were obtained. Milligrams fluoride-absorbance

relationship was plotted and a standard curve is obtained. The sample was pre-treated using 1 drop (0.05 ml) sodium arsenic oxide solution to remove the residual chlorine. The prepared standard 0 mg F-/L standard was used to set the photometer for testing the samples. Testing was performed on 50 ml of the sample bottled water; the sample temperature was adjusted to that used for the standard curve. Five millilitres each of SPADNS solution and zirconyl-acid reagents were added 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. Mean of three different batches of the same brand was calculated along with standard deviation and tabulated [Table/Fig-1].

Sample no.	Product name	Manufacturer	Area of manufacture	Label information on fluoride content (ppm)	Concentration (ppm)	
					Mean	±SD
1.	Gangar	Ganga Mineral Water	Chennai, TN*	Not provided	0.58	0.085
2.	Sabols	Asheerwath enterprise	Chennai, TN*	Not provided	0.59	0.043
3.	Diet Aqua	Akshaya Aqua Farms	Thiruvallur, TN*	Not provided	0.46	0.020
4.	Rail Neer	IRCTC*	Kanchipuram, TN*	Not provided	0.33	0.015
5.	Bisleri	Bisleri International Pvt. Ltd	Chennai, TN*	Not provided	0.27	0.050
6.	Aquafina	Pepsico India holdings Ltd	Chittoor, AP*	Not provided	0.37	0.015
7.	Bailey	Parle Agro Pvt. Ltd	Chittoor, AP*	Not provided	0.51	0.023
8.	Kinley	Hindhustan Coca cola Pvt. Ltd	Bangalore Rural, KA*	Not provided	0.40	0.025
9.	Himalayan	TATA enterprise	Sirmour, HP*	0.20	0.37	0.012
10.	Tata Water Plus	TATA global Beverages Ltd	Hyderabad, AP*	Not provided	0.48	0.140

[Table/Fig-1]: Fluoride concentration and label information of the bottled water samples

*IRCTC-Indian Railway Catering and Tourism Corporation Ltd. *TN-Tamil Nadu *AP-Andhra Pradesh *KA-Karnataka *HP-Himachal Pradesh

Of all the brands included in the study only one brand mentioned the fluoride content in the labels (Himalayan - Tata). The analysis of fluoride content of different batches of the same brand showed different fluoride content, which might imply that fluoride content is not regulated. The optimal fluoride content for optimal caries prevention is 0.7ppm – 1ppm. The Bureau of Indian Standards, has therefore, laid down Indian standards as 1.0 mg/l as maximum permissible limit of fluoride [12]. Except for 3 brands namely Bailey, Sabols and Gangar all others contained less than 0.5ppm fluoride concentration. High Standard deviation was observed in Tata water plus, Gangar followed by Bisleri which implies increased variation of fluoride content among different batches of these brands and least Standard deviation was observed in Himalayan followed by Railneer and Aquafina which implies least variation of fluoride content among different batches of these brands.

Few methods of analysis of fluoride are available; the most promising are supposed to be included in the "Standard Methods", i.e. The Standard Methods for Examination of Water and Wastewater [13]. These are the potentiometric electrode method and the colorimetric

SPADNS method. These analytical methods need a high degree of standardisation and instrumentation in order to obtain a satisfactory quantitative response free of interference. Thus conducting these analyses involves relatively high cost of instrumentation and chemicals and high skills of laboratory work [13].

DISCUSSION

Fluoridation of community water supplies is considered as accessible and cost effective way of preventing dental caries. In a country like India where generalized water supply is rare water fluoridation becomes a myth. In a view of the increasing trend of consumption of packaged drinking water in the community, it is essential to control the concentration of fluoride level in these products [11,14-16]. Indian standard specification for fluoride in drinking water is 0.6 to 1.0 ppm [12,17].

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 common error with SPADNS colorimetric method is the impurities in drinking water like Chlorine which may interfere with the absorbance reading. This was removed by pre-treatment of the samples with sodium arsenic oxide solution. 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 Dobarandaran et al., [18,19]. Though there are methods of analysis of fluoride has been developed [13] we opted to use the SPADNS calorimetric analysis as it was both cost effective and accurate when impurities are removed and controlled temperature is maintained. Edelstien et al., has also suggested that the calorimetric method should be accepted as a clinically useful alternative to the electrode method [20].

In current study, it was observed that almost all brands had not stated their fluoride content in label except for one namely Himalayan, which was also found to be less (0.2ppm) than the actual fluoride level present (0.32ppm). Other similar studies in various regions also found that very few brands stated the fluoride concentration on their labels. In Davangere city India, Thippeswamy et al., found that none of the bottled water samples displayed the fluoride concentration in the label [21]; Ahiropoulos studied 22 bottled water brands in Northern Greece and found that only 18% of the tested samples displayed the fluoride content of the water on the labels and in 50% of the bottled water samples, there was a significant difference between the measured fluoride content and that marked on the label [9].

S. NO	Place	Author	Year	Reported range of fluoride level in mg/L
1	Canada [8]	Weinberger SJ.	1991	0.06-4.0
2	Australia [10]	Conchrane NJ et al.,	2006	0.001-0.1
3	Northern Greece [9]	Ahiropoulos V	2006	0.05-4.80
4	Iran [19]	Dobaradaran S et al.,	2008	0.00-0.59
5	Saudi Arabia [23]	Aldrees AM et al.,	2010	0.50-0.83
6	Babli, Iraq [24]	Mohammad Hashim Matlob	2011	0.058-0.146
7	Agra, India [22]	Guptha P	2012	0.45-0.86
8	Bushehr, Iran [18]	Nabipour I	2013	0.07 and 0.31
9	Najaf and Karbala, Iraq [25]	Fard Mahvi Hosseini	2014	0.13 to 0.50
10	Chennai, India	Sujatha et al.,	Present study	0.27 to 0.59

[Table/Fig-2]: Comparison of fluoride levels in various other studies

According to a report Non-Multinational companies formed a majority of supply to daily usage in Chennai [6]. Most of other studies have taken only multinational brands in their study. In the present study, attempt was made to measure the fluoride content of the largest selling Multinational and Non-Multinational companies. The information regarding the fluoride content of bottled water across the world [8-10,18,19,22-25] has been compared in [Table/ Fig-2].

The fluoride concentrations in this study ranged from 0.27 to 0.59 ppm. Most of the branded water bottles (70%) had more than 0.5ppm but less than 0.6ppm of fluoride concentration which is the required level as per the Indian standard specification of drinking water. Our results was found to be similar to the studies conducted in other parts of India such as fluoride in the bottled drinking waters available in Agra City ranged between 0.45 and 0.86 mg/L as tested by Puneet Gupta and Ashish Kumar [22]; Thippeswamy HM studied 10 commercially available brands of bottled water in Davagere city and found that Fluoride levels ranged from 0.06 to 1.05 mg F/L [21]. This study results also correlate with the studies across world some are; the study conducted by Iraj Nabipour and Sina Dobaradaran showed the mean concentration of fluoride in the bottled water available in Bushehr, Iran to vary between 0.07 and 0.31 mg/L [18]. In Saudi Arabia bottled drinking water had 0.50-0.83mg/L of fluoride [23]. In two different place in Iraq the fluoride concentration in bottled water was found to be in the range of 0.058-0.146 [24] and 0.13 to 0.50 mg/L [25]. Ahiropoulos in Northern Greece observed that the mean fluoride content ranged from 0.05 to 4.80 mg/L [9].

LIMITATION OF THE STUDY

Samples of bottled water were collected only from Chennai city. Future studies needs to be carried out using samples from the entire state and in different climatic conditions. Though Colorimetric method is more time consuming and lack sensitivity of the other methods, it can be used for a gross estimation of fluoride content with pretreatment of water in order to remove impurities.

While the colorimeter may be accurate when all interferences are known and may be compensated for if present, it should not be used when these variables are unknown.

CONCLUSION

This study concludes that the fluoride content of bottled waters in Chennai, India has less than the optimal level of fluoride in drinking water. The finding that 70% of the samples showed high variation within specific brand and fluoride levels displayed in the labels was significantly different from the actual fluoride content measured, suggests that the manufacturers should focus on high standards and to the information stated in their product labels. The label information for the fluoride content must be mentioned for the better consumer awareness and making an informed choice.

ACKNOWLEDGEMENT

We extend our appreciation to RVN laboratories, Mogappair east, Chennai for their support.

REFERENCES

- [1] Tiemann M Fluoride in drinking water a review of fluoridation and regulation issues. Congressional research service, a report for congress, April 5, 2013.
- [2] Fejerskov O, Thylstrup A, Larson MJ. Rational use of fluoride in caries prevention: a concept based on possible cariostatic mechanisms. *Acta Odontologica*. 1981;39:241-49.
- [3] Lewis DW, Bantring DW. Water Fluoridation: current effectiveness and dental fluorosis. *Community dentistry and oral epidemiology*. 1994;22(3):153-58.
- [4] WHO water sanitation and health, world water day 2001: oral health: Dental caries, a worldwide epidemic. Health and sanitation unit and oral health program.
- [5] Mariappan J. Times of India, April 12, 2011. Available from: "http://articles.timesofindia.indiatimes.com/2011-04-12/chennai/29409770_1_drinking-water-water-supply-mltd" (DOA: 30/10/13).
- [6] Long wait a head of packaged drinking water in chennai. The Hindu, Chennai may 17, 2013. Available from: "http://www.thehindu.com/news/cities/chennai/long-wait-ahead-for-packaged-drinking-water-in-chennai/article4721664.ece" (DOA: 30/10/13).
- [7] Tumba KJ, Levy S, Curzon ME. Fluoride content of bottled drinking waters. *Brit Dent J*. 1994;176:266-68.
- [8] Weinberger SJ. Bottled drinking waters – are the fluoride concentrations shown on the labels are accurate. *Int J of ped dent*. 1991;1(3):143-46.
- [9] Ahiropoulos V. Fluoride content of bottled water available in northern Greece. *Int j of ped dent*. 2006;16:111-16.
- [10] Conchrane NJ, Saranathan S, Morgan MV . Fluoride content of still bottled water in Australia. *Aus Dent J*. 2006;51(3) 242-44.
- [11] Comparison of calorimeter and electrode analysis of fluoride in water. *ped dent*. 1992;14(1):37-48.
- [12] Bureau of Indian Standards. Draft Indian standard drinking water specification(second revision of IS: 10500), ICS No. 13.060.20, Doc: FAD 25(2047)C.
- [13] Standard Methods for the Examination of Water and Wastewater. Eaton et al. (Eds.). APHA, AWWA, WEF, Washington, 1995.
- [14] Arancibia JA, Rullo A, Olivieri AC, Di Nezio S, Pistonesi M, Lista A, Band BSF. Fast spectrophotometric determination of fluoride in ground waters by flow injection using partial least-squares calibration. *Analytica chemica acta*. 2004;512:157-63.
- [15] Prevalence of fluorosis and identification of fluoride endemic areas, TamilNadu- *Appl. water sci*. DOI 10.1007/s 13201-0122.
- [16] Vishwanathan G, et al. Mapping of fluoride endemic areas and assessment of fluoride exposure. *Sci total environ*. 2009;407(5):1579-87.
- [17] Indian standard specifications for drinking water IS:10500.
- [18] Nabipour I, Dobaradaran S. Fluoride concentrations of bottled drinking water available in bushehr, Iran. Research report. *Fluoride*. 2013;46(2):63-64.
- [19] Dobaradaran S, Hossein A, Dehdashti S. Fluoride content of bottled drinking water available in Iran. Research note. *Fluoride*. 2008;41(1):93-94.
- [20] Edelstein BL, Cottrel D, O'sullivan D, Tinanoff N. Comparison of calorimeter and electrode analysis of water fluoride. *Pediatric dentistry*. 1992;14(1):47-49.
- [21] Thippeswamy HM, Kumar N, Anand SR, Prashant GM, Chandu GN. Fluoride content in bottled drinking waters, carbonated soft drinks and fruit juices in Davangere city, India. *Indian J Dent Res*. 2010;21:528-30.
- [22] Guptha P, Kumar A. Fluoride levels of bottled and tap water sources in Agra city, India. Research report. *Fluoride*. 2012;45(3pt2):307-10.
- [23] Aldrees AM, Al-Manea SM. Fluoride content of bottled drinking waters available in Riyadh, Saudi Arabia. *The Saudi Dental Journal*. 2010;22:189-93.
- [24] Matloob MH. Fluoride concentration of drinking water in Babil-Iraq. *Journal of Applied Sciences*. 2011;11(18):3315-21.
- [25] Fard RF, Mahvi AH, Hosseini SS, Khazaieic M. Fluoride concentrations in bottled drinking water available in Najaf and Karbala, Iraq. Research report. *Fluoride*. 2014;47(3):249-52.

PARTICULARS OF CONTRIBUTORS:

1. Reader, Department of Pedodontics, Saveetha Dental College and Hospitals, Chennai, India.
2. Student, School of Public Health, SRM University, Chennai, India.
3. Senior Lecturer, Department of Periodontics, SRM Kattankulathur Dental College, Chennai, India.
4. Reader, Department of Pedodontics, Saveetha Dental College and Hospitals, Chennai, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Sujatha Somasundaram,
Reader, Department of Pedodontics, Saveetha Dental College and Hospitals, Chennai – 600077, India.
E-mail: drsujathabds@yahoo.com

FINANCIAL OR OTHER COMPETING INTERESTS: As declared above.

Date of Submission: **Apr 27, 2015**
Date of Peer Review: **Jun 30, 2015**
Date of Acceptance: **Aug 05, 2015**
Date of Publishing: **Oct 01, 2015**