

Fluoride content in various sources of drinking water in Chennai

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ABSTRACT

Fluoride is one of the critical chemical parameters, which influences the quality of groundwater. Excess intake of fluoride through drinking water causes fluorosis on human beings in many states of India. Fluoride is essential for the development of tooth enamel, dentin, and the bones. Fluoride in drinking water is of great benefit to the vulnerable society in terms of prevention and control of dental caries. Whatever may be the type of water being consumed, it is necessary to assess the fluoride level in various sources of water. The aim is to assess the fluoride level in various sources of drinking water in Chennai. Chennai city is divided into north, south, and central, and there are about 15 zones in Chennai. Five zones of Chennai were selected. All drinking water samples about 200 ml were collected in polyethylene bottles with airtight lids. About 22 water samples from groundwater and tap water were collected from selected zones of Chennai. Leading brands of bottled water were selected. The labels of the bottled water were removed after collecting the details regarding fluoride content. All the bottles were numbered, and water samples were sent for fluoride content analysis. Fluoride content was analyzed using SPADNS colorimetric method. Fluoride content in open well was found to be higher in zone 11 (0.69 mg/L), and it is lower in zone 6 (0.46 mg/L). Fluoride content in metro water was found to be higher in zone 11 (0.48 mg/L). pH value was found to be higher in zone 5 (7.70) compared to other zones. Fluoride content in bore water was found to be higher in zone 5 (0.89 mg/L), and it was lower in zones 10 and 11 (0.56 mg/L). The pH value was found to be higher in zone 10 (8.23) and lower in zone 5 (7.12). Fluoride content was found to be higher in Bisleri bottled water (0.06), whereas Aqua firm and Aqua fina contain below the detection level of fluoride content in water. The results obtained from the present study clearly state that the fluoride concentration was suboptimal in both community water supply and bottled drinking water sold in Chennai. Various alternatives for topical as well as systemic fluorides should be suggested for the population in this city to have better dental health.

Keywords: Fluoride, bore water, metro water, open-well water, bottled drinking water

Introduction

Water is an essential natural resource for sustaining life, but over the past few decades, the water quality is deteriorating due to its overexploitation.^[1] Water quality is essential parameter to be studied when the overall focus is sustainable development keeping humankind at focal point.^[2] Fluoride is one of the critical chemical parameters, which influences the quality of groundwater. Excess intake of fluoride through drinking water causes fluorosis on human beings in many states of India. In groundwater, the natural concentration of fluoride depends on the geological, chemical, and physical characteristics of the aquifer, the porosity and acidity of the soil and rocks, the temperature, and the action of other chemical elements.^[2]

Chennai, the capital of Tamil Nadu, largely derives its water supply from the public drinking water supply (the metro water). This supply is not adequate to meet the demands, and hence, a major proportion of the population use groundwater extracted through pumps, as a source of drinking water and most other opt for packaged drinking water.^[3]

Fluoride enrichment in open-well water takes place mainly through leaching and weathering of the fluoride-bearing minerals present in the rocks and sediments which depends on several factors such as the origin of water, composition of water-bearing medium, the length of time the water has been in contact with the medium, the temperature and pressure conditions, ion-exchange, and rate of recharge and discharge.^[4]

Fluoride in drinking water is of great benefit to the vulnerable society in terms of prevention and control of dental caries.^[5] An adequate intake of fluoride during the pre-eruptive stage of enamel formation has a protective effect against dental caries in later life.^[6] The cariostatic effect of fluoride has been well established from studies in the past, and hence fluoride has come to be viewed as the most potent and effective anticaries agent.^[7] Fluorine is often called as a

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two edged sword because of its beneficial effects in optimum doses and harmful effects due to overdose^[8] Whatever may be the type of water being consumed, it is necessary to assess the fluoride level in various sources of water. Hence, the aim of the study was to evaluate the fluoride content in drinking water in Chennai.

Materials and Methods

Chennai city is divided into north, south, and central parts, and there are about 15 zones in Chennai. Five zones of Chennai were selected randomly. Before the start of the study, ethical clearance was obtained from the Institutional Ethics Committee, Saveetha University. All drinking water samples about 200 ml were collected in polyethylene bottles with airtight lids. About 22 water samples from groundwater and tap water were collected from selected zones of Chennai. Leading brands of bottled water were selected. The labels of the bottled were removed after collecting the details regarding fluoride content. All the bottles were numbered, and water samples were sent for fluoride content analysis.

Fluoride content was analyzed using SPADNS colorimetric method. The SPADNS colorimetric test is an inverse colorimetric reaction where fluoride reacts with the zirconium dye, 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.

Statistical analysis

Statistical analysis was done using SPSS Software Version 20. Results were expressed in mean and standard deviation.

Results

Table 1 shows that fluoride content in open well was found to be higher in zone 11 (0.69 mg/L) and it is lower in zone 6 (0.46 mg/L). Table 2 shows that fluoride content in metro water was found to be higher in zone 11 (0.48 mg/L). pH value was found to be higher in zone 5 (7.70) compared to other zones. Table 3 shows that fluoride content in bore water was found to be higher in zone 5 (0.89 mg/L) and it was lower in zones 10 and 11 (0.56 mg/L). The pH value was found to be higher in zone 10 (8.23) and lower in zone 5 (7.12). Table 4 depicts that fluoride content was found to be higher in Bisleri bottled water (0.06), whereas Aqua firm and Aqua fina contain below the detection level of fluoride content in water.

Table 1: Fluoride content and pH in open-well water in five zones of Chennai

Chennai city zone	Open-well water	
	Fluoride mg/L (ppm)	pH
5	0.64	7.86
6	0.46	7.26
8	0.53	8.06
10	0.54	8.34
11	0.69	7.54
Mean	0.57	7.81

Discussion

Studies done by Armfield *et al.* (2004, Australia) clearly showed that the consumption of non-fluoridated community and bottled water may put the children at the increased risk of developing caries.^[9-11] Hence, the importance of consumption of fluoride in optimal amount is very essential for a better dental health. Hence, the determination of fluoride ion in water is important for determining the dosage of fluoride supplements or necessity of topical fluoride in the patients.

In the present study, the fluoride concentration of open-well water was in the range of 0.46–0.69 mg/L. A study done by Kumar *et al.* (2011, Kanchipuram)^[12] showed marginally higher fluoride concentration in the range of 0.98–1.04 mg/L compared to current study results. Another study by Kumar *et al.* (2011, Ennore) found a high concentration of fluoride in open-well water in the range of 1.8–2 mg/L.^[13] This is because the groundwater is contaminated by fluoride released from fertilizer effluents in Ennore. The occurrence of the fluoride in open-well water is predominantly geogenic. Leaching of fluoride from the earth crust could be a source for higher fluoride content in open-well water in a comparative study.

Table 2: Fluoride content and pH in metro water in five zones of Chennai

Chennai city zone	Metro water	
	Fluoride mg/L (ppm)	pH
5	0.47	7.70
6	0.41	7.46
8	0.27	7.23
10	0.45	7.65
11	0.48	7.54
Mean	0.41	7.51

Table 3: Concentration of fluoride and pH of bore water in five zones of Chennai

Chennai city zone	Bore water	
	Fluoride mg/L (ppm)	pH
5	0.89	7.12
6	0.73	7.90
8	0.73	7.11
10	0.56	8.23
11	0.56	7.45
Mean	0.69	7.56

Table 4: Fluoride content in bottled drinking water in Chennai

Brand name	Fluoride mg/L (ppm)	Fluoride content on the label (mg/L)	pH
Aqua firm	BDL	NL	7.00
Aqua fina	BDL	NL	6.50
Bisleri	0.062	NL	7.19
Aqua falls	0.015	NL	6.69
Tata water plus	0.020	NL	6.16
Trustt aqua	0.012	NL	6.52
Kinley	0.045	NL	6.44
Mean	0.02		6.64

BDL: Below detection level, NL: Not labelled

The fluoride concentration in the community water supply (metro water) in the present study ranges from 0.41 to 0.48 mg/L with mean fluoride concentration of 0.41 mg/L. This result was in agreement with the previous studies conducted by Khan *et al.* (2004), which found that fluoride concentration in drinking water was 0.39 mg/L.^[14] According to the water quality standards for drinking water in India (IS 10500:1991), the maximum permissible limit of fluoride in drinking water is 1.2 mg/L. In the light of the result obtained, the fluoride levels of the community water supply were in the range of permissible limit for fluoride in drinking water.^[15] The climate temperature determines the optimum level of fluoride in drinking water. In the present study, in Chennai, it is a warmer climate and so due to thirst people will tend to consume more amount of water which will provide adequate fluoride to the consumer.

With respect to groundwater, in the present study, the fluoride level in bore well water was in the range of 0.56–0.89 mg/L. A similar study done by Manipal *et al.* (2013, Chennai) showed that concentration of fluoride in bore water ranges from 0.35 to 0.83 mg/L. In contrast, Ismail (1982, Chennai) did a survey on the fluoride levels in drinking water in and around Chennai. The levels estimated by Ismail were lower than the levels found in the present study.^[16] The reasons for the increase in the levels of fluoride concentration, in the present study, could be due to the increase in the industrial effluents and the increased usage of agricultural pesticides leading to a shift in the geophysical nature of the soil and water.

In the present study, fluoride concentration in the bottled drinking water had a mean value of 0.012–0.06 mg/L. This is dissimilar with the findings of Somasundaram *et al.* found the fluoride content in bottled drinking water in the range of 0.27–0.59.^[17] There is suboptimal fluoride level in bottled drinking water in the present study. The maximum limit of fluoride was estimated to be 0.12 mg/L which was in accordance with the standard for the packaged drinking water as recommended by the IS 14543: 2004.^[18,19]

In the current study, the concentration of fluoride in open-well water ranges from 0.53 mg/L (zone 8) to 0.69 mg/L (zone 11). The fluoride concentration in metro water ranges from 0.27 mg/L (zone 8) to 0.48 mg/L (zone 11). The fluoride concentration in bore water ranges from 0.56 mg/L (zone 10) to 0.89 mg/L (zone 5). The comparative study done by Sunayana *et al.* (2013, Chennai) showed that the concentrations of fluoride in bore water range from 0.83 mg/L (zone 10) to 0.43 mg/L (zone 5). The concentration of fluoride in metro water ranges from 0.74 mg/L (zone 8) to 0.40 mg/L (zone 10). In present study, water samples are collected from five zones of Chennai, whereas in the comparative study, water samples are collected from 10 zones of Chennai. The fluoride concentration of bore water is higher in zone 5, and the fluoride level in metro water is lower in zone 8 compared with Sunayana *et al.* study.^[3] The reason for higher fluoride content found in bore water and metro water could be the natural concentration of fluoride depends on the geological, chemical, and physical characteristics of the aquifer, the porosity and acidity of the soil and rocks, the temperature, and the action of other chemical elements.

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 increased risk of caries and supplementation may be necessary.^[20]

Conclusion

- The results obtained from the present study clearly state that the fluoride concentration was suboptimal in both community water supply and bottled drinking water sold in Chennai city.
- The label information for the fluoride content must be mentioned for the better consumer awareness and making an informed choice.
- People should make better choices which should supplement their health as well.
- The information gathered from this study will support an important research on the public health and dental health.
- Various alternatives for topical as well as systemic fluorides should be suggested for the population in this city to have better dental health.

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