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ORIGINAL ARTICLE

Estimation of Fluoride Concentration in Municipal Water Supply and Commercially Available Packaged Drinking Water in Mathura City. A -Comparative Study

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ABSTRACT

Introduction: Presence of fluoride in water is known to cause many crippling diseases either by its insufficient or excess intake.

Aim & objectives: To compare the fluoride and TDS concentration in municipal water supply and packaged drinking water sold in Mathura city.

Material and Method: Total five water samples of packaged drinking water and ten samples of municipal water were collected from pumping stations of Mathura city. Fluoride concentration was determined by modified alizarin method, TDS was estimated by TDS meter. The student t test was used to compare the mean fluoride concentration of municipal water and packaged drinking water.

Results: The mean fluoride concentration of packaged drinking water and municipal water supply was 0.16 mg/L, 0.64 mg/L respectively. The difference between the mean of two samples was found to be statistically significant.

Conclusion: The fluoride concentration was low in both municipal water and packaged drinking water.TDS was in permissible range in packaged drinking water and unsatisfactory in municipal water.

Keywords: Fluorides, Total Dissolved Solids, Modified zirconium- alizarin method, Packaged drinking water, municipal water supply.

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INTRODUCTION

Water is an essential resource for living systems, industrial processes, agricultural production and domestic use. One of the key things to be determined in a pure drinking water is the optimum amount of fluoride content present in it. Presence of fluoride in water is known to cause many crippling diseases either by its insufficient or excess intake (1). The fluoride element is found in the

environment and constitutes 0.06 – 0.09 % of the earth's crust. Fluoride is not found naturally in the air in large quantities. Average concentrations of fluoride in air are in the magnitude of 0.5 ng/m^3. Fluoride is found more frequently in different sources of water but with higher concentrations in groundwater due to the presence of fluoride-bearing minerals. Average fluoride concentrations in sea water are approximately 1.3 mgL-1 (2). The permissible limit as given by Bureau of Indian Standards (BIS) and World Health Organization (WHO) is 0.6–1.2 mg/l and 1.5 mg/l respectively for fluoride in drinking water. International studies support the widely held view that the majority of bottled waters available contain negligible fluoride in terms of its dental health benefits (3). 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 nearly 200 billion liters in 2006 (4). Total dissolved solids (TDS) are the term used to describe the inorganic salts and small amounts of organic matter present in solution in water. The principal constituents are usually calcium, magnesium, sodium, and potassium cations and carbonate, hydrogencarbonate, chloride, sulfate, and nitrate anions. The presence of dissolved solids in water may affect its taste. The palatability of drinking water has been rated by panels of tasters in relation to its TDS level as follows: excellent, less than 300 mg/liter; good, between 300 and 600 mg/liter; fair, between 600 and 900 mg/liter; poor, between 900 and 1200 mg/liter; and unacceptable, greater than 1200 mg/liter . Water with extremely low concentrations of TDS may also be unacceptable because of its flat, insipid taste (5). India is a vast country with varied hydrogeological situations resulting from diversified geological, climatological and topographic settings. Water-bearing rock formations (aquifers) range in age from Archaean to Recent. Most of the fluoride found in groundwater is naturally occurring from the breakdown of rocks and soils or weathering and deposition of atmospheric particles. Most of the fluorides are sparingly soluble and are present in ground water in small amounts. The occurrence of fluoride in natural water is affected by the type of rocks, climatic conditions, nature of hydrogeological strata and time of contact between rock and the circulating ground water. Presence of other ions, particularly bicarbonate and calcium ions also affects the concentration of fluoride in ground water. It is well known that small amounts of fluoride (less than 1.0 mg/L) have proven to be beneficial in reducing tooth decay. Community water supplies commonly are treated with NaF or fluorosilicates to maintain fluoride levels ranging from 0.8 to 1.2 ppm to reduce the incidence of dental carries. However, high concentrations such as 1.5 mg/l of F and above have resulted in staining of tooth enamel while at still higher levels of fluoride ranging between 5.0 and 10 mg/L, further pathological changes such as stiffness of the back and difficulty in performing natural movements may take place. Upper desirable limit 1.0 mg/L of F- as desirable concentration of fluoride in drinking water, which can be extended to 1.5 mg/L of F in case no alternative source of water is available. Water having fluoride concentration of more than 1.5 mg/L are not suitable for drinking purposes. The fluoride content in ground water from observation wells in a major part of the country is found to be less than 1.0 mg/L. It is observed that there are several locations in the States of Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Rajasthan, Chattisgarh, Haryana, Orissa, Punjab, Haryana, Uttar Pradesh West Bengal, Bihar, Delhi, Jharkahnd, Maharashtra, and Assam where the fluoride in ground water exceeds 1.5 mg/l (6).

METHODOLOGY

A study was conducted to estimate the fluoride concentration in community water supply and packaged drinking water sold in Mathura city and estimation of total dissolved solid in water. Water samples were collected directly from municipal bore wells of Mathura city there are total 55 bore wells in Mathura city. The city is divided into 5 zones i e east, west, north, south, central, each zones has 10 bore well except central which has 15 bore well. 2 samples were collected from each zone. This makes the total of 10 bore wells samples. They were selected randomly by using lottery method. There are five different production sites of packaged drinking water in Mathura city water samples were collected from all the 5 sites. Prior to start of the study the ethical clearance was obtained from ethical committee of K.D Dental College Mathura. Water samples of one liter were collected in different hard plastic containers for each of selected bore well and for each packaged drinking water. All water samples were stored at room temperature. The samples were handed over to the Uttar Pradesh Jal Nigam –water testing laboratory Mathura city for analysis on the same day. The samples were precoded and not disclosed to the technician.

In laboratory, samples were stored at room temperature (17-25o C) prior to analysis.

The fluoride estimation was done by spectrometric method and TDS by TDS meter.

RESULTS

Statistical analysis – SPSS (statistical package for social sciences) version 16 was used to determined the mean and standard deviation for fluoride in water sample.Unpaired Student t-test, a two tailed p value ≤ 0.05 were considered statistically significant.A study was conducted to estimate the fluoride concentration in municipal water supply and packaged drinking water sold in Mathura city and to estimate total dissolved solids in water.Out of 15 samples of water, 10 samples were

of municipal bore well water and 5 samples were of packaged drinking water Samples. Samples SP-1, SP-2, SP-3, SP-4, SP-5, SP-6, SP-7, SP-8, SP-9, SP-10 were the municipal bore well water samples while S-6, S-7, S-8, S-9, S-10 were the packaged drinking water samples.Out of ten samples collected from the municipal water supply, the fluoride concentration varied from 0.0 to 1.5 mg/L and mean fluoride concentration was 0.64 mg/L (Table 1).

The TDS concentration in ten samples of municipal water supply varied from 618 to 1040 ppm and mean fluoride concentration was 863.6 ppm. (Table 1) Out of five samples collected from the packaged drinking water, the fluoride concentration varied from 0.0– 0.4 and the mean fluoride concentration was 0.16 mg/L (Table 2).

The TDS concentration in five samples of packaged drinking water varied from of 60 to 278 ppm and mean fluoride concentration was 116.4 ppm. (Table 2) The difference between the mean of municipal water supply and packaged drinking water was found to be statistically significant. The mean fluoride concentration in municipal and packaged drinking water was found to be 0.64 ± 0.53 & 0.16 ± 0.15 mg/L respectively. There was statistically significant difference i.e $p \leq 0.03$ observed when mean fluoride levels of municipal & packaged drinking water was compared (Table 3).

Table1: Fluoride and TDS concentrations in municipal water supply water

Sr. No.	Sample of water collected from municipal water supply.	Fluoride concentration in mg/L	TDS concentration in ppm
1.	SP 1	0.0	962
2.	SP 2	0.5	780
3.	SP 3	0.4	1040
4.	SP 4	0.4	947
5.	SP 5	0.5	618
6.	SP 6	1.0	1030
7.	SP 7	0.0	663
8.	SP 8	1.5	740
9.	SP 9	1.5	876
10.	SP 10	0.5	980
	Mean fluoride and TDS concentration of ten samples of water	0.64	863.6

Table 2: Fluoride and TDS concentration in packaged drinking water

Sr. No.	Sample of water collected from packaged drinking water	Fluoride concentration in mg/L	TDS concentration in ppm
1.	S 6	0.2	90
2.	S 7	0.0	68
3.	S 8	0.1	86
4.	S 9	0.4	60
5.	S 10	0.1	278
	Mean fluoride concentration of five samples	0.16	116.4

Table 3: Comparison of mean fluoride concentration among municipal and packaged drinking water

Water samples	Mean fluoride concentration (mg/L)	t-value	df	P-value
Municipal water supply (n=10)	0.64±0.53	2.05	11	0.03*
Packaged drinking water (n=5)	0.16±0.15			
*statistically significant				

DISCUSSION

Excessive consumption of fluoride above the optimum level causes dental and skeletal fluorosis. The importance of fluoride ion in cariostatic mechanism is well documented. Determination of the most appropriate concentration of fluoride in drinking water is crucial for the one that intend to start the community water fluoridation as well as for those that have excessive natural fluoride in their drinking water and therefore require Defluoridation (7). Though there is substantial literature regarding the fluoride and TDS levels, but no study has been conducted in Mathura city that assesses the levels of fluorides and TDS in municipal and packaged drinking water therefore this study was conducted to assess the fluoride and TDS levels in municipal and packaged drinking water Mathura city. In the present study the fluoride concentration in ten samples of municipal water supply ranges from 0.0 to 1.5 mg/L with mean fluoride concentration of 0.64 mg/L. This result was in agreement with the previous studies conducted by Subarayan Bothi Gopalakrishnan et al (8). with fluoride concentration ranging from 0.26 - 1.3 mg/L. Although the studies conducted by Puneet Gupta (9), Bramhanand R. Bhosle et al (10), founded the high fluoride concentration ranging from, 1.6 - 1.7 mg/L, 1.59 - 4 mg/L respectively. And low fluoride concentration was found in studies conducted by Dhingra S et al (4), Parrkar Sujal M (7), Masoumeh Moslemi, et al (11), Lalumandier JA et al (8), 0.11 - 0.26

mg/L, 0.1 - 0.26 mg/L, 0.12 - 0.38 mg/L, 0.1 - 0.94 mg/L, respectively. Out of five samples collected for the packaged drinking water the fluoride concentration varied from 0.0 – 0.4 the mean fluoride concentration was 0.16 mg/L. This result was in agreement with the previous studies conducted by Masoumeh Moslemi , et al. (11) founded fluoride concentration ranging from 0.009 - 0.4 mg/L, although the studies conducted by Lalumandier JA et al,(12) Puneet Gupta et al (9), Sina Dobaradaran et al (13), Tippeswamy HM et al (5), Abdullah M. Aldrees et al(14), Consuelo Fernanda Macedo de Souza et al (15), founded the high fluoride concentration in packaged drinking water ranging from 0.0 - 0.24 mg/L, 0.0 -. 05 mg/L, 0.45 - 0.86 mg/L,0.0 - 0.59 mg/L. 0.06 - 1.05 mg/L. 0.502 – 0.832 mg/L. 0.001 - 0.27 mg/L. respectively. On the other hand studies found the low fluoride concentration Iraj Nabipouret al (16), Anumala Ram et al (17), founded fluoride concentration ranging from 0.07 - 0.13 mg/L, 0.05 - 0.14 mg/L respectively. In this study the TDS concentration in ten samples of municipal water supply ranges from 618 to 1040 ppm with mean fluoride concentration 863.6 ppm. This result was in agreement with the studies conducted by Hubert H. Patterson, et al. (18) found higher concentration of TDS in municipal water ranging from 1226 - 7268 ppm. On the other hand studies shows low concentration of TDS in municipal water Irwin Anthony Akpoborie (19), Emmanuel Bernard (20), founded TDS ranging from 2.26 - 89.6 mg/L, 79 - 86 ppm, respectively.

TDS concentration in five samples of packaged drinking water varied from of 60 to 278 ppm with mean fluoride concentration 116.4 ppm.. This result was in agreement with the previous studies conducted by H.A. Ghrefat (21), TDS level ranging 100 - 253 ppm.

CONCLUSION

The fluoride concentration was found within the optimum range in both municipal water and packaged drinking water. TDS levels were in permissible range in packaged drinking water but it was found to be unsatisfactory in municipal water.

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