Assessment of Fluoride Contamination in the Groundwater of Mandvi Tehsil, Kachchh, Gujarat

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Abstract: *Water is an essential natural resource for sustaining life and environment but over the last few decades the water quality is deteriorating due to its over exploitation. Water quality is essential parameter to be studied when the overall focus is sustainable development keeping mankind at focal point. Groundwater is the major source of drinking water in rural as well as in urban areas and over 94% of the drinking water demand is met by groundwater. Fluoride is one of the critical chemical parameter, which influences the quality of ground water. The present study deals with the investigation of the comparison of fluoride content in Mandvi Tehsil's water at selected study sites. The field survey was carried out during the months between November 2016 and December 2016 area of Mandvi Tehsil, Kachchh district, Gujarat state, India.*
Key word: *Ground Water, Fluoride contamination, selected Mandvi Tehsil, Kachchh.*

1. INTRODUCTION:

"Water is life's matter and matrix, mother and medium. There is no life without water" - *Albert Szent-Gyorgyi*. Water is very much essential for the survival of humans, animals and plants. Water occupy approximately three quarters of earth surface. Nowadays, the expanded population with resulting industrial operation has intensified the old problem of polluting our life, mother and medium. It has raised certain basic challenges in our environment and we are suffering from both the problems of quality and quantity of water. The quality of water is one of the most important criteria that determine its usefulness for a specific need and such not all the water are fit for drinking consequently, a large proportion of people in developing countries lack access to safe drinking water.

Fluoride is a compound of fluorine with another element or radical. Fluoride-containing compounds, such as sodium fluoride and sodium mono fluorophosphates are used in topical and systemic fluoride therapy for preventing tooth decay. Fluoride's molar mass is 19.009 mol^{-1}. Fluoride is widely distributed in nature and it has been estimated that 0.32% of the earth's crust. . Fluoride could be found in number of minerals, of which fluorospar, cryolyte and fluoridate are the most common. Fluorides come naturally into water by dissolving minerals that flour and amphibole minerals. Fluoride can be enriched in natural waters by geological processes. Rocks rich in alkali metals have larger content of fluoride than other volcanic rocks. Fresh volcanic ash, as well as the ash of the other sediments can contribute fluorine. While fluoride is present in air, water and food, the most common way it enters the food chain is via drinking water. Fluoride concentration in seawater averages 1.3 ppm (parts per million), while in fresh water supplies the natural range is typically between 0.01 to 0.3 ppm. The only remedy is prevention by keeping fluoride intake within the safe limits (Teutli et al, 2012; Sujana et al, 2009). Fluoride more than permissible limit, become toxic and causes clinical disturbances in animals and humans. The permissible limit of fluoride in drinking water is 1.5 mg/L by WHO, 1.0 mg/L by ICMR and 0.6 to 1.2 mg/L by BIS (BIS 1991; WHO 1994).

In India, more than 25 million people consuming high fluoride (2 to 20 mg/L) contaminated water and are under severe threat of fluorosis. The major problem is most pronounced in Andhra Pradesh, Punjab, Rajasthan, Tamil Nadu and Uttar Pradesh (Godfrey et al 2007, Khaiwal and Gerg 2007, SIHFW 2008, Hussain et al 2012) as there is no treatment for fluorosis; prevention is the only way to control the disease. Consequently, research into the geochemistry of fluoride and it's movement through the natural environment is necessary step in mitigating the associated health problem. At above 1.5 mg/L (79 µmol/L), fluoride is dangerous to human health leading to dental and skeletal fluorosis, a disease that can cause mottling of the teeth, calcification of ligament, crippling, bone deformities and many other physiological disorders that can ultimately lead to death. (I. Hussain *et al* 2002,2004, 2010, 2011, 2012)

Gujarat is one of the largest states in the country in terms of geographic spread. It has an area of 196024 km. Gujarat has 4.99% of nations population with 33 districts. It is estimated that nearly 70% districts in Gujarat state have fluoride contents beyond the permissible limit in ground water. Gujarat ranks 5th among the 19 states in high fluoride content in ground water. In addition, the nitrate content in ground water is also quite high in various districts of the state. The districts that have such excessive fluoride content include Ahmedabad, Amreli, Anand, Banaskantha, Bharuch, Bhavnagar, Dahod, Junagadh, Kachchh, Mehsana, Narmada, Panchmahals, Patan, Rajkot, Sabarkantha, Surat, Surendranagar and Vadodara. It has to be note that the permissible limit of fluoride and nitrate in ground water is 1.5 mg per liter

Kachchh has different climatic and geographical conditions and it suffers both the problems of quality and quantity of water. Some area of Kachchh has excess fluoride content. The objective of this study is to investigate the quality of drinking water (underground water) with special reference to the concentration of fluoride in rural

habitations of Mandvi taluka of Kachchh district, Gujarat. Excess amount of fluoride is being contributed by industries such as thermal power plants, rubber, and fertilizer, semiconductor manufacturing units, glass and ceramic production and electroplating industries.

2. STUDY AREA:

Mandvi is located in the kachchh district which is located between at western part of Gujarat state. It located between 22.81 N and 69.36 E. Mandvi was developed by Rao of Kachchh state, Khengarji in 1580. It was about 56 km south regional capital of Bhuj and 446 km from Mega city of Gujarat i.e. Ahmadabad

Total 16 villages selected for sampling. The site is as follow: Mandvi, Muska, Bag, Gudiyari, Tragadi, Nana Bhadiya, Shirva, Merau, Bharapar, Durgapur, Nagalpur Rayan, Koday, Jakhaniya, Mota Aasambiya, and Nana Aasambiya. Groundwater samples were collected from 16 villages of Mandvi tehsil. One representative sample was collected from each village in two frequencies during November and December 2016. Samples were directly collected from tube wells and hand pumps.

Figure 1: Map showing the sample collection sites

3. METHODOLOGY:

3.1. Sample Collection

Groundwater samples were collected from 16 villages of Mandvi tehsil. One representative sample was collected from each village in two frequencies during November and December 2016. Samples were directly collected from tube wells and hand pumps .Co-ordinates of the sampling sites were recorded during the sample collection.

3.2. Storage of Samples

Samples were collected in sterile 1000 mL containers and brought immediately to the laboratory and stored in 4°C in refrigeration unit. The boreholes were pumped several times to stabilize the electrical conductivity before filling up with water samples. Analysis was performed within 24 hours from sample collection.

LABORATORY ANALYSIS

3.2.1 Reagents

(A) Alizarin red Solution: 0.75 g of alizarin sulphuric acid sodium salt (alizarin red S) was dissolved in 1 L distilled water and solution was prepared.

(B) Zirconyl acid solution: 0.354 g of zirconyl acid chloride octahydrate ($ZrOCI_2$. $8H_2O$) was dissolved in 600 ml of Distilled water. 33.3 ml of sulphuric acid (concentrated) was added slowly followed by 101 ml of hydrochloric acid (concentrated). The mixture was cooled and the volume was made to 1 L by adding distilled water.

(C) Standard fluoride solution: 0.221 g of sodium fluoride was dissolved in distilled water and made to 1 L volume (ie. 10 ppm).100 ml of this mixture was taken and diluted to 1 L by adding distilled water; this stock solution contains 10 mg F/1. A series of standard fluoride solutions were prepared, preferably in the range of 0.0 to 5.0 mg F/1 at intervals of 0.5 mg F/1, by dilution of the stock solution with distilled water.

3.2.2. Method

100 mL of sample was added with 5 mL of alizarin red solutions (Reagent A) and zirconyl acid solution (reagent B). After 1 hour absorbance was noted in Spectrophotometer at 520 nm. Distilled water was used as a blank.

Run the standard fluoride solution of various concentrations (reagent C) in similar manner and record absorbance for each. Standard curve between concentrations and absorbance of standard solutions were plotted. Fluoride content of the sample was found by comparing its absorbance (S) with standard curve and the results were expressed as mg F/1.

4. OBSERVATION:

All the ground water samples collected in the Mandvi Tehsil were clear without any visible colour, odour and turbidity. The fluoride concentration in ground water varied greatly in different sampling sites of study areas (Figure 1). The fluoride concentration in the ground water samples showed a define trends with respect to sampling sites of Mandvi Tehsil. All the ground water samples collected from 16 villages around the 10 km area of Mandvi Tehsil. There are 16 samples collected from different borewells of 16 villages of Mandvi Tehsil. All the ground water samples collected in the two times. First time ground water collected in November, 2016 of 16 villages and second time ground water again collected in December, 2016 at same location of these villages of Mandvi Tehsil.

Result of November 2016

Fluoride concentration in Mandvi Tehsil ranges from 0.86 to 2.49 mg/L in ground water samples. The lowest value of November month sample is 0.86 mg/L in village Nana Aasambiya. The highest value is 2.49 mg/L of Rayan village of Mandvi Tehsil.

Result of December 2016

Fluoride concentration in December, 2016 ranges from 0.38 to 2.34 mg/L in groundwater samples. The lowest value of December, 2016 is 0.38 mg/L in Nana Aasambiya village. The highest value of this month's sample of Mandvi Tehsil is 2.34 mg/L in Tragadi village

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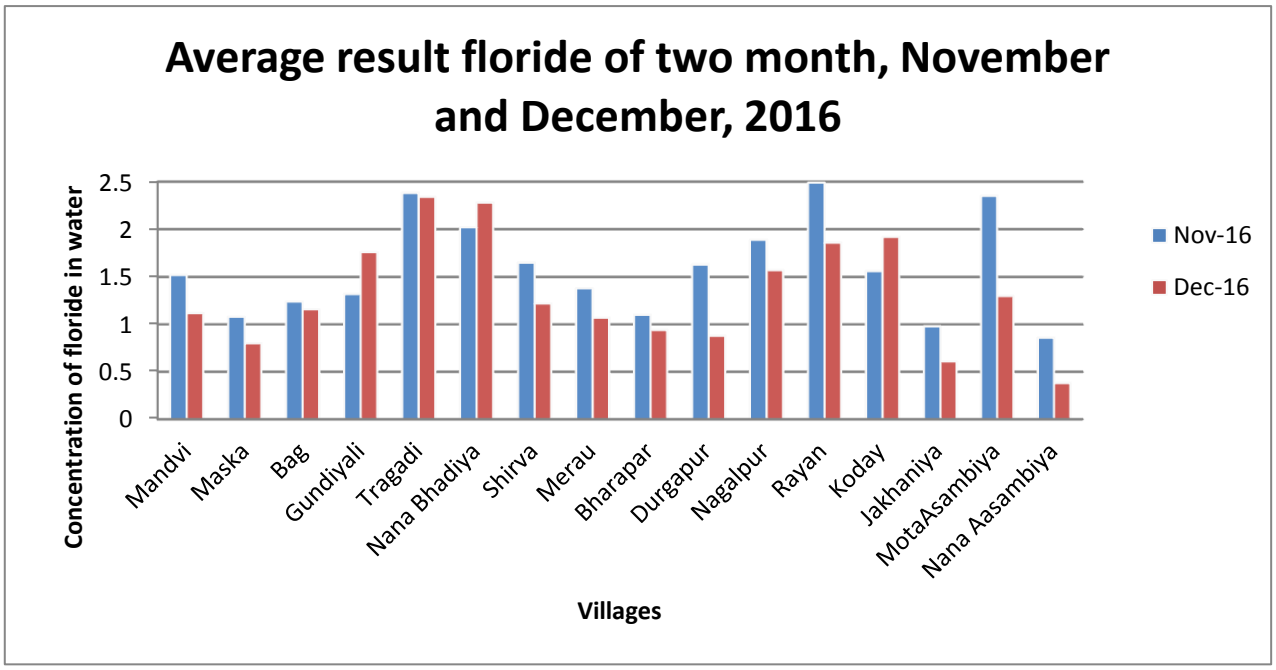

Figure 2: Image showing the variation in fluoride (mg/L) with sampling site of Mandvi Tehsil

Table: 1 Average result of two month, November and December, 2016 is given below.

Sr. No.	Sampling Site	November-2016	December-2016
1	Mandvi	1.52	1.12
2	Maska	1.08	0.80
3	Bag	1.24	1.16
4	Gundiyali	1.32	1.76
5	Tragadi	2.38	2.34
6	Nana Bhadiya	2.02	2.28
7	Shirva	1.65	1.22
8	Merau	1.38	1.07
9	Bharapar	1.10	0.94
10	Durgapur	1.63	0.88
11	Nagalpur	1.89	1.57
12	Rayan	2.49	1.86
13	Koday	1.56	1.92
14	Jakhaniya	0.98	0.61
15	Mota Asambiya	2.35	1.30
16	Nana Asambiya	0.86	0.38

Total Average result of two month, November and December, 2016 is 1.45 mg/L. The average result of November, 2016 is 1.59mg/l. The average result of December, 2016 is the 1.32 mg/l.

5. CONCLUSION:

'Water is life,' so central to human life, yet over one billion people across the world have no access to safe drinking water. Of late, there has been increasing global attention focused on resolving water quality problems especially in developing countries, as the lack of access to clean water denies the most essential of all rights, the right to life. The latest estimates suggest that around 200 million people, from among 25 nations the world over, are under the dreadful fate of fluorosis including India.

This study provides an overview of the fluoride contamination status of ground water and show that there is an acute fluoride problem in Mandvi Tehsil as only 43.75% of ground water samples have fluoride content with in the permissible limit (> 1.5 mg/L, WHO) and remaining 56.25% of villages are having very high fluoride concentrations. The favorable factor which contributes to rise of fluoride in ground water is presence of fluoride rich rock salt system. The result of current study also reveals that there is an immediate requirement of defluoridation techniques and public awareness programmes to prevent the population from fluorosis.

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